Appendix C – Technical Memoranda

12.1 Phase I and Phase II Site Investigation Plans

Eagle Mountain Pumped Storage Project:
Phase I and Phase II Site Investigation Plans

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This memorandum describes a Phase I preliminary design level subsurface site investigation program for the Eagle Mountain Pumped Storage Project (Project), which is being developed by Eagle Crest Energy Company (ECE). This program will commence in the initial stages of engineering design after the Federal Energy Regulatory Commission (FERC) license has been granted and access to all portions of the Project site has been obtained. Coupled with previous work on the site conducted for other purposes, the Phase I program will provide the information needed to finalize the location of Project features and design concepts, assess water quality and groundwater levels, and to plan investigations during a subsequent Phase II program to support final design of the Project. In addition to investigations to support design of pumped storage facilities, the Phase II program will also include field investigations and modeling to support detailed evaluation of potential seepage from the Project features (reservoirs and water conveyance tunnels). Seepage evaluations will include groundwater modeling to refine plans for seepage control, seepage recovery, and groundwater monitoring as required to avoid potential adverse impacts on the local ground water regime and water quality, the Colorado River Aqueduct (CRA), and the proposed landfill (should it be implemented). The Phase II program is typically implemented in a number of progressive steps. Geotechnical field programs during the design stage are implemented in a phased or step-wise manner with subsequent field work planned based on what is learned from the preceding field work.

Existing Data

Extensive geologic and geotechnical investigations have been carried out at the Eagle Mountain site over many decades. Initial investigations were conducted prior to, and during, operation of the iron ore mining operations. More recently, comprehensive site investigations were completed in the late 1980's and 1990's as in support of planning and preliminary design studies for the proposed landfill project. These investigations included:

- Geologic mapping
- Seismic refraction studies
- Drilling of borings to depths in excess of 1500 feet
- Borehole video logs
- Installation of monitoring wells and piezometers

- Downhole pressure testing
- Sampling and laboratory testing of rock samples collected from the major rock units present on site as well as sampling and extensive laboratory analyses of mine tailings materials
- Investigations into the age of several faults that pass through or close to the site including age dating of dikes which cross but are not offset by one or more faults

Laboratory testing of both bedrock and alluvium involved an extensive program that included:

- Grain size distribution
- Direct shear testing
- L.A. abrasion tests (to evaluate material durability)
- Specific gravity
- Triaxial shear tests
- Expansion index
- Atterberg limits
- Consolidation tests
- Swell potential
- Moisture content/dry density
- Leachate compatibility and durability
- Shrinkage limit
- X-ray diffraction
- Hydraulic conductivity
- Pinhole dispersion
- Petrographic analyses
- Maximum dry density/moisture content
- Chemical analyses

The site investigations and studies were completed between 1988 and the spring of 1993 by GeoSyntec Consultants of Huntington Beach, California, and GSi/Water of South Pasadena, California. Results of these investigations are presented in the Report on Waste Discharge, which was filed with the California Water Quality Control Board, as part of the landfill permitting process. Additional geologic information is presented in the Environmental Impact Statement for the Eagle Mountain Landfill, dated July 1991.

The existing data are adequate to support conceptual design, and to solicit contractors for construction of the water supply wells and extensometers.

Phase I Site Investigations

The data used for characterization of the site for the Eagle Mountain Pumped Storage Project's Final License Application (FLA) and Environmental Impact Report (EIR) are drawn from the previous reports, and from observations made during a reconnaissance visit to the mine during the previous 1992 to 1994 FERC licensing process. The previous investigations were not tailored specifically to gaining data that would support design of large dam, tunnel, and related structures for a hydroelectric development. However, data are available to understand the site characteristics in sufficient detail to document the feasibility of constructing the Project.

ECE will undertake Phase I site investigations to support final configuration and preliminary design of the Project. Based on available information and the current Project configuration, a limited pre-design field investigation program will be undertaken to confirm Project feature locations, assess water quality associated with future ore body contact, determine groundwater levels, and provide design parameters for the final layout of the Project features. Phase I subsurface investigations will be initiated after licensing and obtaining site access, after the initiation of the Project design phase. Field work will be completed within 6 months of the start of field investigations, and results filed with the FERC and SWRCB within 12 months after the start of field investigations.

The general scope of the Phase I program is discussed in the following paragraphs and shown, in schematic form on Figure 1.

Water Storage Reservoirs

The Project involves adapting two existing mining pits for use as water storage reservoirs. At the Upper Reservoir, the existing mine pit does not have adequate volume to provide the entire water storage needed. To create the required storage, two dams will be constructed in order to close off low areas around the mine pit rim. Both the FERC and the California Division of Safety of Dams (DSOD) will review the design of these dams and confirm that the designs meet their strict safety criteria and standards. Both agencies require geologic and foundation conditions and construction materials for the dam to be thoroughly investigated and documented. The scope of these investigations must be appropriate for the dam size and type and the complexity of the foundation. The potentials for seepage from the reservoir that could affect the design and safety of the dams will also be investigated in support of design, and construction, and operation of control measures.

Upper Reservoir Dam 1: Three borings are planned for the pre-design program; one boring at the low point on the rim and one boring at each abutment.

Upper Reservoir Dam 2: Three borings are planned; one boring at the low point on the rim and one at each abutment.

Upper Reservoir Conditions: Detailed reconnaissance and geologic mapping of the Upper Reservoir will be performed to characterize conditions that will affect the stability of existing slopes during reservoir level fluctuations. Mapping will identify the degree and orientation of jointing and fracturing, faulting, weathering, and the dimensions of the benches excavated during mining. The apparent stability of the cut slopes and benches will be assessed. Potential measures to control seepage and leakage from the reservoir will be assessed in the field, as observations of pit conditions are made. During the reconnaissance, plans for further investigations will be developed to obtain information that supports design of seepage remediation measures, as well as slope stability enhancements.

Lower Reservoir Conditions: Unlike the Upper Reservoir, the Lower Reservoir has two distinct characteristics. The west, north and south rims are primarily exposed bedrock, while the east rim exposes alluvial material (fan deposits/debris flow), which will be the primary location of seepage from the Lower Reservoir. A minimum of two borings, at approximately surface elevation 1100 are planned to explore conditions of this alluvial material where seepage controls will be installed. Each boring will have a depth of 300 feet and will be drilled vertically. Samples for laboratory testing will be obtained at pre-determined intervals and when changes in stratigraphy are apparent. In-situ permeability tests will be performed and piezometers will be installed. Total drilling will be 600 linear feet. As in the case of the Upper Reservoir, geologic mapping will be performed to identify conditions of the exposed schistose meta-arkose rock types in the mine pit. Detailed geologic mapping will be performed to characterize conditions that will affect the stability of existing slopes during reservoir level fluctuations. Mapping will identify the degree and orientation of jointing and fracturing, faulting, weathering, and the dimensions of the benches excavated during mining. The apparent stability of the cut slopes and benches will be assessed. Potential measures to control seepage and leakage from the reservoir will be assessed in the field as observations of pit conditions are made. Based upon the reconnaissance and geologic mapping, plans for subsequent investigations will be developed to obtain information required to support design of seepage remediation measures, as well as slope stability enhancements.

Hydraulic Structures

In addition to the Upper Reservoir dams, there will be two large reinforced concrete hydraulic structures associated with the Project. These are the Upper and Lower Reservoir inlet/outlet (I/O) structures. These structures will be built in excavations made at the east end of the Upper Reservoir and the northwest portion of the Lower Reservoir, as shown on Figure 1.

Upper Reservoir I/O Structure: For the pre-design exploration, one boring is planned to be advanced from the top of the slope cut at approximately elevation 2600 at a minimum of about 10 feet below the proposed structure foundation at elevation 2260. The estimated boring depth is 362 feet at an angle of 70 degrees (340 feet vertical). Rock coring methods will be used and permeability tests will be performed in addition to logging and sampling the core for testing. The purpose of the boring and testing will be to evaluate slope integrity, rock type and quality, and foundation conditions. This information may be used to evaluate the upstream tunnel portal location and to provide criteria for design of the I/O structure.

Lower Reservoir I/O: One boring is planned to be advanced from the top of the slope cut at approximately elevation 1550 at a minimum of about 10 feet below structure foundation at elevation 840. The boring depth will be 755 feet at 70 degrees (710 feet vertical). Rock coring methods will be used and permeability testing using standard methods will be performed.

Data from this boring will be used to evaluate slope integrity, rock type and quality, and foundation conditions. This information will be used to evaluate conditions at the upstream tunnel portal location and to provide criteria for design of the I/O structure.

Tunnels, Shafts and Powerhouse

The Project includes a number of large-diameter tunnels and shafts for water conveyance between the two I/O structures and for access to the proposed underground powerhouse. The water conveyance tunnel alignment is stationed from the I/O structure at the Upper Reservoir (Station 0+00) to the I/O structure at the Lower Reservoir (Station 130+00). The underground powerhouse is located at approximately Station 65+00. The access tunnel extends from the Lower Reservoir I/O to the underground powerhouse.

Water Conveyance Tunnels: The purpose of these borings will be to evaluate rock type, quality and permeability characteristics within the tunnel target elevations described above and to assess conditions for construction using a tunnel boring machine. One boring planned at Station 20+00 at approximate ground elevation 2600 will be drilled vertically to elevation 2250, a boring depth of 350 feet. Another boring will be drilled at Station 90+00 at approximate ground elevation 1800 and drilled vertically to elevation 740, a boring depth of 1060 feet. A third boring would be drilled at Station 110+00 at approximate ground elevation 1870 and drilled vertically to elevation 800, a boring depth of 1070 feet. Rock coring methods will be used at these three set-ups, with total boring length of 2480 feet. In addition to logging and sampling for rock testing, permeability testing will be performed within 1.5 tunnel diameters (approximately 50 feet) above and below the tunnel spring-line elevation.

Access Tunnel: The access tunnel will parallel the tailrace tunnel. At this time, we believe that explorations for the water conveyance tunnel between the Lower Reservoir I/O structure and the powerhouse, as well as exploration for the underground powerhouse, will be adequate to characterize the geologic conditions for design of the access tunnel.

Shaft: The current Project plan envisions a 1390-foot-deep shaft between the upper tunnel and the deeper lower tunnel section located just upstream of the powerhouse and the deeper tunnel that will form the Project tailrace. The shaft is located at approximate Station 40+00. One boring near Station 40+00 is planned to be advanced from elevation 2600 to elevation 760, a depth of 1840 feet. The shaft boring will be used to evaluate rock type, quality and permeability and to provide design parameters for the shaft.

Underground Powerhouse: One boring will be advanced from approximate ground elevation 2000 at Station 65+00 to elevation 680, a total depth of 1320 feet. Permeability testing will be performed above, at, and below the elevations defining the proposed powerhouse cavern. This boring will be used to evaluate rock type, quality and permeability and to provide design parameters for the powerhouse cavern and to help define rock treatment requirements.

Reservoir and Tunnel Seepage Potentials

Detailed mapping of rock types, faults, fractures and jointing in the two reservoirs, coupled with data obtained and interpretations made from the core drilling described above, will allow definition of the seepage potentials from the Project facilities. Data relative to primary and secondary permeabilities of the local bedrock will be collected during the Phase I program described above. Seepage estimates will then be revised and alternative lining options will be evaluated.

Reservoir-Triggered Seismicity

While the size and depth of the Project reservoirs suggest that reservoir-triggered seismicity (RTS) will not be an issue, further research is needed. This issue cannot be addressed with subsurface investigations. In preparation of the FERC Final License Application, and in response to comments received on the Draft License Application, GEI Consultants, Inc. reviewed relevant literature on RTS. Findings are presented below.

RTS is the activation of fault movement, and hence the production of earthquakes, by the impoundment or operation of a reservoir. This phenomenon is most commonly referred to in the literature as reservoir induced seismicity. However, because those crustal masses experiencing RTS were likely only marginally stable to begin with, most experts consider the term “triggering” as more accurately describing increases in seismicity associated with reservoir impoundment.

From a worldwide perspective, only a small percentage of reservoirs impounded by large dams have triggered known seismic activity. It is generally accepted that reservoir filling will not cause damaging earthquakes in areas where they would not otherwise occur. Accordingly, the maximum credible earthquake for an area is not changed by the reservoir filling, although the frequency of earthquakes may be increased, at least on a temporary basis (FEMA, 2005).

General theory suggests that reservoir impoundment alters the stress regime within the crust of the earth by increasing shear stress due to the weight of the water, and reducing the shear strength by increasing pore-water pressure. While these changes appear insufficient to generate failure in unfractured rock, it is possible that faulted rock under significant tectonic strain may be induced to slip by the compounding effects of reservoir impoundment (United States Commission on Large Dams (USCOLD), 1997). As such, zones of active faulting appear to be the most susceptible to RTS.

Studies for the landfill investigated those faults that trend towards or through the proposed landfill footprint. These include several northwest trending fault segments among which are the Bald Eagle Canyon fault, the East Pit fault, and Fault A. The East Pit Fault crosses through the East Pit, which is the proposed site for the Lower Reservoir of the Project. The Bald Eagle Canyon fault and Fault A extend through the broad area separating the proposed Upper (Central Pit) and Lower Reservoirs. Reports by GeoSyntec (1996) and their consultants indicated that surface displacement has not occurred on these faults for at least

40,000 years and probably more than 100,000 years. Some of the faults were crossed by unbroken dikes estimated to be at least 100 million years old.

GeoSyntec (1996) indicates that other northwest trending fault segments exist in the proposed landfill area, but activity on these was indeterminable due to lack of dateable features. However, they argue that the en echelon structure of the northwest trending faults indicates a common age and tectonic stress regime during their formation. Therefore, they conclude that the other northwest trending fault segments have the same general age as the Bald Canyon fault, the East Pit fault, and Fault A.

Detailed mapping of the Upper Reservoir (Central Pit) was not performed during the landfill studies. Previous mapping, provided in the landfill documentation, indicates that northwest trending fault segments, similar to those in the area of the proposed landfill, extend across the Upper Reservoir. Based on the GeoSyntec (1996) investigations for the landfill site, it could be concluded that the northwest trending fault segments crossing the Upper Reservoir have also not experienced displacement within the past 40,000 years or more. All faults in the general Eagle Mountain mining area, whether northwest trending or oriented in other directions (e.g. the Substation and Victory Pass faults), are indicated as not displaying Quaternary (last 1.6 million years) movement on the State fault map (Jennings, 1994).

The California Division of Safety of Dams (DSOD) criterion for active faults (Fraser, 2001) is displacement within the last 35,000 years. Using this criterion, the on-site faults should be designated as inactive.

The mining pits selected to contain the Upper and Lower Reservoirs were formed by the excavation of vast quantities of overburden and ore rock. The depth of excavation in the pit areas is estimated to range up to about 290 feet in the Upper Reservoir and up to about 480 feet in the Lower Reservoir. When the reservoirs are filled to maximum operation level, the deepest column of water will be about 255 feet in the Upper Reservoir and 377 feet in the Lower Reservoir. Considering that the weight of water is about 2 (overburden) to 2.5 (ore rock) times less than that of the excavated material, the loads applied by the reservoirs at high-water will be substantially less than that originally imposed on the pit surfaces prior to mining. As such, the reservoir load may tend to restore some of the equilibrium lost through the site excavations rather than imposing potentially destabilizing stresses that could lead to earthquakes.

Because of the deepness of the pit excavations, the south embankment (URD-1) will need to be a height of 120-foot to contain the maximum water depth of about 377 feet at the Upper Reservoir. (The west embankment (URD-2) will be 60 feet in height). With 5 feet of freeboard, this indicates that the maximum water thickness added to the pre-excavation level of the land surface by the impoundment of the reservoir will be about 115 feet. Water storage (active and inactive) for both reservoirs combined is estimated at about 24,200 acre-feet.

A statistical examination of 234 reservoirs (with and without RTS) was performed by Baecher and Keeney (1982) to better understand site characteristics that correlate with RTS and to develop a model for predicting RTS from these characteristics. In their analysis, five attributes of reservoirs appear to correlate with RTS: depth, volume, stress state, presence of active faulting, and rock type. These attributes were chosen based solely on the ready availability of data (either site specific or regional) with the recognition that other attributes such as water level fluctuation and pore pressure changes may also be important in RTS. The model criteria define the attributes of shallow and small as less than 302 feet in depth and less than 40 x 354 cubic feet in volume, respectively. Using this model, the proposed Upper and Lower reservoirs would be designated as shallow (assumes only the maximum depth of water above the original ground surface) and small in volume. In their study, Baecher and Keeney (1982) indicate that shallow, small reservoirs were not pursued further in their analyses since they would have a probability of RTS that is "very near zero."

Macro-seismicity within 12 miles of the proposed reservoirs is rare with only one M4.0 to M4.99 event recorded about 3 miles south of the proposed reservoirs, possibly on the east-west trending Substation Fault. In consideration of the size of the proposed reservoirs coupled with the apparent lack of active faults in and near the areas of impoundment and the rarity of local seismicity, the potential of RST at the site appears remote and should not prove a hindrance to site development. Responding to the question of whether certain geologic settings are more prone to RTS than others, USCOLD (1997) states: "Studies that have examined the geologic setting of RTS have not been able to provide any clear guidance that would justify abandonment of any reservoir site because of concerns about the seismic safety of the dam."

The ICOLD (International Commission on Large Dams, 2008) recommends that an earthquake monitoring program be initiated at reservoir sites prior, during and after impoundment. This long-term monitoring is important as it provides the only conclusive evidence as to whether or not storage impoundment triggers earthquakes. Accordingly, a seismic monitoring program will be initiated at the site prior to filling the reservoirs.

Water Quality Issues in the Reservoir Associated with Ore-Body Contact

The FERC (2009) requested ECE to provide available lab reports and supporting documentation for leachate analysis, including descriptions of the sample locations, methods and quality assurance/quality control procedures.

To determine the possible impacts to the reservoir water quality and subsequent infiltration water quality due to contact with the ore body, laboratory analytical testing was performed on five samples of the ore body material in 1993. The samples were acquired from the sample storage facilities at the Kaiser Eagle Mountain Mine, and consisted of five drill hole cores. Efforts were made to obtain a variety of rock types representative of the geologic formations present in the pits. Cores were delivered to an analytical laboratory where the samples were air dried, broken up and ground with a hammer-mill type of apparatus until approximately 95 percent passed a 10 mesh (2 mm) sieve. Sample locations are noted as East Pit on the analytical reports. No drill hole identification or footage notes are recorded. No geological descriptions of the samples or unit names are noted on the records.

Standard soil analyses procedures from the USDA Handbook 60 and the ASA Monograph No. 9 were used to prepare samples. ASTM methods for sulfur analyses were employed.

Analytical procedures were performed in water soluble leachate from saturated paste extracts and analyzed with Inductively-Coupled Plasma.

In discussions with ACZ Laboratories, the laboratory that performed the analyses in 1993, it was confirmed that no analytical records and results from the 1993 time period remain in existence. Data from the period prior to 2000 were deleted or impacted in such a manner as to render them "indefensible" by a Y2K computer problem. In addition, current laboratory policy for data retention, as recommended by the National Environmental Laboratory Accreditation Conference (NELAC), the industry accreditation body, is to retain data for 5 years. No original data reports, including quality assurance/quality control records exists. While one could reasonably speculate as to the analytical method used, in the 16 years since these samples were run, methods have been modified or supplanted by improved methods, and so we cannot report on the methods used.

If the total sulfur and neutralization potential values from the 1993 ACZ Laboratory results are used to calculate acid production potential (APP) and net neutralization potential (NNP), for the minimum and maximum total sulfur values of less than 0.01 percent (use 0.01 percent) and 0.09 percent, NNP ranges from -0.23 to 36.9 kg CaCo3/ton. Tests reported by Lapakko (1993) indicate that NNP of less than -20 kg caCO3/ton are likely to produce acid, NNP of -20 to 20 kg CaCO3/ton are ambiguous and NNP greater than 20 kg CaCO3/ton and unlikely to generate acid.

The sample with the value of 36.9 is not likely to form acid (greater than the 20 cut-off) and the other four samples are in the ambiguous category, and they would be in the upper 50th percentile (the category ranges from -20 to 20). There are no samples in the 'likely to produce' category. More importantly, since the sulfur (pyritic) content of 4 of the 5 samples is below the detection of less than 0.01, effectively the acid production potential of these samples could be considered 0. The fact that 4 of the samples are in the "ambiguous" category, is really due to the fact that there is little carbonate to form a neutralizing or buffering reaction. However, since there is essentially no acid production potential, this is a moot point.

Additionally, this calculation does not take into account other non-reactive sulfur minerals, the use of a strong acid in the test may dissolve minerals that would not otherwise react in a natural environment, and the neutralization potential may be underestimated by contribution from metal hydroxides that precipitate in the sodium hydroxide titration step of the test. The acid-base accounting test is a tool to estimate acid generation potential and neutralization potential, but it does not simulate natural conditions. More important consideration should be given to actual field observations of rock type, mineralogy, relative volumes and distribution of sulfide minerals and actual water quality measurements taken over decades at similar iron ore mines.

Therefore, based on the samples collected and tested from the Eagle Mountain cores, it is unlikely that the host rock has much, if any, acid generation capability. ECE's consultants expect that this preliminary conclusion will be confirmed by the testing program outlined later in this memorandum.

In their Additional Information Request (AIR), FERC (2009) also requested the following:

> In order to quantitatively address acid production of the former mining pits if they are exposed to frequent wetting/drying cycles, please calculate and provide the following parameters:
>
> - The maximum acid production potential (APP)
> - The maximum neutralization potential (NP)
> - The net neutralization potential (NNP)
>
> These parameters should be calculated separately for the upper and Lower Reservoirs and should reflect the mineral content of reservoir materials that would be in contact with project waters (from the bottom of the Upper Reservoir to EL 2,845 and from the bottom of the Lower Reservoir up to EL 1,092).

After access is obtained, samples will be collected from each of the mine pits. Samples will then be analyzed for sulfur to calculate acid production potential, neutralization potential will be determined by acid dissolution and back titration, and net neutralization potential will be calculated (as defined in U.S. Environmental Protection Agency (EPA) 530-R-94-036).

The Phase I site investigation will include the following field and analytical program:

1. Obtain samples from the Central Pit and East Pit across the stratigraphic section (porphyritic quartz monzonite, upper quartzite, middle quartzite, schistose meta arkose, vitreous quartzite and the ore zones). The thickness of each unit as exposed in the pit will be measured or estimated to calculate the percentage contribution of each unit to potential acid production. Each unit will be tested separately and the final results weighted by the percentage contribution of the unit. Alternatively, the units could be crushed and composited according to their percentage contribution to produce a single, composite result. Given the variability in mineral content within a unit, and the feasibility of obtaining a sulfur analysis representative of the unit, either sampling scenario is judged to be adequate.
2. Perform analysis for total, pyrite, and sulfate sulfur (ASTM Method 1915-97(2000) for total sulfur, and ASTM 1915-99 method E (2000) for sulfide sulfur
3. Calculate acid production potential (APP) by the method of Sobek et al. (1978) which uses total sulfur
4. APP (tons acidity/tons rock) = 31.25 (sulfur percent)
5. Calculate acid production
6. Determine the neutralization potential (NP) by the method of Sobek et al. (1978) which consists of hydrochloric acid dissolution under boiling conditions until the reaction stops and then back titrating with sodium hydroxide to pH 7 to determine the amount of acid consumed in sample dissolution. This method may overestimate the NP since an overly strong acid may react with minerals, which would not happen in the natural environment, and the use of boiling acid could react with iron and manganese carbonates.

7. Calculate the net neutralizing potential (NNP): NNP = NP – APP expressed as kg calcium carbonate/ton.

Current Groundwater Levels

During Phase I, groundwater levels will be measured to the nearest 0.01 feet at each of the monitoring wells shown on Figure 2.

Phase II Site Investigations

Coupled with previous work on the site conducted for other purposes, the Phase I program described above will provide the information needed to finalize the location of the Project features and basic facility design concepts and to plan investigations during the Phase II program to support final design of the Project. In addition to investigations to support design of pumped storage facilities, the Phase II program will also include field investigations and modeling to support detailed evaluation of potential seepage from the Project features (reservoirs and water conveyance tunnels). Seepage evaluations will include groundwater modeling to refine plans for seepage control, seepage recovery, and monitoring as required to avoid potential adverse impacts on the local groundwater regime and water quality, the CRA, and the proposed landfill. The Phase II program will be implemented in a number of progressive steps with subsequent field work planned based on what is learned from the preceding field work.

Investigations for Pumped Storage Facilities

Phase II field geotechnical investigations for the pumped storage facilities will be similar to those described for Phase I; however, they will be more extensive in scope and extent and will be performed at the confirmed locations of the dam and tunnel alignments, powerhouse and shafts, and the inlet/outlet locations in the reservoirs. These investigations will include additional geologic site reconnaissance and mapping; core drilling, logging, sampling and testing; test pit excavations, sampling and testing; construction materials sampling and testing; and preparation of geotechnical investigation and baseline reports. Seismicity studies for Project feature design will also be advanced. Further investigation of issues related to RTS will be undertaken if determined to be necessary based upon the Phase I work.

Investigations Related to Compatibility with Existing and Proposed Land Uses in the Project Area

Following the site reconnaissance and field investigations and geotechnical evaluations completed in Phase I, it will be possible to develop a focused program to obtain the information required to complete more detailed evaluation of seepage issues and to prepare final designs for seepage control and recovery, and for water quality monitoring. Phase II will include additional borings, logging, sampling, and testing for refinements of seepage and groundwater modeling. In addition, the additional data and refined modeling will be used to design seepage control measures, including grouting, lining, and seepage collection wells. The additional field investigations will be used to determine final engineering designs required to avoid potential conflicts with the landfill. To the extent feasible, Phase II borings will be located so that they can be used for both baseline data collection and long-term monitoring purposes.

The following investigations also will be completed in Phase II:

- Subsurface investigations at the bottom of the Upper Reservoir and Lower Reservoir will be completed to assess sub-grade permeability and to support design of seepage mitigation measures. These investigations will be integrated with pumping tests and the use of observation wells to study the complex fractured bedrock "aquifer" in the area of the existing mine.
- Using the existing subsurface information supplemented with the Phase I and Phase II field investigations, the existing groundwater model for seepage recovery of water from the Lower Reservoir will be updated to support the final design of monitoring and seepage recovery wells.
- Although not required until final dam design and construction are completed, a preliminary dam failure analysis for the Upper Reservoir will be performed based upon FERC and DSOD dam safety requirements to facilitate landfill compatibility evaluations.
- During Phase II, the currently planned seepage control measures (grouting, fine tailings blanket, and use of other lining methods) will be evaluated. The feasibility of synthetic liners will be evaluated in the Phase II investigations. Horizontal seepage detection wells will be included in this assessment.
- Reservoir slope stability will be evaluated under normal operating conditions (frequent water level fluctuations) and seismic loadings. The potential for reservoir the slope failures that could increase seepage from the reservoirs will be evaluated.

The Phase I field program will include borings that are part of the seepage and groundwater evaluations and these will become part of a 4-year groundwater monitoring and field testing program that will continue during Phase II. To the extent feasible, it is expected that most of the borings and wells completed for design and construction of the Project will become part of the long-term water quality and groundwater level monitoring plans required for the Project.

Baseline Groundwater Level and Quality Monitoring

Groundwater levels and water quality need to be monitored to establish baseline conditions with which to assess any changes that are created by the Project. At least four calendar quarters of measurements are needed to allow development of statistical-based methods to assess whether the changes are Project related. Quarterly monitoring of groundwater levels and water quality sampling will commence during Phase II investigations.

Groundwater levels will be measured to the nearest 0.01 feet at each of the monitoring wells shown on Figure 2. In some cases transducers may be installed in key wells to develop a more detailed record of groundwater level changes.

Groundwater quality samples will also be collected from each of the monitoring wells shown on Figure 2. Each well will be purged using either a disposable bailer or portable purge pump prior to collection of the samples. A minimum of three well volumes (including water contained within the filter pack) will be removed from the well prior to collection of the samples. The samples will be analyzed in the field for pH, temperature, dissolved oxygen, electrical conductivity and alkalinity. The samples will be placed directly into laboratory-prepared sample bottles that will be placed into a cooled (2 to 6 degrees centigrade) ice chest and transported under chain-of-custody to the laboratory for analyses. The samples will be analyzed for general mineral, general physical, drinking water metals, selenium, fluoride, arsenic, and boron using U.S. Environmental Protection Agency approved methods (40 CFR 136.3).

Reservoir Seepage Recovery

Detailed mapping of rock types, faults, fractures and jointing in the two reservoirs, coupled with data obtained and interpretations made from the core drilling described above, will allow clearer definition of the seepage potentials from the Project facilities. Data relative to primary and secondary permeabilities of the local bedrock will be collected during the Phase I program described above and a total estimate of seepage from each reservoir will be made. This portion of the site investigation focuses on obtaining actual permeability values to then update the seepage recovery model for the Lower Reservoir and to determine whether the joints and fractures are interconnected beneath the Upper Reservoir.

As part of engineering design for the Lower Reservoir seepage monitoring system, one boring will be drilled using the sonic drilling method (which produces continuous cores), to a depth of 420 feet below ground surface (bgs), into the alluvial deposits between the Lower Reservoir and the CRA, at the MW-5R monitoring well location. Figure 2, shows the location of the monitoring well. The cores will be logged by a geologist in accordance with the United Soil Classification System. During drilling of the boring, permeability tests will be performed using the USBR E-18 permeability test method. The boring will then be converted into a monitoring well. The well will be surrounded with a lockable security vault. The well will be developed by bailing and airlifting the water. The samples and testing from the boring will be correlated with the findings from existing monitoring well MW-1 to develop a north-south geologic profile of the sediments in which the seepage recovery wells will be located.

Using the geologic profile seepage recovery well, SRW-09 will be constructed. Figure 2 shows the location of the well. An 18-inch diameter borehole will be drilled to a depth of 500 feet bgs using the mud rotary drilling method. Upon completion of the boring the electric and gamma ray geophysical logs will be run. The cores will be logged by a geologist in accordance with the United Soil Classification System. The well will be developed by bailing, swabbing, and air-lift methods. A temporary pump will then be installed.

Upon completion of the monitoring and seepage recovery wells MW-5R and SRW-09 an 8-hour step-drawdown test and a 72-hour constant rate aquifer test will be performed. Observation wells MW-1, MW-2, MW-5, MW-5R, MW-4, P-1 and the Kaiser MW will be used to monitor the pumping effects. Prior to the testing, background water level measurements will be obtained. Both drawdown and recovery data will be acquired. The results of the testing will then be used to re-calibrate the groundwater model to assess the spacing between seepage recovery wells needed to recover an equal volume of water as is predicted to seep from the Lower Reservoir. Typical seepage recovery well designs will be prepared. Additional wells or modifications of the well locations may be proposed as needed depending on the results of the testing program.

The interconnectedness of the joints and fractures beneath the Upper Reservoir will be assessed by drilling a 700-foot-deep seepage recovery well at SRW-06 using the air-rotary drilling method. Figure 2 shows the well location. The location may be adjusted based on field surveys so that saturated joint and fracture patterns are encountered within the boring. Upon completion of the borehole an oriented video survey will be performed to assess the orientation of the major joint and fracture patterns and to determine where open joint and fracture patterns are present. The well will be developed using airlift methods followed by placement of a temporary pump.

Following completion of the seepage recovery well SRW-06 an 8-hour step-drawdown test and a 72-hour constant rate aquifer test will be performed. Observation wells MW-7, MW-11, and MW-10, will be used to monitor the pumping effects. Prior to the testing, background water level measurements will be obtained. Both drawdown and recovery data will be acquired. Drawdown and recovery measurements will be plotted to evaluate whether the joint and fracture patterns are interconnected.

The results of the drilling, testing, modeling and recommendations will be documented in a technical memorandum which will be submitted to the SWRCB and FERC.

Hydrocompaction and Subsidence Potentials

As documented in the EIR, groundwater levels due to Project pumping are not expected to be lowered below historic water levels near Desert Center, and therefore no hydrocompaction or subsidence is expected. Subsidence related to groundwater extraction is typically caused by dewatering of thick clays by pumping of confined aquifers. These are not the geologic conditions beneath the CRA or in the upper Chuckwalla Valley. Because groundwater levels have been lowered over multiple years, inelastic subsidence, to the extent it would occur, should have already occurred. The assessment of potential cumulative effects suggests that groundwater levels in the upper Chuckwalla Basin within the alluvial sediments east of the proposed reservoirs, at the eastern edge of the Orocopia groundwater basin, and the mouth of the Pinto Basin, will be lowered slightly, 1 to 7 feet below historic water levels. The potential for subsidence will also be assessed during logging of the water supply wells to confirm that there are no thick clay layers near the wells. Aquifer testing of the supply wells will also be performed once the wells are constructed to confirm that aquifers are unconfined. However, prior to construction and use of the protect water supply wells, two extensometers will be constructed and monitored. Their locations are shown on Figures 2 and 3.

There is a low potential for hydrocompaction of the soils because the debris flows/fan deposits were deposited with water. However, to fully evaluate this potential, soil samples collected during the site investigation of the water storage reservoirs, Lower Reservoir conditions will be analyzed for hydrocompaction potential using the laboratory consolidometer, ASTM D2435 / D2435M - 11 (Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading), or another approved method. Up to 6 soil samples, at approximately 50-foot intervals will be analyzed.

Eagle Creek Channel Surveys

Surveys of the Eagle Creek channel will be performed during the Phase 2 site investigations to assess hydraulic performance relative to dam outlet works releases or spills from the Upper Reservoir. Flood and drainage studies completed for the FLA and EIR will be updated based on the field surveys of the Eagle Creek channel to confirm that Project operations and Upper Reservoir releases will not impact the proposed landfill under the design flood event governing landfill design.

Brine Pond Basis of Design

Borings at the brine ponds will be at selected locations to evaluate the soil properties that will be used in the engineering design of the ponds. The results of the testing of samples taken from the borings will be documented in a technical memorandum. The number and location of the borings will be determined based on a geotechnical reconnaissance of the site; however, we expect that at 5 to10 relatively shallow borings may be required for preliminary design of the ponds, with additional borings to support final design based on results of the initial field investigations at the brine pond location.

References

ASTM. 2000. Annual Book of ASTM Standards, 11.04. American Society for Testing and Materials, West Conschohokcken, PA.

Baecher, Gregory B. and Keeney, Ralph L. 1982. Statistical Examination of RIS in Bulletin of the Seismological Society of America. Volume 72, Number 2.

Federal Emergency Management Agency (FEMA). 2005. Federal Guidelines for Dam Safety – Earthquake Analyses and Design of Dams.

Federal Energy Regulation Commission (FERC). 2009. Deficiency of License Application and Additional Information Request. Dated July 29, 2009.

Fraser, William A. 2001. California Division of Safety of Dams Fault Activity Guidelines.

GeoSyntec Consultants.1996.Seismic Information Summary Report: Eagle Mountain Landfill and Recycling Center, Riverside County, California. Mine Reclamation Corporation, Palm Springs, California.

International Commission on Large Dams (ICOLD). 2008. Reservoirs and Seismicity: State of Knowledge. Bulletin 137.

Jennings, Charles W. 1994. Fault Activity map of California and adjacent Areas. California Geologic Data Map Series Map No. 6. California Division of Mines and Geology (now California Geological Survey).

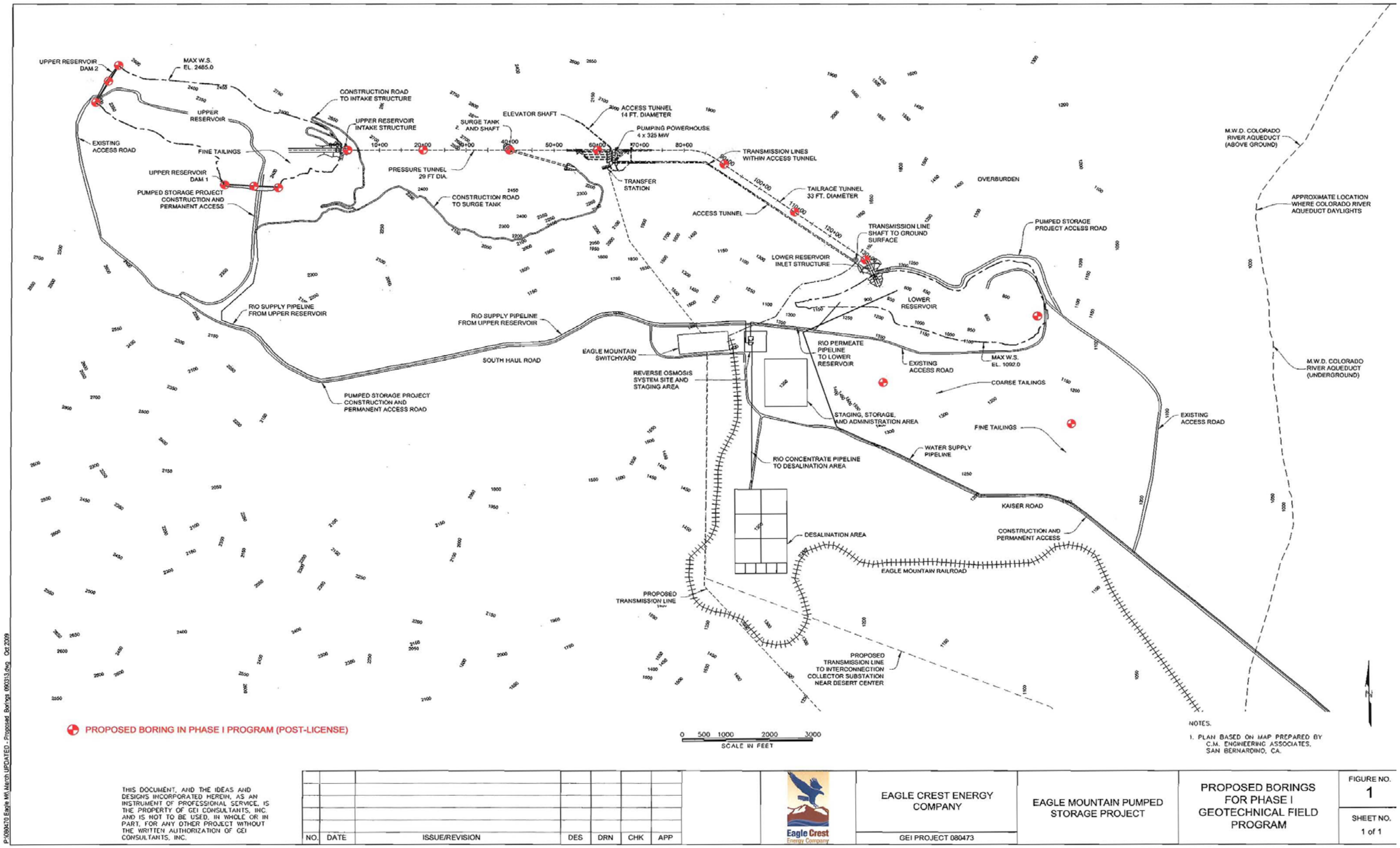
Lapakko, K. 1993. Mine Waste Drainage Quality Prediction: A Literature Review. Draft. Minnesota Department of Natural resources, Division of Minerals, St. Paul, MN.

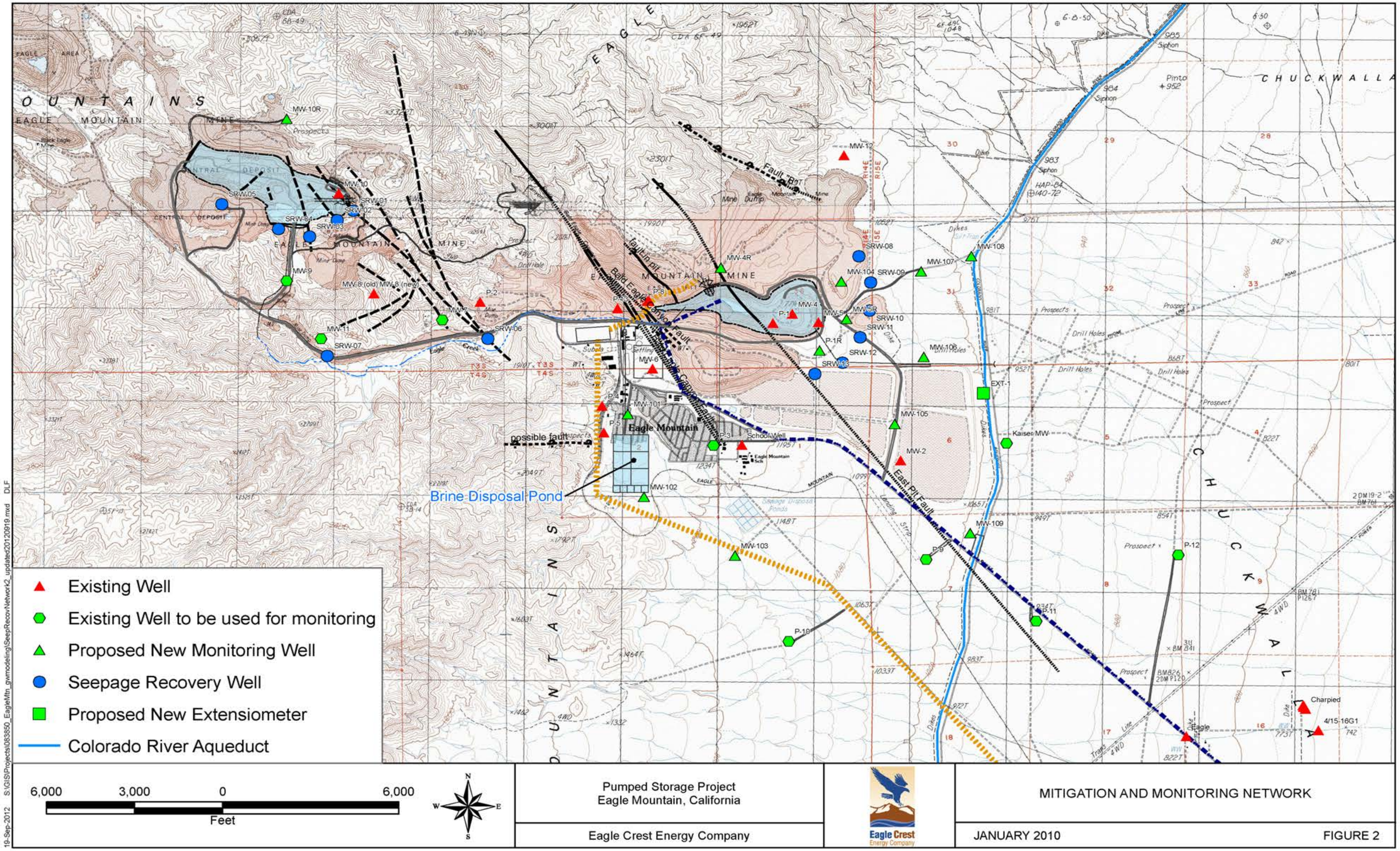
Sobek, A.A., Schuller, W.A., Freeman, J.R., Smith, R.M. 1978. Field and Laboratory Methods Applicable to Overburden and Mine Soils. EPA 600/2-78-054.

The PRA Group, Inc. 1991. Eagle Mountain Landfill, Riverside County, California - Geologic Map (Figure 6). Mine Reclamation Corporation. Map dated 9/16/91.

U.S. Committee on Large Dams (USCOLD). 1997. Reservoir Triggered Seismicity.

U.S. Environmental Protection Agency (EPA). 1994. Technical Document, Acid Mine Drainage Prediction. EPA530-R-94-036. 48 p.


UPPER RESERVOIR DAM 2
MAX W.S. EL. 2485.0
CONSTRUCTION ROAD TO INTAKE STRUCTURE
UPPER RESERVOIR
UPPER RESERVOIR INTAKE STRUCTURE
SURGE TANK AND SHAFT
ELEVATOR SHAFT
ACCESS TUNNEL 14 FT. DIAMETER
PUMPING POWERHOUSE 4 x 325 MW
EXISTING ACCESS ROAD
FINE TAILINGS
PRESSURE TUNNEL 29 FT DIA.
UPPER RESERVOIR DAM 1
PUMPED STORAGE PROJECT CONSTRUCTION AND PERMANENT ACCESS
CONSTRUCTION ROAD TO SURGE TANK
TRANSFER STATION
TRANSMISSION LINES WITHIN ACCESS TUNNEL
TAILRACE TUNNEL 33 FT. DIAMETER
ACCESS TUNNEL
OVERBURDEN
TRANSMISSION LINE SHAFT TO GROUND SURFACE
LOWER RESERVOIR INLET STRUCTURE
PUMPED STORAGE PROJECT ACCESS ROAD
M.W.D. COLORADO RIVER AQUEDUCT (ABOVE GROUND)
APPROXIMATE LOCATION WHERE COLORADO RIVER AQUEDUCT DAYLIGHTS
RIO SUPPLY PIPELINE FROM UPPER RESERVOIR
RIO SUPPLY PIPELINE FROM UPPER RESERVOIR
LOWER RESERVOIR
SOUTH HAUL ROAD
EAGLE MOUNTAIN SWITCHYARD
RIO PERMEATE PIPELINE TO LOWER RESERVOIR
EXISTING ACCESS ROAD
MAX W.S. EL. 1092.0
M.W.D. COLORADO RIVER AQUEDUCT (UNDERGROUND)
REVERSE OSMOSIS SYSTEM SITE AND STAGING AREA
COARSE TAILINGS
PUMPED STORAGE PROJECT CONSTRUCTION AND PERMANENT ACCESS ROAD
STAGING, STORAGE, AND ADMINISTRATION AREA
FINE TAILINGS
EXISTING ACCESS ROAD
WATER SUPPLY PIPELINE
RIO CONCENTRATE PIPELINE TO DESALINATION AREA
KAISER ROAD
CONSTRUCTION AND PERMANENT ACCESS
DESALINATION AREA
EAGLE MOUNTAIN RAILROAD
PROPOSED TRANSMISSION LINE
PROPOSED TRANSMISSION LINE TO INTERCONNECTION COLLECTOR SUBSTATION NEAR DESERT CENTER
PROPOSED BORING IN PHASE I PROGRAM (POST-LICENSE)
0 500 1000 2000 3000
SCALE IN FEET
NOTES:
1. PLAN BASED ON MAP PREPARED BY C.M. ENGINEERING ASSOCIATES, SAN BERNARDINO, CA.
THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF GEI CONSULTANTS, INC. AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF GEI CONSULTANTS, INC.
NO. DATE ISSUE/REVISION DES DRN CHK APP
Eagle Crest Energy Company
EAGLE CREST ENERGY COMPANY
GEI PROJECT 080473
EAGLE MOUNTAIN PUMPED STORAGE PROJECT
PROPOSED BORINGS FOR PHASE I GEOTECHNICAL FIELD PROGRAM
FIGURE NO. 1
SHEET NO. 1 of 1



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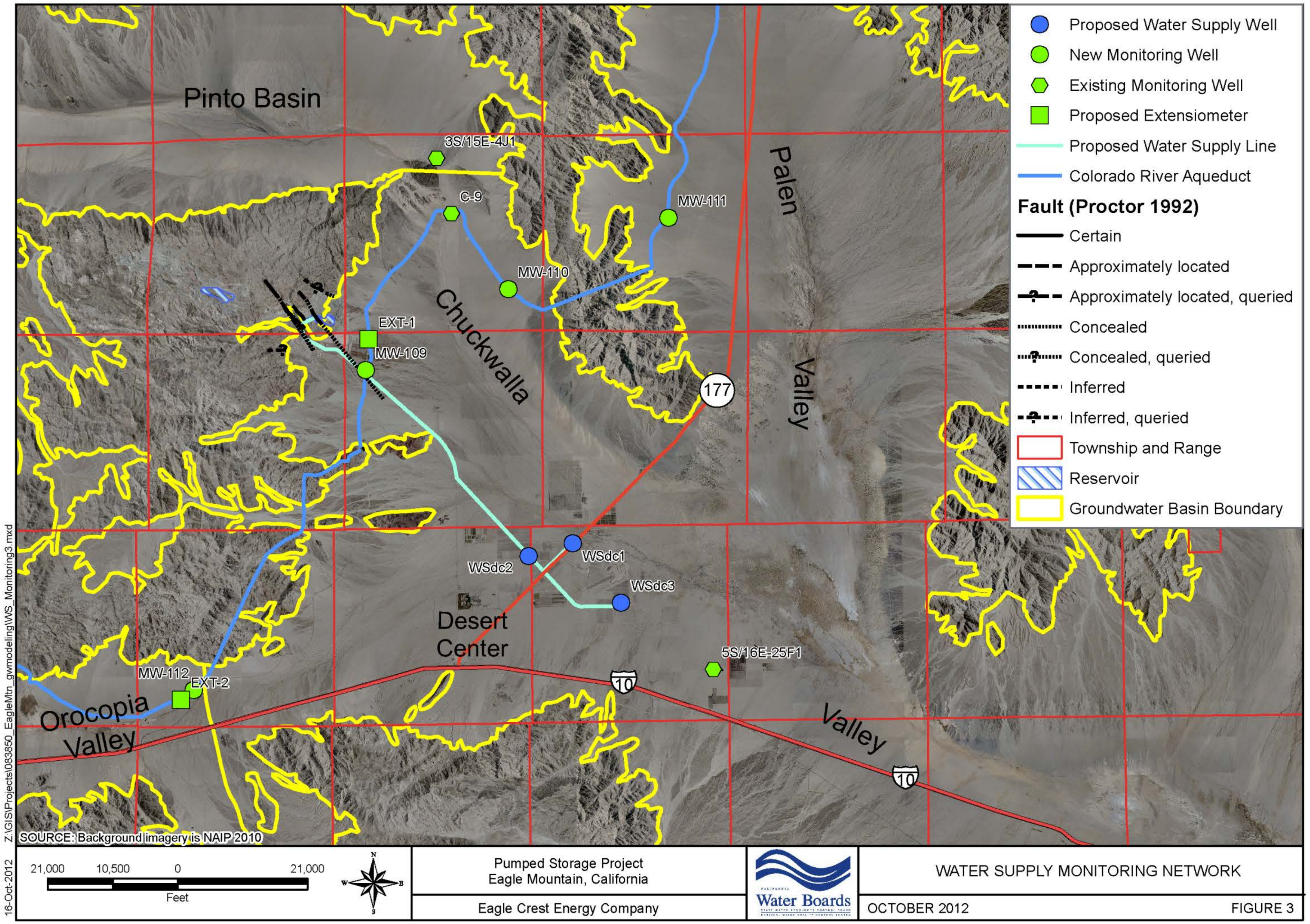
Pinto Basin
3S/15E-4J1
C-9
MW-111
MW-110
EXT-1
MW-109
Chuckwalla
Palen
Valley
177
WSdc1
WSdc2
WSdc3
Desert Center
5S/16E-25F1
10
MW-112
EXT-2
Orocopia Valley
Valley
SOURCE: Background imagery is NAIP 2010
Proposed Water Supply Well
New Monitoring Well
Existing Monitoring Well
Proposed Extensiometer
Proposed Water Supply Line
Colorado River Aqueduct
Fault (Proctor 1992)
Certain
Approximately located
Approximately located, queried
Concealed
Concealed, queried
Inferred
Inferred, queried
Township and Range
Reservoir
Groundwater Basin Boundary
21,000 10,500 0 21,000
Feet
Pumped Storage Project
Eagle Mountain, California
Eagle Crest Energy Company
Water Boards
WATER SUPPLY MONITORING NETWORK
OCTOBER 2012
FIGURE 3
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16-Oct-2012

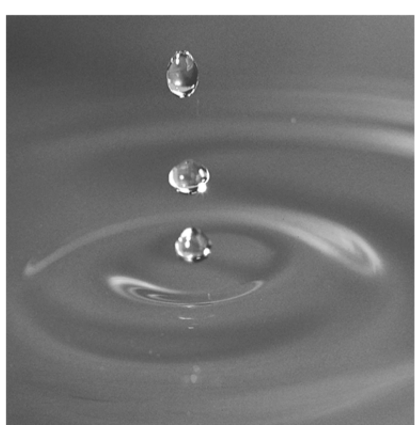
Geotechnical
Environmental and
Water Resources
Engineering

Erosion and Sedimentation Control Plan

Eagle Mountain Pumped Storage Project
Riverside County, California

Submitted to:
Eagle Crest Energy Company
3000 Ocean Park Blvd.
Suite 1020
Santa Monica, CA 90405

Submitted by:
GEI Consultants, Inc.
10860 Gold Center Drive, Suite 350
Rancho Cordova, CA 95670
May 2009, revised January 2012
Project 080474



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1.0 Project Description

The Eagle Crest Energy Company proposes to develop the 1,300 MW Eagle Mountain Pumped Storage Project near the Town of Eagle Mountain in Riverside County, California. The proposed project is a hydroelectric pumped storage project that will provide peak generation capacity and transmission system regulating benefits to the southern California electricity grid. The Project will use off-peak energy to pump water from the lower reservoir to the upper reservoir during night and weekend hours and generate valuable peak energy by passing the water from the upper to the lower reservoir through the generating units during periods of high electrical demand. Power will be supplied to and delivered from the Project by a double circuit 500kV transmission line. The line will extend approximately 13.5 miles from the Project switchyard to a new interconnection switchyard proposed near Desert Center, California. The reservoirs will be constructed in two out-of-use mining pits. Tunnels will be constructed to carry water between the pits, and an underground powerhouse, equipped with reversible pump turbines will be used to generate electricity. Water to initially fill the reservoirs and provide annual make-up water will be pumped from three groundwater wells within the Chuckwalla Valley. The water supply pipeline will extend approximately 15 miles from the wells to the lower reservoir.

The construction project vicinity map (Figure 1) and erosion control plan (Figures 2 and 3) show the project location, project boundaries, geographic features, erosion control measures, Colorado River Aqueduct, construction site perimeter, major roadways, the town of Eagle Mountain, and the Eagle Mountain Railroad.

Significant components of the Eagle Mountain Pumped Storage Project are summarized in Table 1. These features include the upper dams and reservoir, lower reservoir, inlet/outlet structures, water conveyance tunnels, vertical shaft, surge control facilities, underground powerhouse, access and cable tunnels, switchyard, spillways, discharge channels, water supply pipeline, power transmission lines, water treatment facility and brine disposal ponds, a groundwater monitoring system, groundwater recovery well system, and water supply facilities.

Table 1. Significant Project Components for Eagle Mountain Pumped-Storage Project

Project Feature	Feature Data
Hydroelectric Plant	
Total Rated Capacity	1,300 MW
Number of Units	4 (Reversible)
Unit Rated Capacity	325 MW
Maximum Plant Discharge	11,600 cfs
Pump/Turbine and Motor/Generator Unit Data	
Rated Head	1410 ft
Rated Turbine Output	319 MW
Maximum Turbine Flow	2,900 cfs
Operating Speed	333.3 rpm
Generator Rating	347 MVA
Low Pressure Upper Tunnel	
Diameter	29 ft
Length	4,000 ft
Shaft	
Diameter	29 ft
Length	1,390 ft
High Pressure Lower Tunnel	
Diameter	29 ft
Length	1560 ft
Tailrace Tunnel	
Diameter	33 ft
Length	6,835 ft
Powerhouse Cavern	
Height	130 ft
Length	360 ft
Width	72 ft
Upper Reservoir	
Dam Type	Roller-compacted
Volumes	
Total Reservoir Capacity	20,000 ac-ft
Inactive Storage	2,300 ac-ft
Active Storage	17,700 ac-ft
Operating Levels	
Minimum Operating Level	El. 2343
Maximum Operating Level	El. 2485
Water Surface Areas	
Water Surface Area at El. 2,343 feet	48 acres
Water Surface Area at El. 2,485 feet	191 acres
Dimensions of Dams (West and South Saddle Dams)	

Structural Heights	60 ft and 120 ft
Top Widths	20 ft (both dams)
Crest Lengths	1100 to 1300 ft
Crest Elevation	El. 2490
Spillway, ogee crest elevation	El. 2486
Spillway Width	100 ft
Spillway Channel Length	4,230 ft
Spillway Channel Elevations	El. 2380 - 2200
Lower Reservoir	
Dam Type	None
Volumes	
Total Reservoir Capacity	21,900 ac-ft
Inactive Storage	4,200 ac-ft
Active Storage	17,700 ac-ft
Operating Levels	
Minimum Operating Level	El. 925
Maximum Operating Level	El. 1092
Water Surface Areas	
Water Surface Area at El. 925 feet	63 acres
Water Surface Area at El. 1,092 feet	163 acres
Spillway Ogee Crest elevation	El. 1094
Spillway width	15 ft
Water Treatment Facilities	
Treatment Type	Reverse osmosis
Volume treated	2055 gpm
Target water quality (Total dissolved solids)	~660 ppm
Brine ponds	56 acres
Brine quantity (annual)	270 ac-ft
Frequency of salt removal from ponds for disposal	Every 10 years
Water Supply Wells	3
Pumps	2,000 gpm 1,000 HP
Monitoring Wells	15
Seepage Recovery Wells	13
Extensiometers	2
Roads (new, all within project site)	4
To West Saddle Dam, from existing access road	0.32 mi.
Elevator access road	0.36 mi
On north side of lower reservoir, to lower reservoir inlet	0.96 mi
To South Saddle Dam, from existing access road	0.78 mi

2.0 Existing Site Conditions

The primary project site (reservoirs, reverse osmosis water treatment plant, switchyard, and underlying tunnels and powerhouse) is located in the northeast portion of the Eagle Mountains. The site was formerly used for open pit mining (Photo 1), and extensive fine and coarse mine tailings are deposited near and around the project site.

The only surface water occurring at the site is that associated with storm events. The main surface drainage feature at the project site is Eagle Creek, which is an ephemeral stream that is generally dry throughout the year, except during large storm events, which occur infrequently in this area of California. Eagle Creek is located on the southern edge of the pumped storage project site, within the proposed Project boundary (Photo 2). Currently Eagle Creek is diverted in two locations by embankments in the main channel that direct flood flows into the existing East Pit of the mine (Lower Reservoir). These embankments are engineering works that were completed many years ago during active mining operations to provide flood protection at the Eagle Mountain town site. In addition, the mining pits (proposed reservoir sites) receive incidental runoff and sheet flow from surrounding slopes in a limited watershed area within the historically mined lands. Both the upper and lower reservoirs are located in closed basins, with minimal drainage areas.

Bald Eagle Canyon is a dry canyon which drains the mountains to the northwest of the East Pit. There are numerous dry desert washes south of the primary project site, which cross the water supply pipeline and transmission pipeline routes. When construction activities are present in the ephemeral stream channels and dry desert wash areas, erosion control methods will be used as outlined in Section 5.0.

Photo 1. Eagle Mountain Pumped Storage Project area, showing proposed location of the upper reservoir, looking towards the northeast. The lower reservoir site is shown in the far right of the photo.

Photo 2. View towards the south, Eagle Mountain Pumped Storage Project area. Eagle Creek channel is visible in upper right of photo.

3.0 Overview

This plan conceptually describes the erosion control practices and sediment control practices planned for implementation during construction of the Eagle Mountain Pumped Storage Project. Site erosion and sedimentation control measures are intended to minimize the erosion of soils in construction areas and prevent the transport of sediment into storm water discharges away from the construction site.

4.0 Erosion Control Areas

The key features of the Eagle Mountain Project are shown in Attachment A, including:

Figure 3 – Erosion and Sedimentation Control Plan – Pumped Storage Facilities

Figure 4 – Erosion and Sedimentation Control Plan – Transmission Line and Water Supply Pipeline

Figure 5 – Erosion and Sedimentation Control Plan – Cross Section.

The limits of the areas to be cleared for project construction are illustrated on Figures 2 and 3. Based on this clearing plan, the following three main types of areas have been defined for erosion and sedimentation control measures, based on their similar characteristics and implementation of anticipated impacts:

Area Type 1 – Area Type 1 represents the area of greatest potential impact. This will include cleared and graded areas for minor cuts and fills (permanent roads, power cable conduit trench, interconnection switchyard at Desert Center, and transmission tower pads) and will have permanent structures, including roads, dams, piping, and tunnels remaining on site after construction activities are finished.

Area Type 2 - Area Type 2 represents medium potential impacts. This will include cleared and graded areas containing temporary soil stockpiles, equipment staging/laydown areas, temporary access roads, water supply pipeline route, and construction trailer/field office areas; and

Area Type 3 – Area Type 3 represents the lowest potential impacts. This will include areas near the upper and lower reservoir used for temporary stockpiling and general low impact use activities.

These area types are described in more detail in Sections 4.1 through 4.3. Recommended erosion and sediment control measures for each area type are listed in Section 5, and more detailed descriptions are included in Attachment B, *Examples of Best Management Practices for the Eagle Mountain Pumped Storage Project.* Erosion control requirements will be specified in the Water Quality Certification, which will be prepared by the State Water Resources Control Board when the Project has completed CEQA and is determined to comply with all pertinent State and Federal regulations.

4.1 Area Type 1

This area type encompasses construction where project facilities, such as offices, permanent access roads and above ground structures will remain after construction has finished. Most of these areas were impacted during previous mining activities on the site. Area Type 1 locations include:

- The staging, storage and administrative area, where a permanent office will remain after construction activities have finished.
- The work around permanent access roads;
- The area near the project site switchyard and east along the access road;
- Road cuts and embankments;
- Transmission tower pads along the power transmission line extending aboveground from the project site switchyard approximately 13.5 miles south to the interconnection switchyard at Desert Center;
- Water treatment (R/O) plant and brine pond area;
- Lower reservoir inlet structure area;
- Upper reservoir intake structure; and
- West and south saddle dams on upper reservoir.
- Upper and lower reservoir spillways and discharge channels.
- Eagle Creek channel improvements.

Material from the tunnel excavation will be used during construction of the proposed Project to the extent feasible. Tunnel material can be used for backfill, road base, rough grading, flood berms, and possibly for roller compacted concrete in the dams. Any material in excess of what is used in construction will be placed in the reservoirs or spoiled in areas from which fine tailings were removed. The upper reservoir will have 2,300 AF of inactive storage, the lower reservoir will have 4,300 AF of inactive storage. The estimated quantity of material to be excavated is estimated in Table 2), with.

Table 2. Material to be excavated during construction of the Eagle Mountain Pumped Storage Project.

Feature	Quantity of material (in-place volume)
Tunnel excavations	735,800 CY
Underground caverns	132,100 CY
Excavations and benching for intakes	673,000 CY
Total (including additional 15% volume for air voids)	1,772,000 CY (approximately 1,100 AF)
Total if compacted	1,541,000 CY (approximately 955 AF).

4.2 Area Type 2

Area Type 2 includes areas that will be cleared and graded (minor cuts and fills) to accommodate construction operations and access. These temporary use areas would be initially cleared of vegetation and would be re-vegetated after construction. Erosion control measures to protect washes will be used as outlined in Section 5.0. The following areas have been identified as Area Type 2:

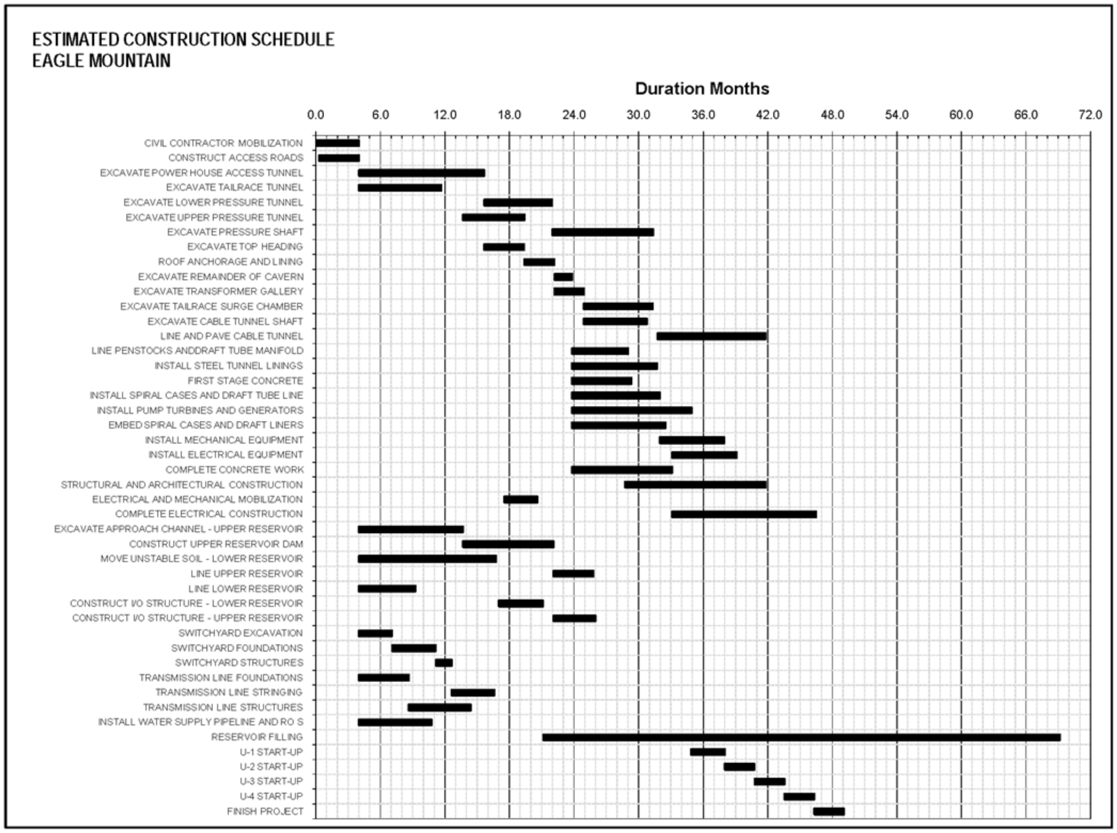
- The area around the surge tank and shaft and above the powerhouse;
- The area where the transmission line daylights from the tunnel portal and along the overhead transmission line alignment to the switchyard;
- Water supply pipeline extending from wells in the Chuckwalla Valley approximately 15 miles northwest to the lower reservoir;
- The area around the R/O supply pipeline from the upper reservoir to the R/O system site and staging area;
- The area around the R/O concentrate pipeline to the desalination area;
- Any areas that contain washes, dry streams, or channels that intersect with proposed alignments and construction activities;
- The areas adjacent to access and construction roads.

4.3 Area Type 3

Area Type 3 includes locations for the upper and lower reservoir used for temporary stockpiling of construction materials. The following areas have been identified as Area Type 3:

- A portion of the upper reservoir area as indicated on Figure 3 in Attachment A.
- A portion of the lower reservoir area as indicated on Figure 3 in Attachment A.
- Construction areas for monitoring and seepage recovery wells

Construction practices, and the proposed schedule for construction are displayed below. Construction practices for permanent features of the project are Type 1, construction in temporary use areas are Type 2.



ESTIMATED CONSTRUCTION SCHEDULE
EAGLE MOUNTAIN
Duration Months
0.0
6.0
12.0
18.0
24.0
30.0
36.0
42.0
48.0
54.0
60.0
66.0
72.0
CIVIL CONTRACTOR MOBILIZATION
CONSTRUCT ACCESS ROADS
EXCAVATE POWER HOUSE ACCESS TUNNEL
EXCAVATE TAILRACE TUNNEL
EXCAVATE LOWER PRESSURE TUNNEL
EXCAVATE UPPER PRESSURE TUNNEL
EXCAVATE PRESSURE SHAFT
EXCAVATE TOP HEADING
ROOF ANCHORAGE AND LINING
EXCAVATE REMAINDER OF CAVERN
EXCAVATE TRANSFORMER GALLERY
EXCAVATE TAILRACE SURGE CHAMBER
EXCAVATE CABLE TUNNEL SHAFT
LINE AND PAVE CABLE TUNNEL
LINE PENSTOCKS ANDDRAFT TUBE MANIFOLD
INSTALL STEEL TUNNEL LININGS
FIRST STAGE CONCRETE
INSTALL SPIRAL CASES AND DRAFT TUBE LINE
INSTALL PUMP TURBINES AND GENERATORS
EMBED SPIRAL CASES AND DRAFT LINERS
INSTALL MECHANICAL EQUIPMENT
INSTALL ELECTRICAL EQUIPMENT
COMPLETE CONCRETE WORK
STRUCTURAL AND ARCHITECTURAL CONSTRUCTION
ELECTRICAL AND MECHANICAL MOBILIZATION
COMPLETE ELECTRICAL CONSTRUCTION
EXCAVATE APPROACH CHANNEL - UPPER RESERVOIR
CONSTRUCT UPPER RESERVOIR DAM
MOVE UNSTABLE SOIL - LOWER RESERVOIR
LINE UPPER RESERVOIR
LINE LOWER RESERVOIR
CONSTRUCT I/O STRUCTURE - LOWER RESERVOIR
CONSTRUCT I/O STRUCTURE - UPPER RESERVOIR
SWITCHYARD EXCAVATION
SWITCHYARD FOUNDATIONS
SWITCHYARD STRUCTURES
TRANSMISSION LINE FOUNDATIONS
TRANSMISSION LINE STRINGING
TRANSMISSION LINE STRUCTURES
INSTALL WATER SUPPLY PIPELINE AND RO S
RESERVOIR FILLING
U-1 START-UP
U-2 START-UP
U-3 START-UP
U-4 START-UP
FINISH PROJECT

5.0 Erosion and Sediment Control Measures

Best management practices (BMPs) will be used to stabilize soil and prevent erosion or to retain sediment before it can travel into surface drainages. Table 2 presents examples of BMPs that would be used for the various erosion control areas, and the intended purpose of each BMP.

Soil stabilization – also referred to as erosion control – consists of source control measures that are designed to prevent soil particles from detaching and becoming suspended in storm water runoff. Soil stabilization BMPs protect the surface by covering/or binding soil particles. Construction operations for the Eagle Mountain Project will follow stringent dust control guidelines. The guidelines are contributory to soil stabilization for erosion control and will be defined in the protection, mitigation, and enhancement measures developed for air quality in the Applicant Prepared Environmental Impact Statement. Project construction will utilize and implement the following principles for effective temporary and final soil stabilization during construction:

- Preserving existing vegetation where required and when feasible to prevent or minimize erosion. Once existing vegetation is cleared, construction will follow immediately behind to reduce unnecessary exposure of scarified soil to wind and water.

- Sloping roadways and excavations away from washes will prevent or minimize erosion into washes. Where haul roads cross surface washes, the ground will be cleared of loose soil and pre-existing sediments, as necessary.

- The installation of riprap at the washes which will prevent or minimize erosion.

- Small earthen embankments will be built within washes in order to slow or divert surface water to reduce erosion.

- Silt fences will be installed when working around a wash Silt fences will prevent sediment from entering into a wash during a rain storm. They will be constructed as described in Attachment B, including being buried to a depth of at least 12”.

- The construction contractor will be required to preserve and protect existing vegetation not required, or otherwise authorized, to be removed. Vegetation will be protected from damage or injury caused by construction operations, personnel, or equipment by the use of temporary fencing, protective barriers, or other similar methods.

- Water will be applied to disturbed soil areas of the project site to control wind erosion and dust. Water applications will be monitored to prevent excessive runoff.

Sediment controls are structural measures that are intended to complement and enhance the soil stabilization (erosion control) measures. Sediment controls are designed to intercept and filter out soil particles that have been detached and transported by the force of water.

Temporary sediment control BMPs are implemented to prevent a net increase of sediment in storm water discharge relative to pre-construction levels. Permanent erosion control measures are intended to prevent an net increase in sediment as a result of the existence of the project. The following temporary and permanent sediment control BMPs may be used on this project:

Table 2: Erosion and Sediment Control Measures (BMPs)

Area	BMP	Intended Purpose	Specific Measures*
Areas 1 and 2	Silt Fence and Straw Bale Barriers	Sediment control in active construction areas.	EC-6, SE-1, SE-9,
	Fiber Rolls Across Disturbed Slopes	Temporary slope stabilization/sediment control.	EC-7, SE-5
	Mulch and Tackifier	Temporary slope stabilization (soil stockpiles) – use certified weed-free straw or approved alternatives.	EC-3
	Hydroseeding (with or without mulch and tackifier)	Temporary and permanent stabilization (re-vegetated slopes and flat areas).	EC-4
	Maximum slope inclinations on soil stockpiles (3 horizontal to 1 vertical)	Temporary slope stabilization.	SE-9, SE-5
	Stabilized Construction Entrance	Reduce tracking of sediment off-site from staging areas.	TC-1
	Construction Road Stabilization/Paving	Stabilize graded areas used for transportation.	TC-2, WE-1
	Temporary Drainage Control (Run-off control, Culverts, and Swales)	Intercept storm water runoff and divert it to a stable outlet or sediment trapping device before leaving the construction site. Divert runoff around disturbed areas.	SE-2, SE-3, EC-9
	Control of Excavated Tailings	Temporary slope stabilization/sediment control, sediment trapping	EC-7, SE-5, SE-2, SE-3
	Tunnel cuttings and drilling fluids	Recycle into seepage control, dam construction, road berms, or other construction features	WM-3
	Stormwater Drainage Control	Route stormwater into reservoir. *See* Project Drainage Plan Section 12.9.	EC-9

Area	BMP	Intended Purpose	Specific Measures*
Area 3	Silt Fence and Straw Bale Barriers	Sediment control in active construction areas.	EC-6, SE-1, SE-9,
	Fiber Rolls Across Disturbed Slopes	Temporary slope stabilization/ sediment control.	EC-7, SE-5
	Soil Stabilization Blanket (Erosion Control Matting)	Temporary slope stabilization.	EC-7, SE-5
	Hydroseeding (with or without mulch and tackifier)	Temporary and permanent stabilization (re-vegetated slopes).	EC-4
	Temporary Drainage Control (Run-off control, Culverts, and Swales)	Intercept storm water runoff and divert it to a stable outlet or sediment trapping device before leaving the construction site. Prevent runoff from entering a disturbed area.	SE-2, SE-3, EC-9
	Restoration of vegetation	Preserving existing vegetation, restore disturbed vegetation	EC-2

*Best Management Practices including, but not limited to, these specific measures which are detailed in Attachment B

Permanent erosion control measures will be maintained for the life of the project.

6.0 Storm Water Pollution Prevention Plan

Prior to construction, a Storm Water Pollution Prevention Plan (SWPPP) will be prepared detailing the BMPs that will be implemented at the site. The Technical Memoradum in Section 12.9 describes the planned construction of Project drainage facilities. A monitoring plan will be incorporated into the SWPPP to insure that stormwater is managed to control erosion. During construction, the BMPs would be updated and the SWPPP amended as dictated by changes in construction and construction schedule. The SWPPP and a Mitigation, Monitoring and Reporting Program will be required as part of the Water Quality Certification.

7.0 Monitoring and Reporting

A Monitoring Plan will be prepared as part of the SWPPP detailing the inspection, documentation, and corrective action procedures for the BMPs during the dry and rainy season. Inspections will be conducted and inspection reports prepared on a routine basis and after significant storm events in conformance with the SWPPP. The reports will include information on performance of the erosion control measures, damage to or deficiencies with installed BMPs, needed maintenance or repair activities, monitoring information, and the degree of vegetation establishment (in conjunction with re-vegetation monitoring plan). Reporting documents will be kept on file with the SWPPP and construction records.

8.0 Non-Storm Water Control

Non-stormwater management BMPs are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source or eliminating off-site discharge. These practices involve day-to-day operations at the construction site and are usually under the control of the contractor. In addition, relevant BMPs will be implemented throughout the operation of the project. Implementation of BMPs during operation will be the responsibility of the licensee. Non-stormwater management BMPs also include procedures and practices designed to minimize or eliminate the discharge of pollutants from vehicle and equipment cleaning, fueling, and maintenance operations to stormwater drainage systems or to watercourses. The following list indicates the BMPs that normally are implemented to control construction site wastes and materials.

- Procedures will be defined for the safe delivery, storage, and use of various construction materials, oils, fuels, and chemicals.
- Spill prevention control measures will be implemented to contain and clean up spills and prevent material discharges outside the construction and operation area.
- Solid waste management and hazardous waste management will be implemented to minimize storm water contact with waste materials and prevent waste discharges. Solid wastes will be stored in dumpsters throughout the project site. Dumpster locations will change according to where construction activities are occurring. One dumpster will always be located next to the contractor's office trailers and yard. Hazardous wastes will be stored in the covered containment area as discussed above for materials storage. Hazardous wastes will be stored in appropriate and clearly marked containers. Hazardous materials will be segregated from other non-waste materials.
- Concrete waste management will be implemented to reduce or eliminate stormwater contamination during construction activities. Concrete and rubble will be stockpiled at least 20 feet from washes and channels and disposed off-site when necessary. Concrete (RCC) will be hauled in open trucks and unloaded into the paving machine. These trucks will not require regular washouts. When necessary, discharges will consist of rinse water and residual concrete (Portland cement, aggregates, admixtures, and water). Concrete trucks will not washout within 20 feet of any watercourses. All excess concrete will be broken up and used as fill material.
- Sanitary and septic waste management will be implemented throughout the project area. Portable toilets will be located and maintained throughout the project site and maintained for the duration of the project. The location of the toilets will follow the construction activity throughout the site. The toilets will always be positioned away from concentrated flow paths and heavy traffic flow to prevent possible spills.

Attachment B

Examples of Best Management Practices (BMPs) for the Eagle Mountain Pumped Storage Project

Attachment A

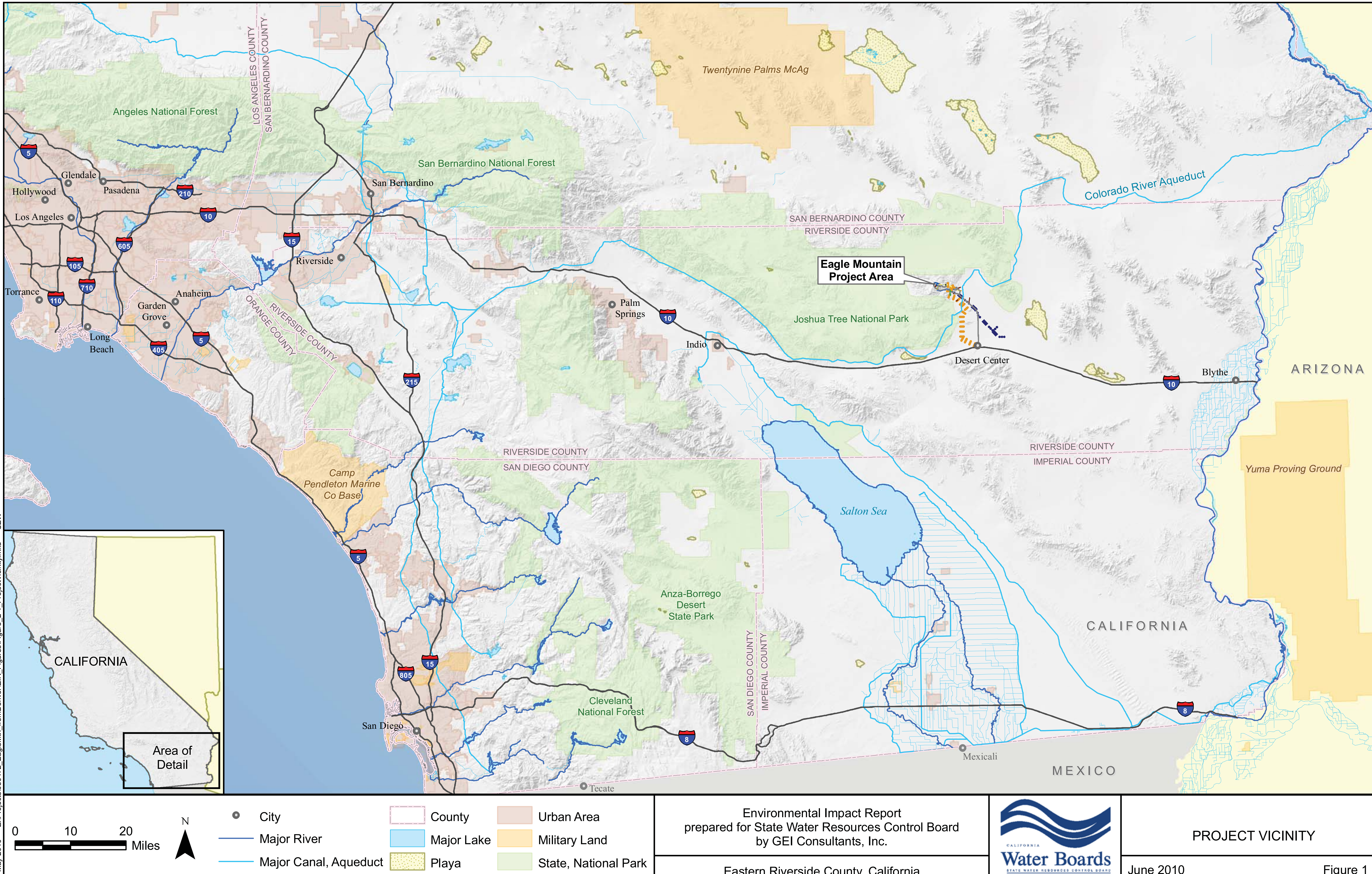
Figure 1 – Vicinity Map

Figure 2 – Project Boundary (2 sheets)

Figure 3 – Erosion Control and Sedimentation Plan –Pumped Storage Facilities

Figure 4 – Erosion Control and Sedimentation Plan – Transmission Line and Water Supply Line, and Wells

Figure 5 – Erosion Control and Sedimentation Plan – Cross Section



Environmental Impact Report
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by GEI Consultants, Inc.

Eastern Riverside County, California

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State Water Resources Control Board
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PROJECT VICINITY

June 2010

Figure 1

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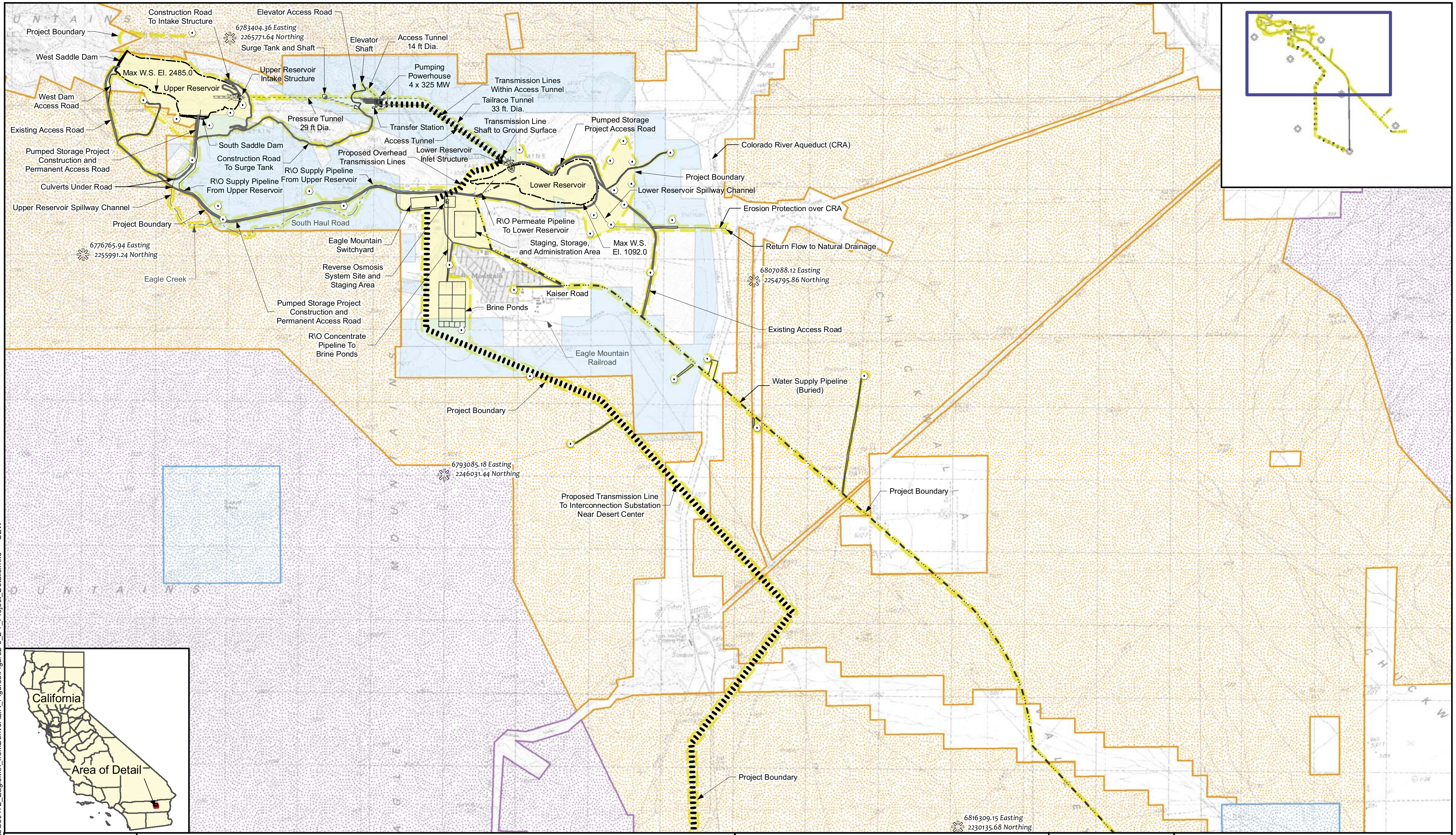

N

0 2,000 4,000 Feet

Georeference Locations	Interconnection Substation
Mitigation Monitoring Network Well	Water Supply Well Area
Water Supply Line	BLM Land Subject to Land Exchange
Transmission Route	Project Boundary
Bureau of Land Management	
National Park Service	
State	
Private	

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PROJECT BOUNDARY
(PAGE 1 OF 2)

June 2010 Figure 2

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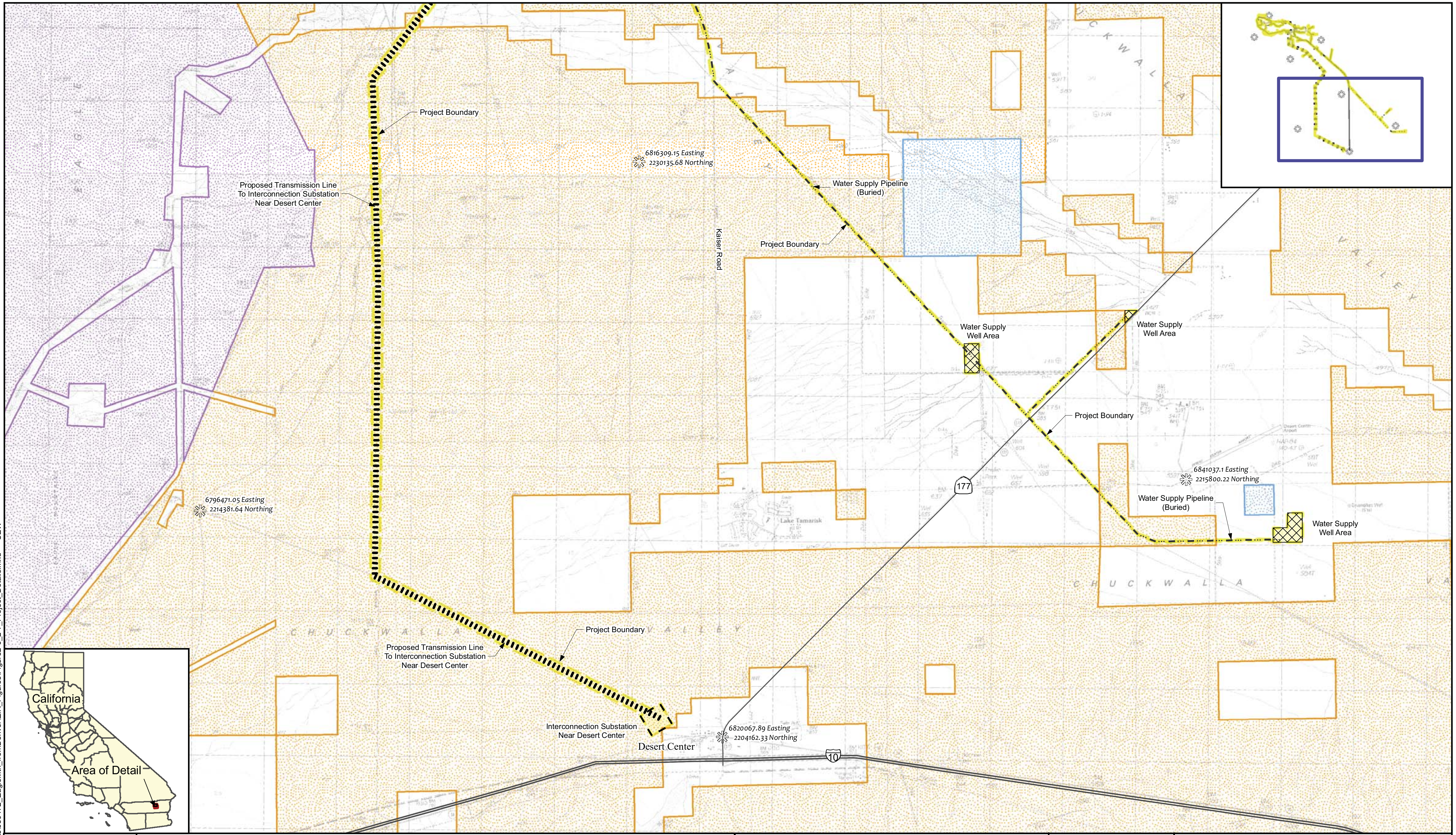

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N

0 2,000 4,000 Feet

Georeference Locations	Interconnection Substation	Bureau of Land Management
Mitigation Monitoring Network Well	Water Supply Well Area	National Park Service
Water Supply Line	BLM Land Subject to Land Exchange	State
Transmission Route	Project Boundary	Private

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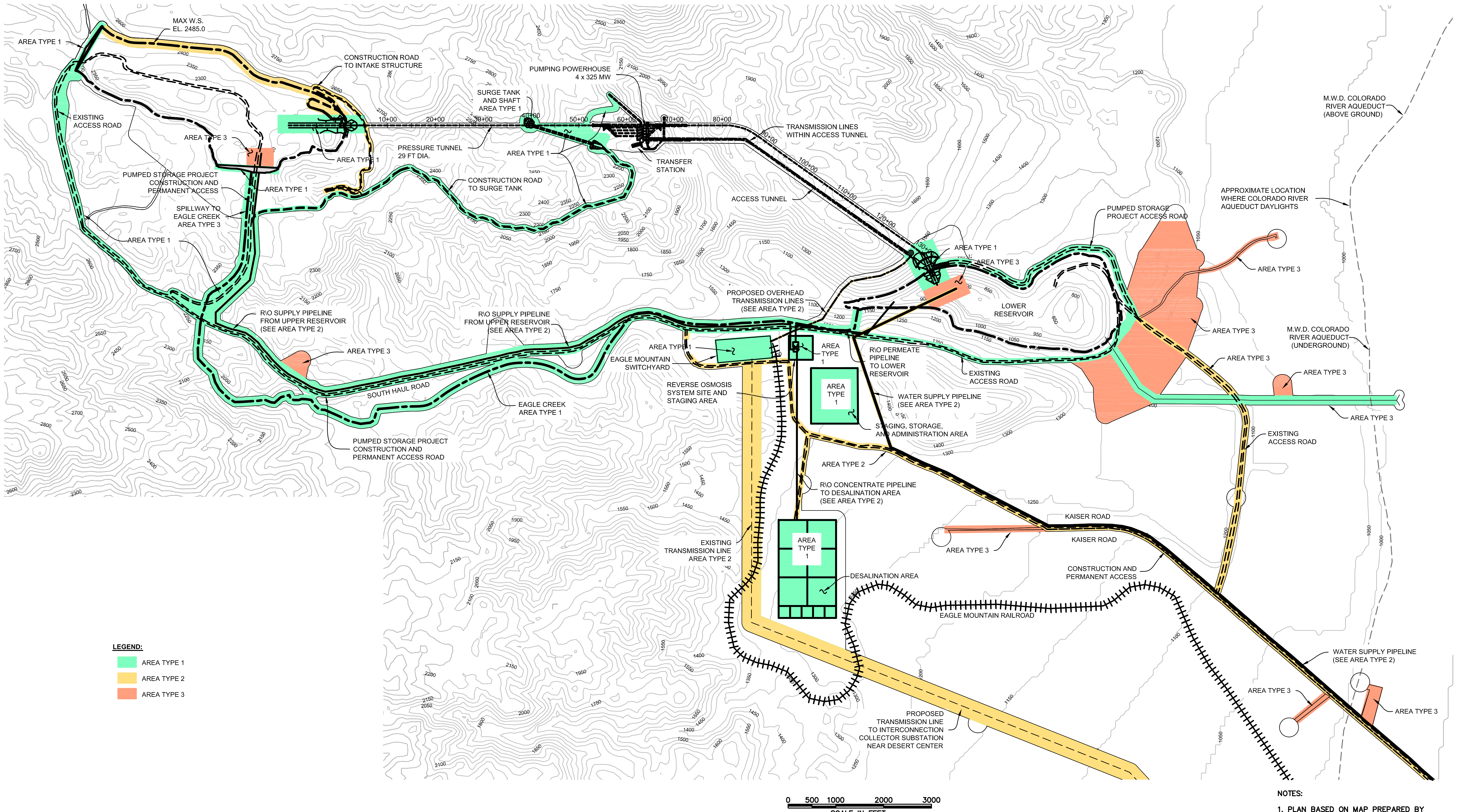
PROJECT BOUNDARY
(PAGE 2 OF 2)

June 2010 Figure 3



NOTES:

1. PLAN BASED ON MAP PREPARED BY C.M. ENGINEERING ASSOCIATES, SAN BERNARDINO, CA.

NO.	DATE	ISSUE/REVISION	DES	DRN	CHK	APP

EAGLE CREST ENERGY COMPANY

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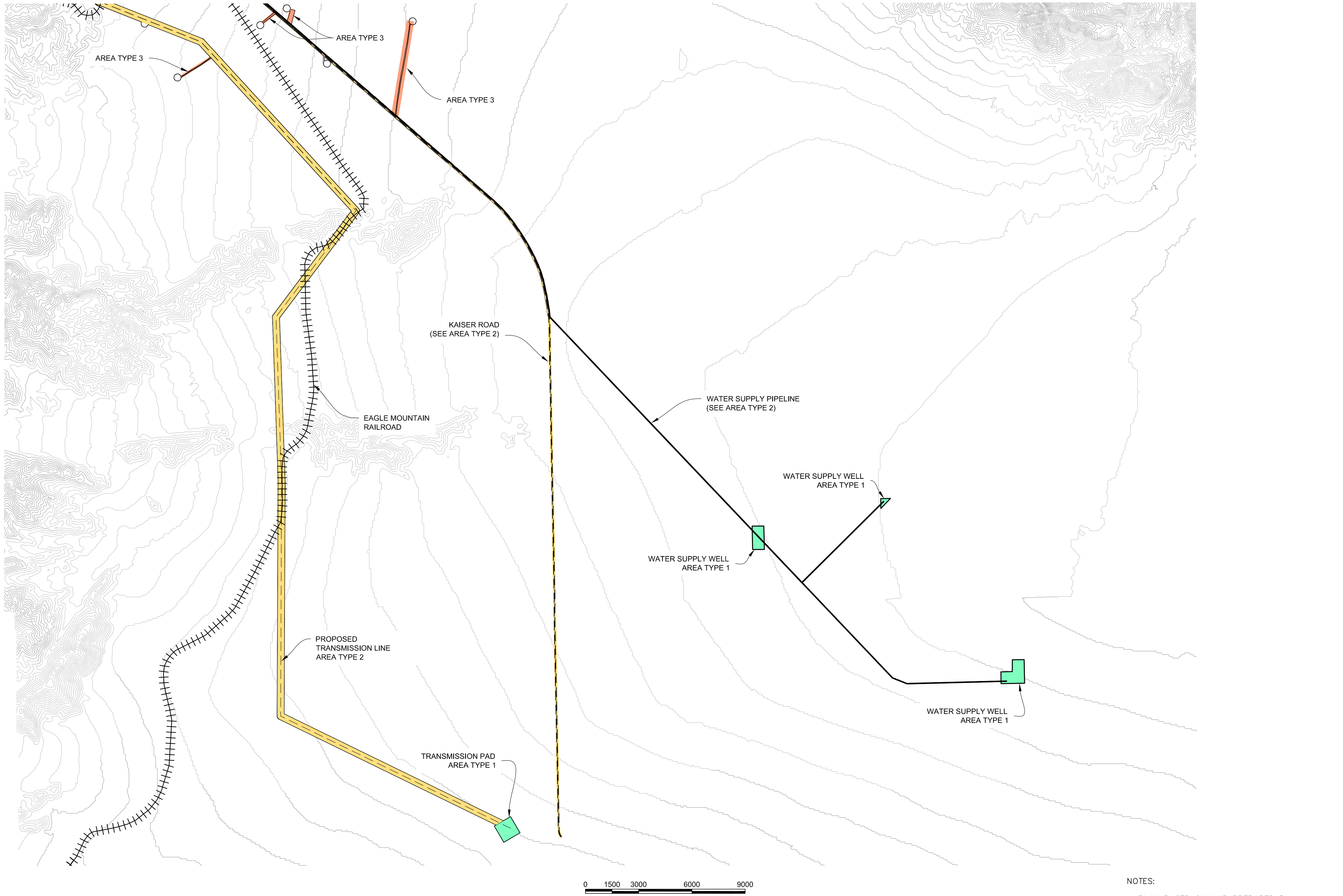
EAGLE MOUNTAIN PUMPED STORAGE PROJECT

EROSION AND SEDIMENTATION CONTROL PLAN - PUMPED STORAGE FACILITIES

FIGURE NO. 4

SHEET NO. 4 of 6

P:\080470 Eagle Mt\Erosion Control\ 30 Nov 09 ErosionControlPlan.dwg Jun 2010



LEGEND:

- AREA TYPE 1
- AREA TYPE 2
- AREA TYPE 3

NOTES:

1. PLAN BASED ON MAP PREPARED BY C.M. ENGINEERING ASSOCIATES, SAN BERNARDINO, CA.

NO.	DATE	ISSUE/REVISION	DES	DRN	CHK	APP

Eagle Crest Energy Company

EAGLE CREST ENERGY COMPANY

GEI PROJECT 080473

EAGLE MOUNTAIN PUMPED STORAGE PROJECT

EROSION AND SEDIMENTATION CONTROL PLAN - TRANSMISSION LINE, WATER LINE, AND WELLS

FIGURE NO. 5

SHEET NO. 5 of 6

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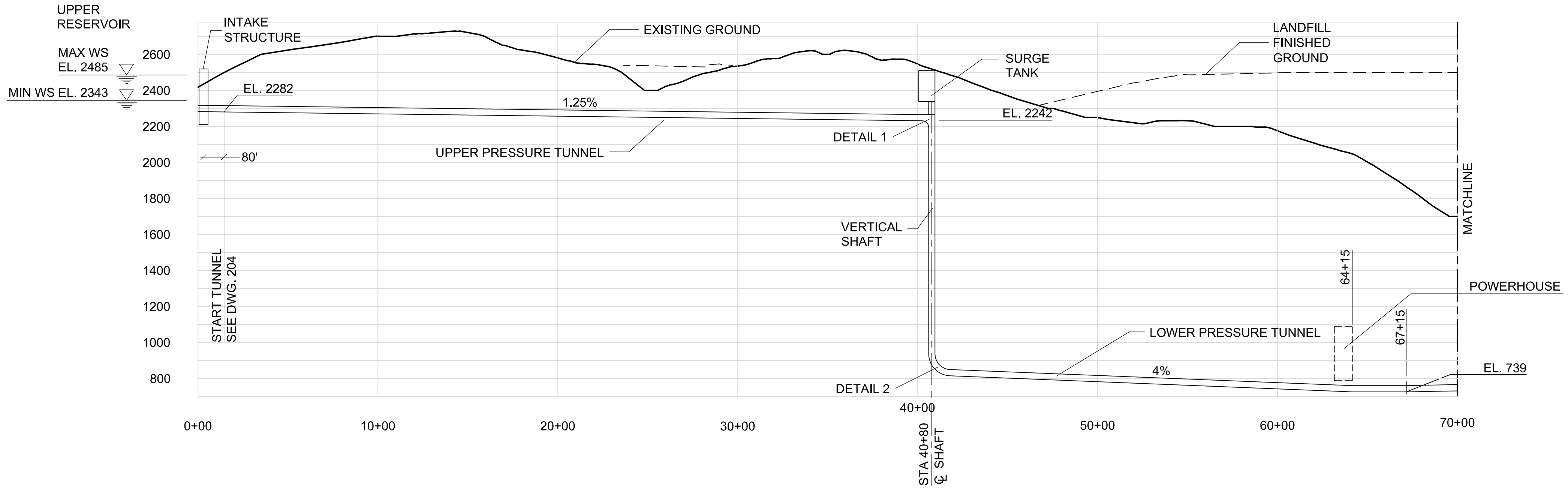
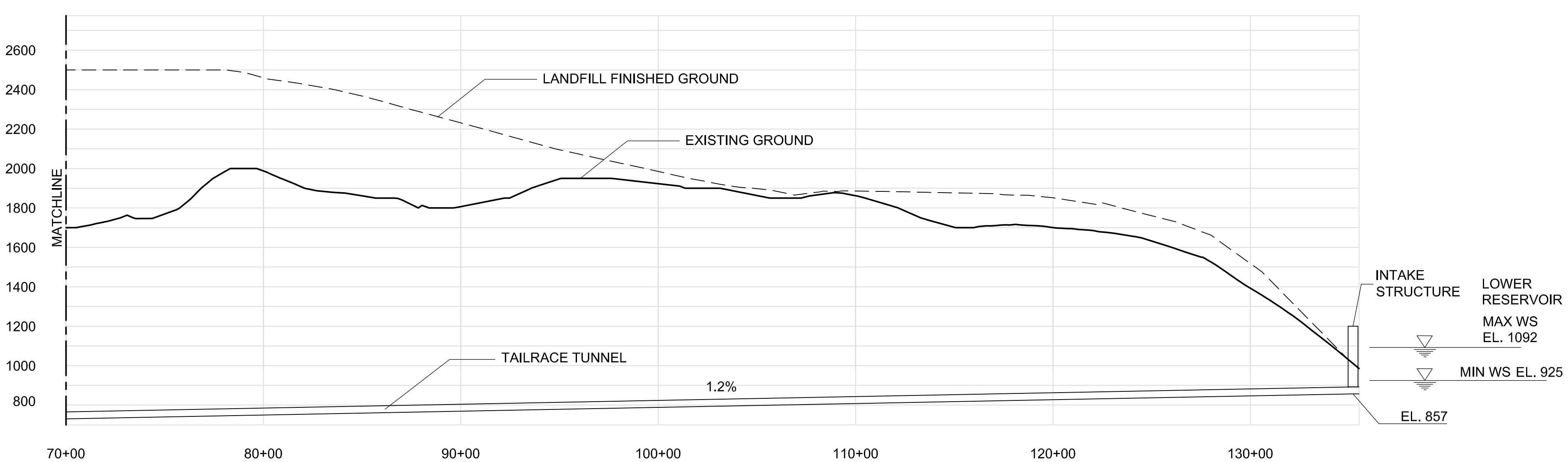




NOTES:

1. UNDEFINED LANDFILL CONTOURS WERE ASSUMED TO FOLLOW DEFINED CONTOURS AND TO COME INTO ALIGNMENT WITH THE EXISING GROUND SURFACE.

CROSS SECTION ALONG WATER CONDUITS

NOTES:

1. PLAN BASED ON MAP PREPARED BY C.M. ENGINEERING ASSOCIATES, SAN BERNARDINO, CA.

PLAN

0 400 800

SCALE, FEET

NO.	DATE	ISSUE/REVISION	DES	DRN	CHK	APP

EAGLE CREST ENERGY COMPANY

GEI PROJECT 080473

EAGLE MOUNTAIN PUMPED STORAGE PROJECT

EROSION AND SEDIMENTATION CONTROL PLAN - CROSS SECTION

FIGURE NO. 6

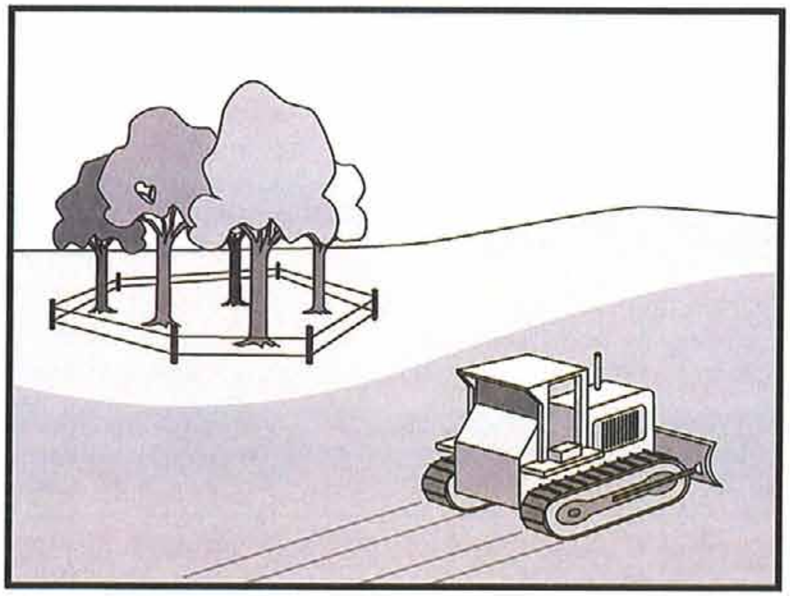
SHEET NO. 6 of 6

P:\080470 Eagle Mt\Erosion Control PROFILE_ErosionControlPlan.dwg May 2009

Attachment B

Examples of Best Management Practices (BMPs) for the Eagle Mountain Pumped Storage Project

Preservation Of Existing Vegetation EC-2



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.

- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.

- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.

- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

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Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

  - Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

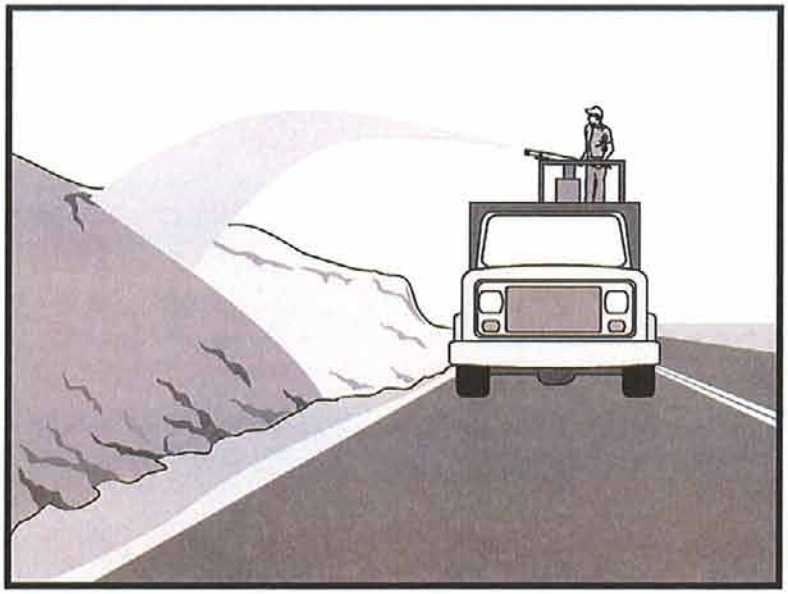
References

County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Hydraulic mulch consists of applying a mixture of shredded wood fiber or a hydraulic matrix, and a stabilizing emulsion or tackifier with hydro-mulching equipment, which temporarily protects exposed soil from erosion by raindrop impact or wind.

Suitable Applications

Hydraulic mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be re-disturbed following an extended period of inactivity.

Limitations

Wood fiber hydraulic mulches are generally short lived and need 24 hours to dry before rainfall occurs to be effective. May require a second application in order to remain effective for an entire rainy season.

Implementation

- Prior to application, roughen embankment and fill areas by rolling with a crimping or punching type roller or by track walking. Track walking shall only be used where other methods are impractical.
- To be effective, hydraulic matrices require 24 hours to dry before rainfall occurs.
- Avoid mulch over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

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- Paper based hydraulic mulches alone shall not be used for erosion control.

Hydraulic Mulches
Wood fiber mulch can be applied alone or as a component of hydraulic matrices. Wood fiber applied alone is typically applied at the rate of 2,000 to 4,000 lb/acre. Wood fiber mulch is manufactured from wood or wood waste from lumber mills or from urban sources.

Hydraulic Matrices
Hydraulic matrices include a mixture of wood fiber and acrylic polymer or other tackifier as binder. Apply as a liquid slurry using a hydraulic application machine (i.e., hydro seeder) at the following minimum rates, or as specified by the manufacturer to achieve complete coverage of the target area: 2,000 to 4,000 lb/acre wood fiber mulch, and 5 to 10% (by weight) of tackifier (acrylic copolymer, guar, psyllium, etc.)

Bonded Fiber Matrix
Bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion resistant blanket that promotes vegetation, and prevents soil erosion. BFMs are typically applied at rates from 3,000 lb/acre to 4,000 lb/acre based on the manufacturer's recommendation. A biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Costs
Average cost for installation of wood fiber mulch is $900/acre. Average cost for installation of BFM is $5,500/acre.

Inspection and Maintenance
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.

- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when the soils are not being reworked.

References
Controlling Erosion of Construction Sites Agricultural Information #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Soil Erosion by Water, Agriculture Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

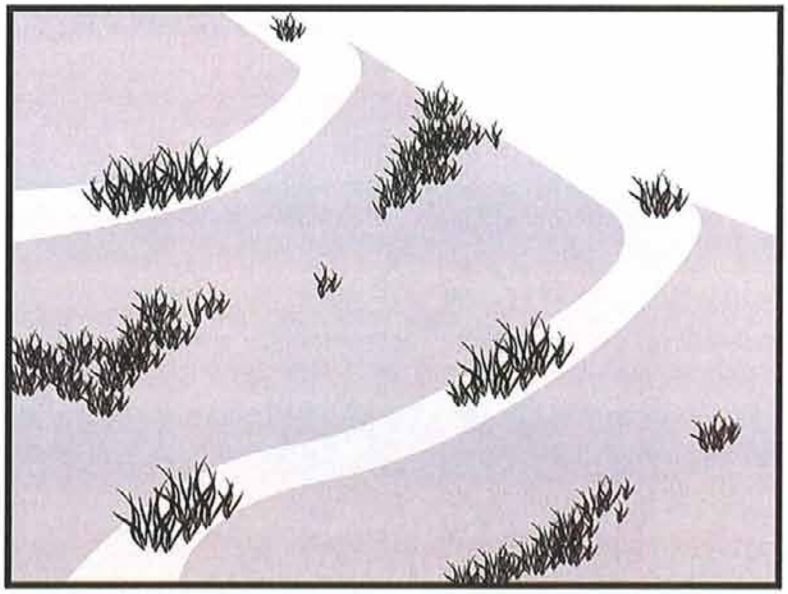
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydroseeding EC-4



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Hydroseeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment, to temporarily protect exposed soils from erosion by water and wind.

Suitable Applications

Hydroseeding is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be re-disturbed following an extended period of inactivity.

Limitations

- Hydroseeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control. Otherwise, hydroseeding must be used in conjunction with mulching (i.e., straw mulch).
- Steep slopes are difficult to protect with temporary seeding.
- Temporary seeding may not be appropriate in dry periods without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Temporary vegetation is not appropriate for short term inactivity.

Implementation

In order to select appropriate hydroseeding mixtures, an evaluation of site conditions shall be performed with respect to:

- Soil conditions
- Site topography
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

The local office of the U.S.D.A. Natural Resources Conservation Service (NRCS) is an excellent source of information on appropriate seed mixes.

The following steps shall be followed for implementation:

- Avoid use of hydroseeding in areas where the BMP would be incompatible with future earthwork activities and would have to be removed.
- Hydroseeding can be accomplished using a multiple step or one step process. The multiple step process ensures maximum direct contact of the seeds to soil. When the one step process is used to apply the mixture of fiber, seed, etc., the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.
- Prior to application, roughen the area to be seeded with the furrows trending along the contours.
- Apply a straw mulch to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- All seeds shall be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. The container shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. All legume seed shall be pellet inoculated. Inoculant sources shall be species specific and shall be applied at a rate of 2 lb of inoculant per 100 lb seed.
- Commercial fertilizer shall conform to the requirements of the California Food and Agricultural Code. Fertilizer shall be pelleted or granular form.
- Follow up applications shall be made as needed to cover weak spots and to maintain adequate soil protection.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Costs

Average cost for installation and maintenance may vary from as low as $300 per acre for flat slopes and stable soils, to $1600 per acre for moderate to steep slopes and/or erosive soils.

Hydroseeding		Installed Cost per Acre
High Density	Ornamentals	$400 - $1600
	Turf Species	$350
	Bunch Grasses	$300 - $1300
Fast Growing	Annual	$350 - $650
	Perennial	$300 - $800
Non-Competing	Native	$300 - $1600
	Non-Native	$400 - $500
Sterile	Cereal Grain	$500

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

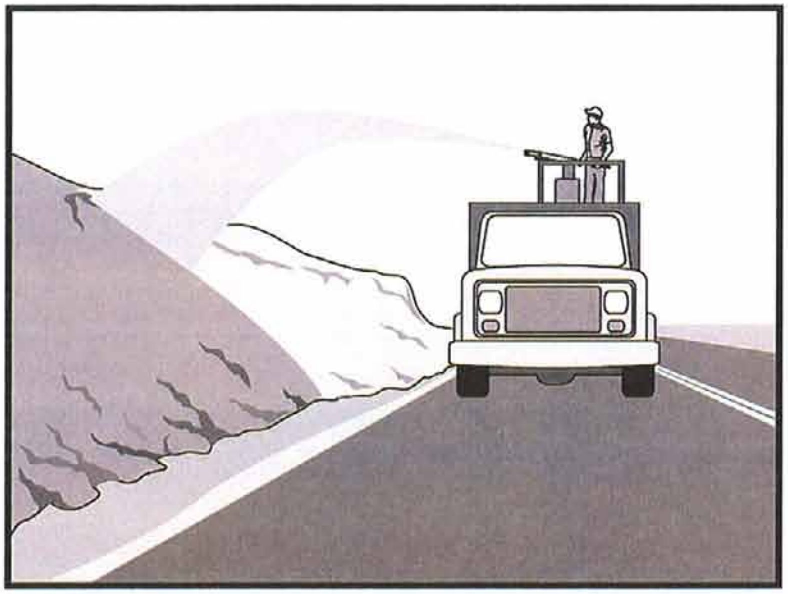
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Where seeds fail to germinate, or they germinate and die, the area must be re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates.
- Irrigation systems, if applicable, should be inspected daily while in use to identify system malfunctions and line breaks. When line breaks are detected, the system must be shut down immediately and breaks repaired before the system is put back into operation.
- Irrigation systems shall be inspected for complete coverage and adjusted as needed to maintain complete coverage.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller or anchoring it with a tackifier stabilizing emulsion. Straw mulch protects the soil surface from the impact of rain drops, preventing soil particles from becoming dislodged.

Suitable Applications

Straw mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established. Straw mulch is typically used for erosion control on disturbed areas until soils can be prepared for permanent vegetation. Straw mulch is also used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Limitations

- Availability of straw and straw blowing equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- There is a potential for introduction of weed seed and unwanted plant material.
- When straw blowers are used to apply straw mulch, the treatment areas must be within 150 ft of a road or surface capable of supporting trucks.
- Straw mulch applied by hand is more time intensive and potentially costly.

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- Wind may limit application of straw and blow straw into undesired locations.
- May have to be removed prior to permanent seeding or prior to further earthwork.
- "Punching" of straw does not work in sandy soils, necessitating the use of tackifiers.

Implementation

- Straw shall be derived from wheat, rice, or barley. Where required by the plans, specifications, permits, or environmental documents, native grass straw shall be used.
- A tackifier is the preferred method for anchoring straw mulch to the soil on slopes.
- Crimping, punch roller-type rollers, or track walking may also be used to incorporate straw mulch into the soil on slopes. Track walking shall only be used where other methods are impractical.
- Avoid placing straw onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.
- Straw mulch with tackifier shall not be applied during or immediately before rainfall.
- In San Diego, use of straw near wood framed home construction has been frowned on by the Fire Marshall.

Application Procedures

- Apply straw at a minimum rate of 4,000 lb/acre, either by machine or by hand distribution.
- Roughen embankments and fill rills before placing the straw mulch by rolling with a crimping or punching type roller or by track walking.
- Evenly distribute straw mulch on the soil surface.
- Anchor straw mulch to the soil surface by "punching" it into the soil mechanically (incorporating). Alternatively, use a tackifier to adhere straw fibers.
- Methods for holding the straw mulch in place depend upon the slope steepness, accessibility, soil conditions, and longevity.
  - On small areas, a spade or shovel can be used to punch in straw mulch.
  - On slopes with soils that are stable enough and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw can be "punched" into the ground using a knife blade roller or a straight bladed coulter, known commercially as a "crimper".
  - On small areas and/or steep slopes, straw can also be held in place using plastic netting or jute. The netting shall be held in place using 11 gauge wire staples, geotextile pins or wooden stakes as described in EC-7, Geotextiles and Mats.
  - A tackifier acts to glue the straw fibers together and to the soil surface. The tackifier shall be selected based on longevity and ability to hold the fibers in place. A tackifier is

typically applied at a rate of 125 lb/acre. In windy conditions, the rates are typically 180 lb/acre.

Costs
Average annual cost for installation and maintenance (3-4 months useful life) is $2,500 per acre. Application by hand is more time intensive and potentially costly.

Inspection and Maintenance
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- The key consideration in inspection and maintenance is that the straw needs to last long enough to achieve erosion control objectives.
- Maintain an unbroken, temporary mulched ground cover while disturbed soil areas are inactive. Repair any damaged ground cover and re-mulch exposed areas.
- Reapplication of straw mulch and tackifier may be required to maintain effective soil stabilization over disturbed areas and slopes.

References
Controlling Erosion of Construction Sites, Agricultural Information Bulletin #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

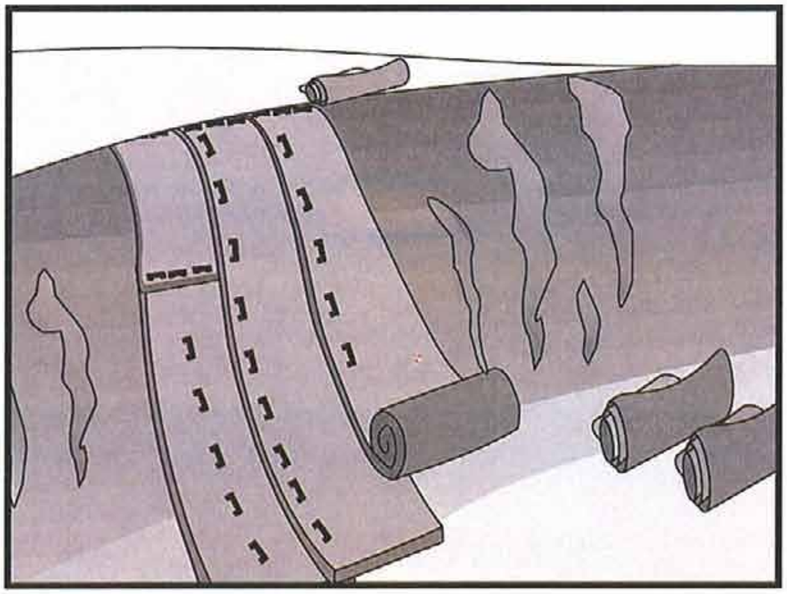
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Soil Erosion by Water, Agricultural Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	3
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-8 Wood Mulching

Description and Purpose

Mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

Suitable Applications

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 ft/s and 6 ft/s are likely to wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive. These measures should be considered in the following situations.

- Steep slopes, generally steeper than 3:1 (H:V)
- Slopes where the erosion potential is high
- Slopes and disturbed soils where mulch must be anchored
- Disturbed areas where plants are slow to develop
- Channels with flows exceeding 3.3 ft/s

- Channels to be vegetated
- Stockpiles
- Slopes adjacent to water bodies of Environmentally Sensitive Areas (ESAs)

Limitations

- Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.
- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs.
- Geotextiles and Mats may delay seed germination, due to reduction in soil temperature.
- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats must be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until alternative measures, such as seeding and mulching, may be installed.
- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.
- Not suitable for areas that have heavy foot traffic (tripping hazard) – e.g., pad areas around buildings under construction.

Implementation

Material Selection

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness, moisture, weed growth, and availability of materials.

The following natural and synthetic mattings are commonly used:

Geotextiles

- Material should be a woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft and should have minimum tensile strength of 150 lbs (warp), 80 lbs (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric should be approximately 0.07 sec^{-1} in conformance with the requirements in ASTM Designation: D4491. The fabric should have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets must be secured in place with wire staples or sandbags and by keying into tops of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Geotextiles may be reused if they are suitable for the use intended.

Plastic Covers

- Plastic sheeting should have a minimum thickness of 6 mils, and must be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 ft apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in soil.

- All sheeting must be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakages occur, the material should be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable.

  - **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Excelsior** (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide, and should have an average weight of 0.8 lb/yd^2, ±10 percent, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Straw blanket** should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd². Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 ft wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd². Coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Straw coconut fiber blanket** should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd². Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

■ Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

- **Plastic netting** is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Plastic mesh** is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Bonded synthetic fibers** consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.

- Grade and shape the area of installation.

- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.

- Prepare seedbed by loosening 2 to 3 in. of topsoil.

Seeding

Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots are made of glass fiber strips, excelsior matting strips or tight folded jute matting blanket or strips for use on steep, highly erodible watercourses. The check slots are placed in narrow trenches 6 to 12 in. deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the friable seedbed made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations.

- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.

- Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.

- Wire staples and metal stakes should be driven flush to the soil surface.

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.

- Unroll blanket down slope in the direction of water flow.

- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft.

- When blankets must be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1 ½ staples/yd^2.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.

- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work must be disposed of if necessary.

Costs

Relatively high compared to other BMPs. Biodegradable materials: \$0.50 - \$0.57/yd². Permanent materials: \$3.00 - \$4.50/yd². Staples: \$0.04 - \$0.05/staple. Approximate costs for installed materials are shown below:

Rolled Erosion Control Products		Installed Cost per Acre
Biodegradable	Jute Mesh	$6,500
	Curled Wood Fiber	$10,500
	Straw	$8,900
	Wood Fiber	$8,900
	Coconut Fiber	$13,000
	Coconut Fiber Mesh	$31,200
	Straw Coconut Fiber	$10,900
Non-Biodegradable	Plastic Netting	$2,000
	Plastic Mesh	$3,200
	Synthetic Fiber with Netting	$34,800
	Bonded Synthetic Fibers	$50,000
	Combination with Biodegradable	$32,000

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.
- Check that disturbed areas are seeded.

References

Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service, January 1991.

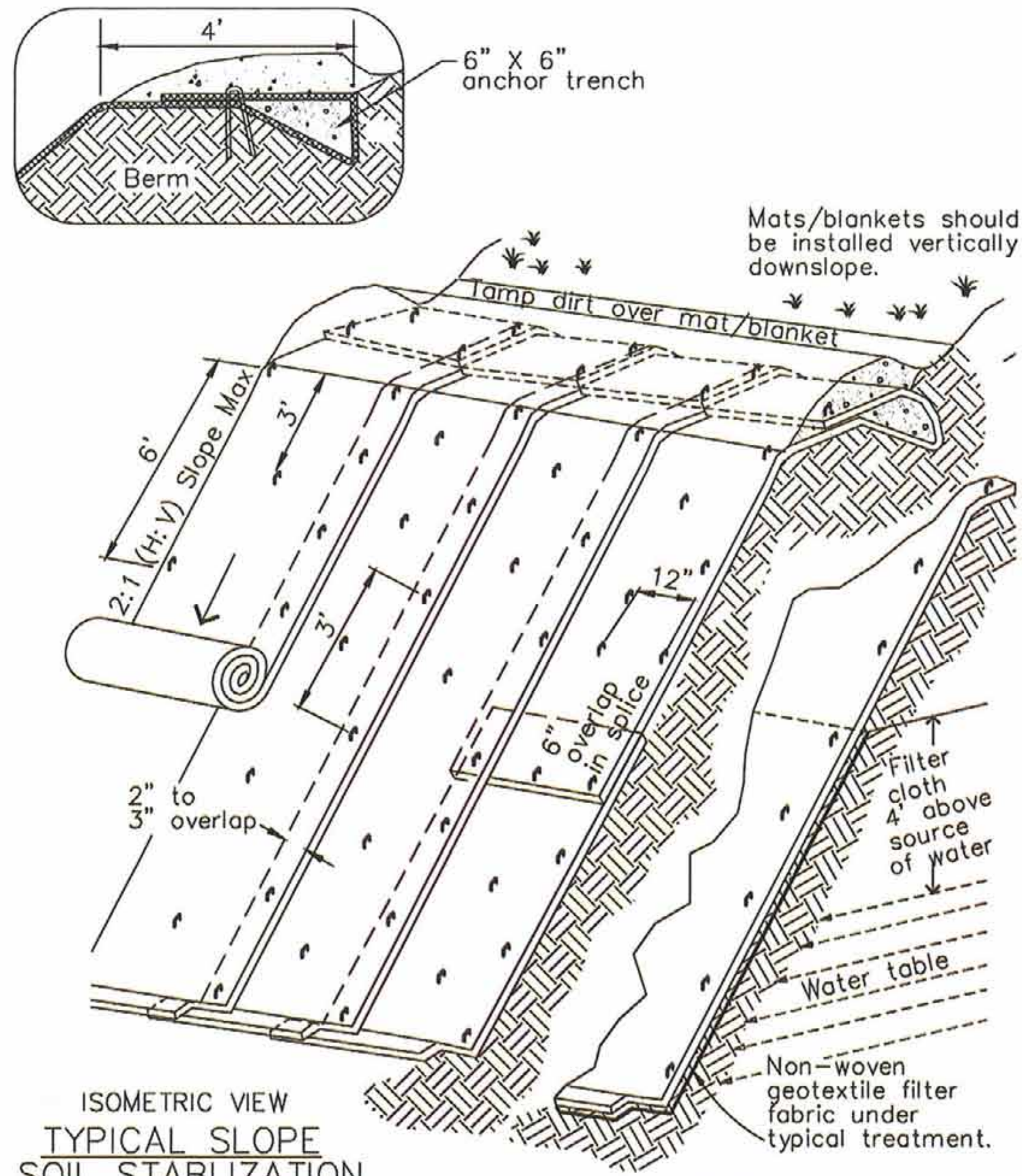
National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

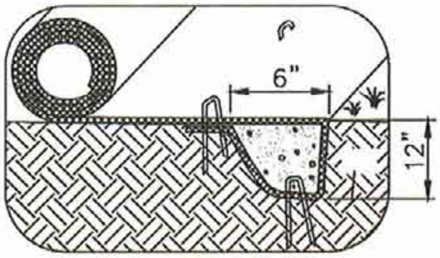
Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



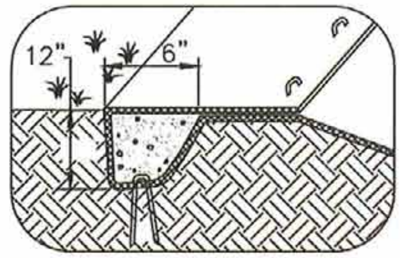
NOTES:

1. Slope surface shall be free of rocks, clods, sticks and grass. Mats/blankets shall have good soil contact.
2. Lay blankets loosely and stake or staple to maintain direct contact with the soil. Do not stretch.
3. Install per manufacturer's recommendations

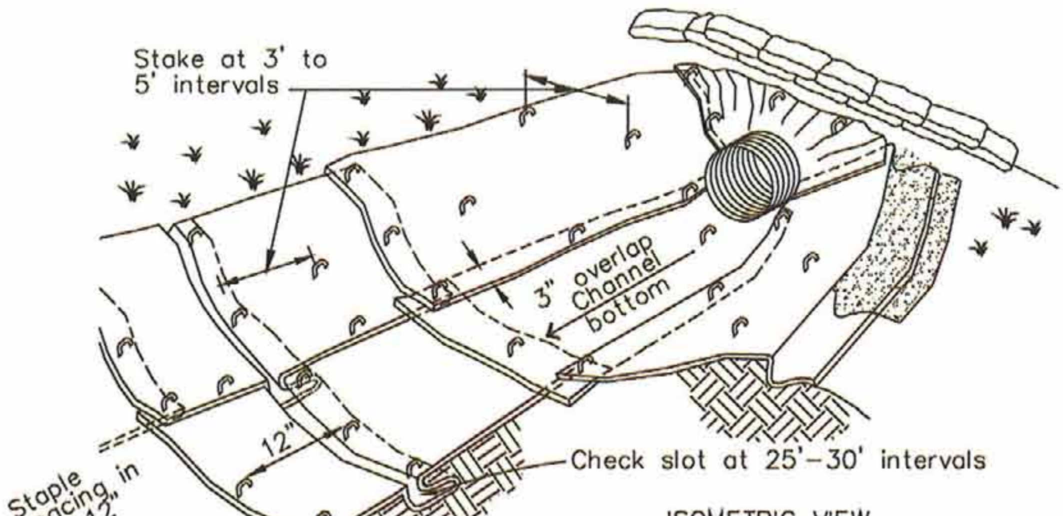
TYPICAL INSTALLATION DETAIL



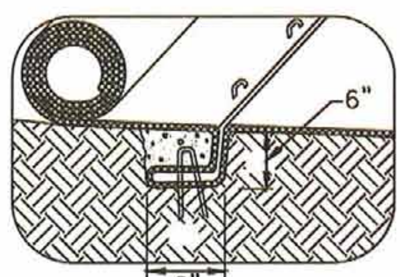
INITIAL CHANNEL ANCHOR TRENCH
NTS



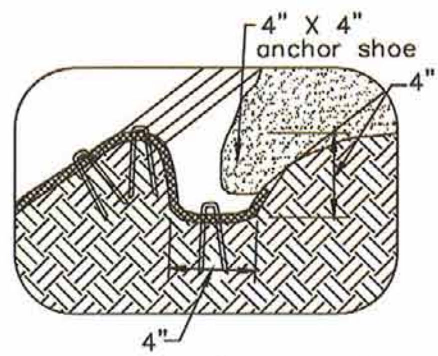
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
NTS



ISOMETRIC VIEW
NTS



INTERMITTENT CHECK SLOT
NTS

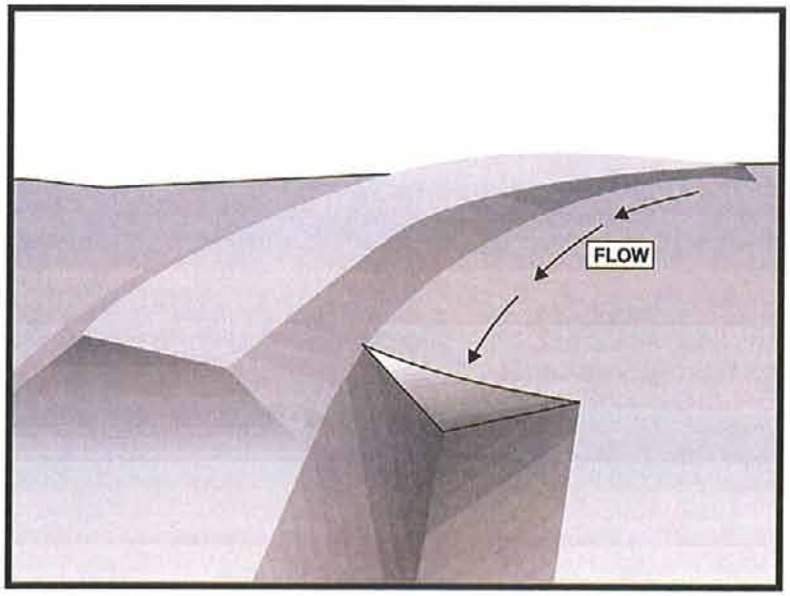


LONGITUDINAL ANCHOR TRENCH
NTS

NOTES:
1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.
3. Install per manufacturer's recommendations

TYPICAL INSTALLATION DETAIL

Earth Dikes and Drainage Swales



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to divert off site runoff around the construction site, divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth dikes and drainage swales are suitable for use, individually or together, where runoff needs to be diverted from one area and conveyed to another.

- Earth dikes and drainage swales may be used:
  - To convey surface runoff down sloping land
  - To intercept and divert runoff to avoid sheet flow over sloped surfaces
  - To divert and direct runoff towards a stabilized watercourse, drainage pipe or channel
  - To intercept runoff from paved surfaces
  - Below steep grades where runoff begins to concentrate
  - Along roadways and facility improvements subject to flood drainage

- At the top of slopes to divert runon from adjacent or undisturbed slopes
- At bottom and mid slope locations to intercept sheet flow and convey concentrated flows
- Divert sediment laden runoff into sediment basins or traps

Limitations

Dikes should not be used for drainage areas greater than 10 acres or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted stormwater may cause downstream flood damage.
- Dikes should not be constructed of soils that may be easily eroded.
- Regrading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices.
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales, and ditches.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert stormwater to a sediment trapping device or a stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off site and from undisturbed areas away from disturbed areas and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff. A dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike at the top of a slope can divert runoff to a location where it can be brought to the bottom of the slope (see EC-11, Slope Drains). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded and remain in place until post construction BMPs are installed and the slopes are stabilized.

Diversion practices concentrate surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. If significant erosion will occur, a swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization. Any drain or swale that conveys sediment laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

General

- Care must be applied to correctly size and locate earth dikes, drainage swales. Excessively steep, unlined dikes, and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert stormwater runoff. Temporary diversion dikes should be installed in the following manner:

- All dikes should be compacted by earth moving equipment.
- All dikes should have positive drainage to an outlet.
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic.
- The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (SE-3) or Sediment Basin (SE-2) when either the dike channel or the drainage area above the dike are not adequately stabilized.

- Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain.
- If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. -12 in. Riprap

- The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
- Filter cloth may be used to cover dikes in use for long periods.
- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used (see the local drainage design manual). Unless local drainage design criteria state otherwise, drainage swales should be designed as follows:

- No more than 5 acres may drain to a temporary drainage swale.
- Place drainage swales above or below, not on, a cut or fill slope.
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 in.
- Side slopes should be 2:1 or flatter.
- Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent.
- The swale must not be overtopped by the peak discharge from a 10-year storm, irrespective of the design criteria stated above.
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built.
- Compact any fill material along the path of the swale.

- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent. For temporary swales, geotextiles and mats (EC-7) may provide immediate stabilization.

- Irrigation may be required to establish sufficient vegetation to prevent erosion.

- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.

- Permanent drainage facilities must be designed by a professional engineer (see the local drainage design criteria for proper design).

- At a minimum, the drainage swale should conform to predevelopment drainage patterns and capacities.

- Construct the drainage swale with a positive grade to a stabilized outlet.

- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach an erosive velocity.

Costs

- Cost ranges from $15 to $55 per ft for both earthwork and stabilization and depends on availability of material, site location, and access.

- Small dikes: $2.50 - $6.50/linear ft; Large dikes: $2.50/yd^3.

- The cost of a drainage swale increases with drainage area and slope. Typical swales for controlling internal erosion are inexpensive, as they are quickly formed during routine earthwork.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.

- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.

- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction

References

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company, 1986.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Association of Home Builders (NAHB). Stormwater Runoff & Nonpoint Source Pollution Control Guide for Builders and Developers. National Association of Home Builders, Washington, D.C., 1995

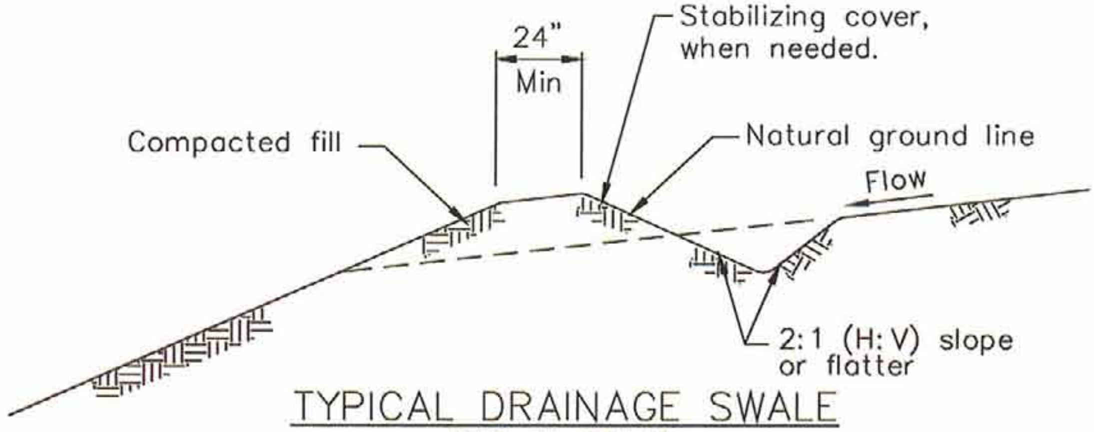
National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

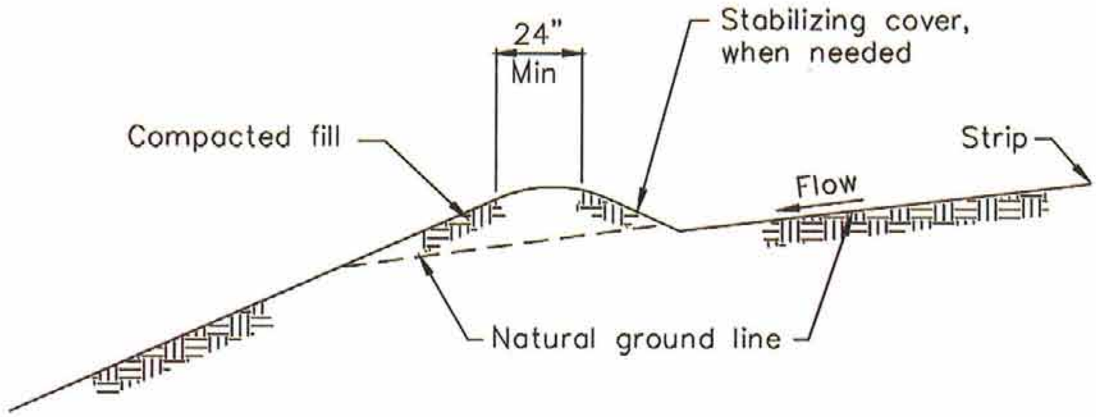
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



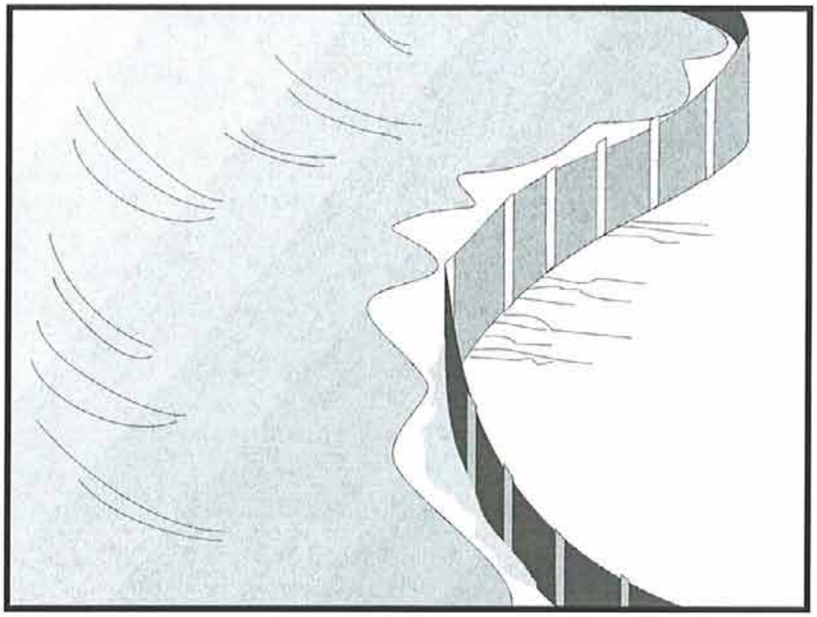
TYPICAL DRAINAGE SWALE
NOT TO SCALE

NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade.



TYPICAL EARTH DIKE
NOT TO SCALE



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They should also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.

- Do not use in locations where ponded water may cause flooding.
- Do not place fence on a slope, or across any contour line. If not installed at the same elevation throughout, silt fences will create erosion.
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.
  - Not effective unless trenched and keyed in.
  - Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
  - Do not allow water depth to exceed 1.5 ft at any point.

Implementation

General

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

Silt fences are preferable to straw bale barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw bale barriers, there are many instances where silt fences have been improperly installed. The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Don't use in streams, channels, or anywhere flow is concentrated. Don't use silt fences to divert flow.
- Don't use below slopes subject to creep, slumping, or landslides.
- Select filter fabric that retains 85% of soil by weight, based on sieve analysis, but that is not finer than an equivalent opening size of 70.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.

- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area is permanently stabilized.

Design and Layout

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet that it has openings large enough to permit drainage and prevent clogging. The following criteria is recommended for selection of the equivalent opening size:

1. If 50 percent or less of the soil, by weight, will pass the U.S. Standard Sieve No. 200, select the EOS to retain 85 % of the soil. The EOS should not be finer than EOS 70.
2. For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 except where direct discharge to a stream, lake, or wetland will occur, then the EOS should be no larger than Standard Sieve No. 100.

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100. If 85% or more of a soil, by weight, passes through the openings in a No. 200 sieve, filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large and they would clog the fabric quickly if the EOS were small enough to capture the soil.

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 °F to 120 °F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Materials

- Silt fence fabric should be woven polypropylene with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

- There are new products that may use prefabricated plastic holders for the silt fence and use bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement.

Installation Guidelines

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line the proposed silt fence.

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength filter fabric is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the mesh support fence may be eliminated. Filter fabric should be purchased in a long roll, and then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with compacted native material.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where a silt fence is determined to be not practicable due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.

Costs

- Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre). Range of cost is $3.50 - $9.10 per lineal foot.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Repair undercut silt fences.

- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.

- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of, and replaced with new silt fence barriers.

- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.

- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence must be inspected and maintained.

- Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, and Inventory of Current Practices (Draft), UESPA, 1990.

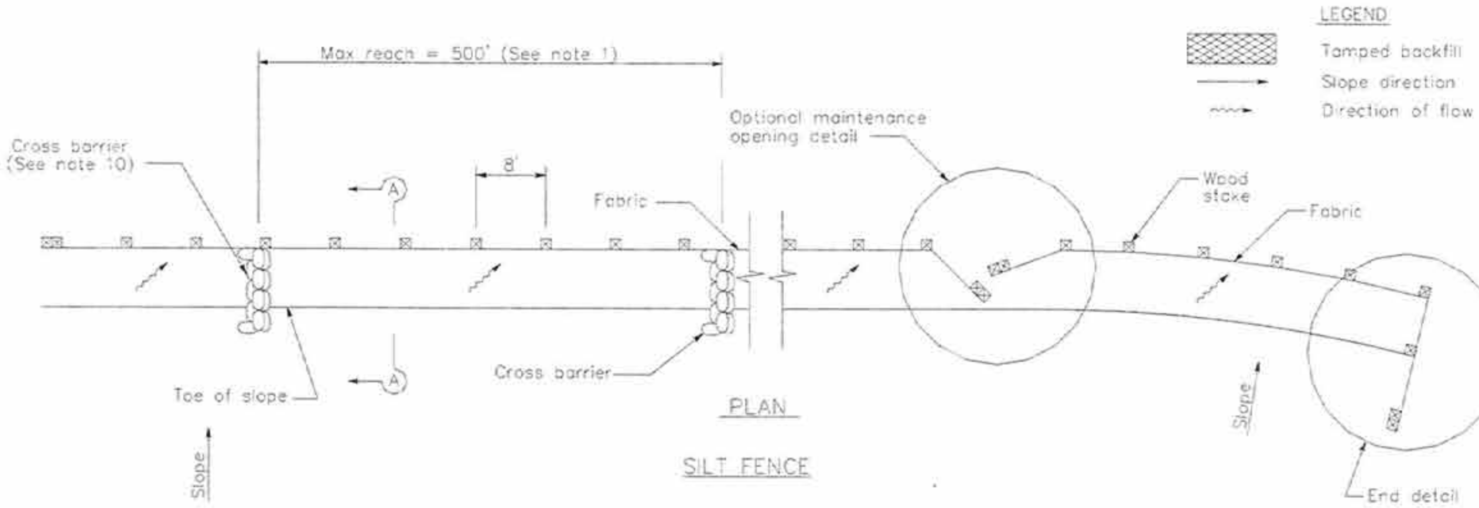
Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

U.S. Environmental Protection Agency (USEPA). Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

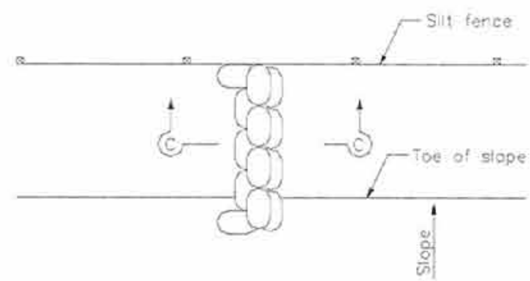


PLAN

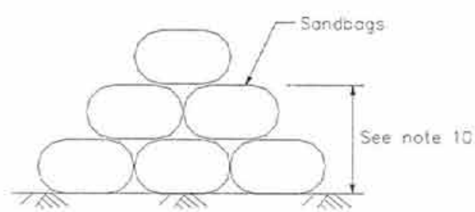
SILT FENCE

NOTES

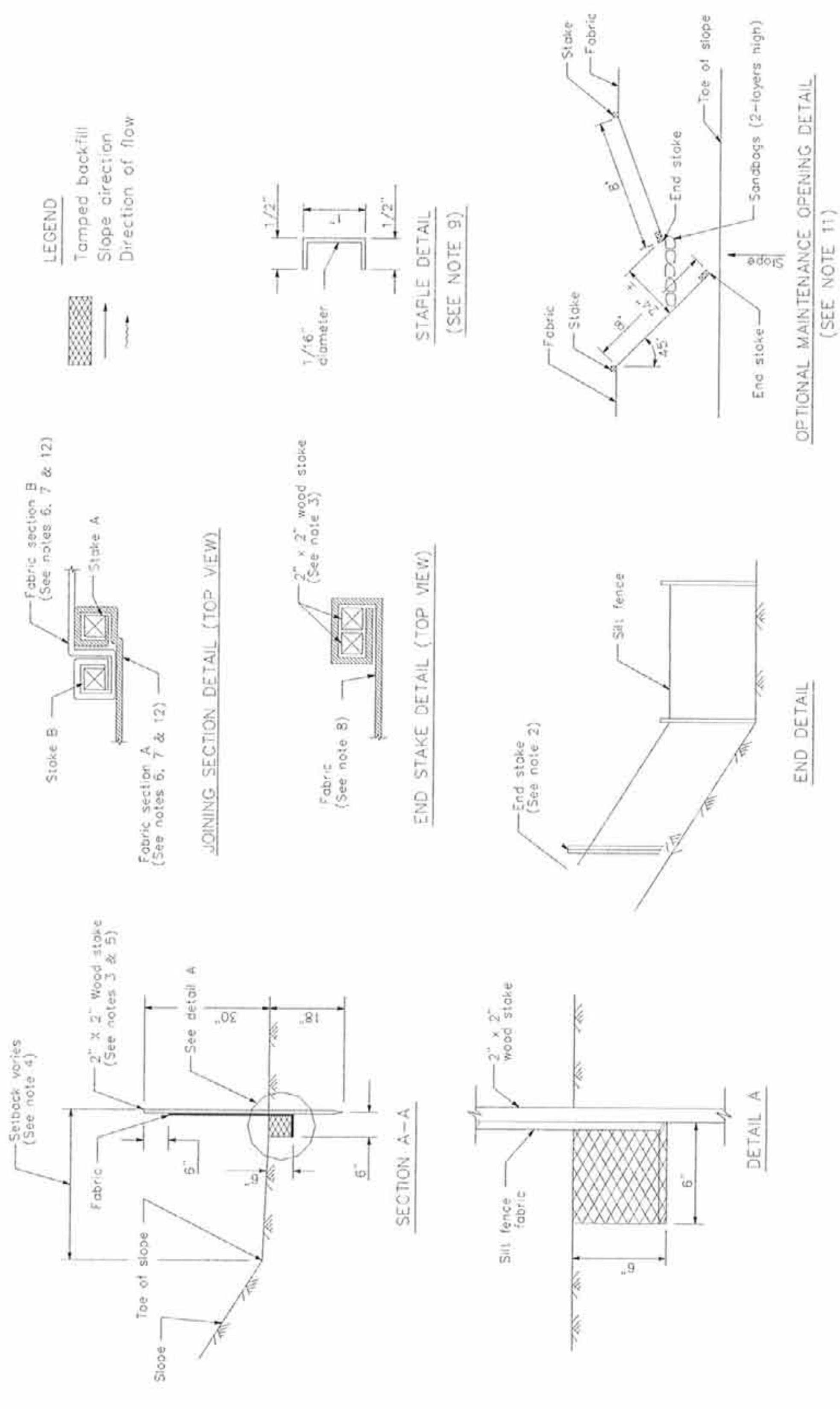
1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. The last 8'-0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'-0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow-through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.



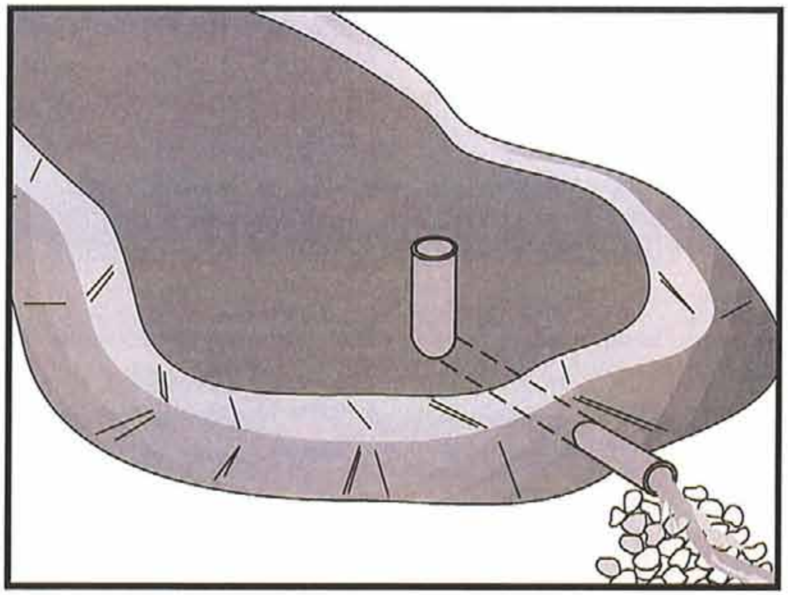
CROSS BARRIER DETAIL



SECTION C-C



LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1/2"
L
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
Toe of slope
Sandbags (2-layers high)
End stake
8'
8'
45°
Slope
End stake
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" x 2" Wood stake
(See notes 3 & 5)
See detail A
Fabric
30"
18"
6"
6"
6"
Toe of slope
Slope
SECTION A-A
2" x 2" wood stake
Silt fence fabric
6"
6"
DETAIL A



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres
- At the outlet of large disturbed watersheds, as necessary
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of

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public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- Generally, sediment basins are limited to drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this handbook are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical treatment is used in addition to the sediment basin.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from Division of Safety of Dams.
- Standing water may cause mosquitoes or other pests to breed.
- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure with a design life of 12 to 28 months in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in California will be required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80 % of the sediment that flows into them if designed according to this handbook. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas. Drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). The basin must not be located in a stream but it should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

- Construct before clearing and grading work begins when feasible.
- Do not locate in a stream.
- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Large basins are subject to state and local dam safety requirements.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

Sediment basins must be designed in accordance with Section A of the State of California NPDES General Permit for Stormwater Discharges Associated with Construction Activities (General Permit) where sediment basins are the only control measure proposed for the site. If there is insufficient area to construct a sediment basin in accordance with the General Permit requirements, then the alternate design standards specified herein may be used.

Sediment basins designed per the General Permit shall be designed as follows:

Option 1:

Pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 3.

OR

Option 2:

Sediment basin(s), as measured from the bottom of the basin to the principal outlet, shall have at least a capacity equivalent to 3,600 cubic feet (133 yd^3) of storage per acre draining into the sediment basin. The length of the basin shall be more than twice the width of the basin. The length is determined by measuring the distance between the inlet and the outlet; and the depth must not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency.

OR

Option 3:
Sediment basin(s) shall be designed using the standard equation:

$$As=1.2Q/Vs \qquad \text{(Eq. 1)}$$

Where:

As = Minimum surface area for trapping soil particles of a certain size

Vs = Settling velocity of the design particle size chosen

Q = C I A

Where

Q = Discharge rate measured in cubic feet per second

C = Runoff coefficient

I = Precipitation intensity for the 10-year, 6-hour rain event

A = Area draining into the sediment basin in acres

The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the *Vs* used shall be 100 percent of the calculated settling velocity.

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). The basin(s) shall be located on the site where it can be maintained on a year-round basis and shall be maintained on a schedule to retain the 2 ft of capacity.

OR

Option 4:
The use of an equivalent surface area design or equation, provided that the design efficiency is as protective or more protective of water quality than Option 3.

Other design considerations are:

- The volume of the settling zone should be sized to capture runoff from a 2-year storm or other appropriate design storms specified by the local agency. A detention time of 24 to 40 hours should allow 70 to 80 % of sediment to settle.

- The basin volume consists of two zones:

  - A sediment storage zone at least 1 ft deep.

  - A settling zone at least 2 ft deep.

- The length to settling depth ratio (L/SD) should be less than 200.

- Sediment basins are best used in conjunction with erosion controls. Sediment basins that will be used as the only means of treatment, without upstream erosion and sediment controls, must be designed according to the four options required by the General Permit (see Options 1-4 above). Sediment basins that are used in conjunction with upstream erosion and sediment controls should be designed to have a capacity equivalent to 67 yd^3 of sediment storage per acre of contributory area.

- The length of the basin should be more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet.

- The depth must be no less than 3 ft.

- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.

- Basins should be designed to drain within 72 hours following storm events. If a basin fails to drain within 72 hours, it must be pumped dry.

- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.

  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.

  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.

- Rock or vegetation should be used to protect the basin inlet and slopes against erosion.

- A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.

- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- Basin inlets should be located to maximize travel distance to the basin outlet.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen; although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.
- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 72 hours (also referred to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 72-hour limit is specified to mitigate vector control concerns.
- The two most common outlet problems that occur are: (1) the capacity of the outlet is too great resulting in only partial filling of the basin and drawdown time less than designed for; and (2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, the following outlet types are recommended for use: (1) a single orifice outlet with or without the protection of a riser pipe, and (2) perforated riser. Design guidance for single orifice and perforated riser outlets follow:
  - *Flow Control Using a Single Orifice At The Bottom Of The Basin (Figure 1)*: The outlet control orifice should be sized using the following equation:

$$a = \frac{2A(H - Ho)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H - Ho)^{0.5}}{CT} \qquad \text{(Eq. 2)}$$

where:

a = area of orifice (ft^2)

A = surface area of the basin at mid elevation (ft^2)

C = orifice coefficient

T = drawdown time of full basin (hrs)

g = gravity (32.2 ft/s²)

H = elevation when the basin is full (ft)

Ho = final elevation when basin is empty (ft)

With a drawdown time of 40 hours, the equation becomes:

$$a = \frac{(1.75x10^{-6})A(H - Ho)^{0.5}}{C} \qquad \text{(Eq. 3)}$$

- *Flow Control Using Multiple Orifices (see Figure2):*

$$a_t = \frac{2A(h_{\max})}{3600CT(2g[h_{\max} - h_{centroid\ of\ orifices}])^{0.5}} \qquad \text{(Eq. 4)}$$

With terms as described above except:

a_t = total area of orifices

h_{max} = maximum height from lowest orifice to the maximum water surface (ft)

$h_{centroid\ of\ orifices}$ = height from the lowest orifice to the centroid of the orifice configuration (ft)

Allocate the orifices evenly on two rows; separate the holes by 3x hole diameter vertically, and by 120 degrees horizontally (refer to Figure 2).

Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

Care must be taken in the selection of "C"; 0.60 is most often recommended and used. However, based on actual tests, GKY (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:

C = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or

C = 0.80 when the material is thicker than the orifice diameter

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

Average annual costs for installation and maintenance (2 year useful life) are:

- Basin less than 50,000 ft^3: Range, \$0.24 - \$1.58/ft^3. Average, \$0.73 per ft^3. \$400 - \$2,400, \$1,200 average per drainage acre.
- Basin size greater than 50,000 ft^3: Range, \$0.12 – \$0.48/ft^3. Average, \$0.36 per ft^3. \$200 - \$800, \$600 average per drainage acre.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at appropriate locations.
- Remove standing water from basin within 72 hours after accumulation.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

References

A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zones, Metropolitan Washington Council of Governments, March 1992.

Draft-Sedimentation and Erosion Control, an Inventory of Current Practices, USEPA. April 1990.

Guidelines for the Design and Construction of Small Embankment Dams, Division of Safety of Dams, California Department of Water Resources, March 1986.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

McLean, J., 2000. Mosquitoes in Constructed Wetlands: A Management Bugaboo? In T.R. Schueler and H.K. Holland [eds.], The Practice of Watershed Protection. pp. 29-33. Center for Watershed Protection, Ellicott City, MD, 2000.

Metzger, M.E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. The dark site of stormwater runoff management: disease vectors associated with structural BMPs, 2002.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Water, Work Group-Working Paper, USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

U.S. Environmental Protection Agency (USEPA). Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters. EPA 840-B-9-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1993

Water Quality Management Plan for the Lake Tahoe Region, Volume II Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

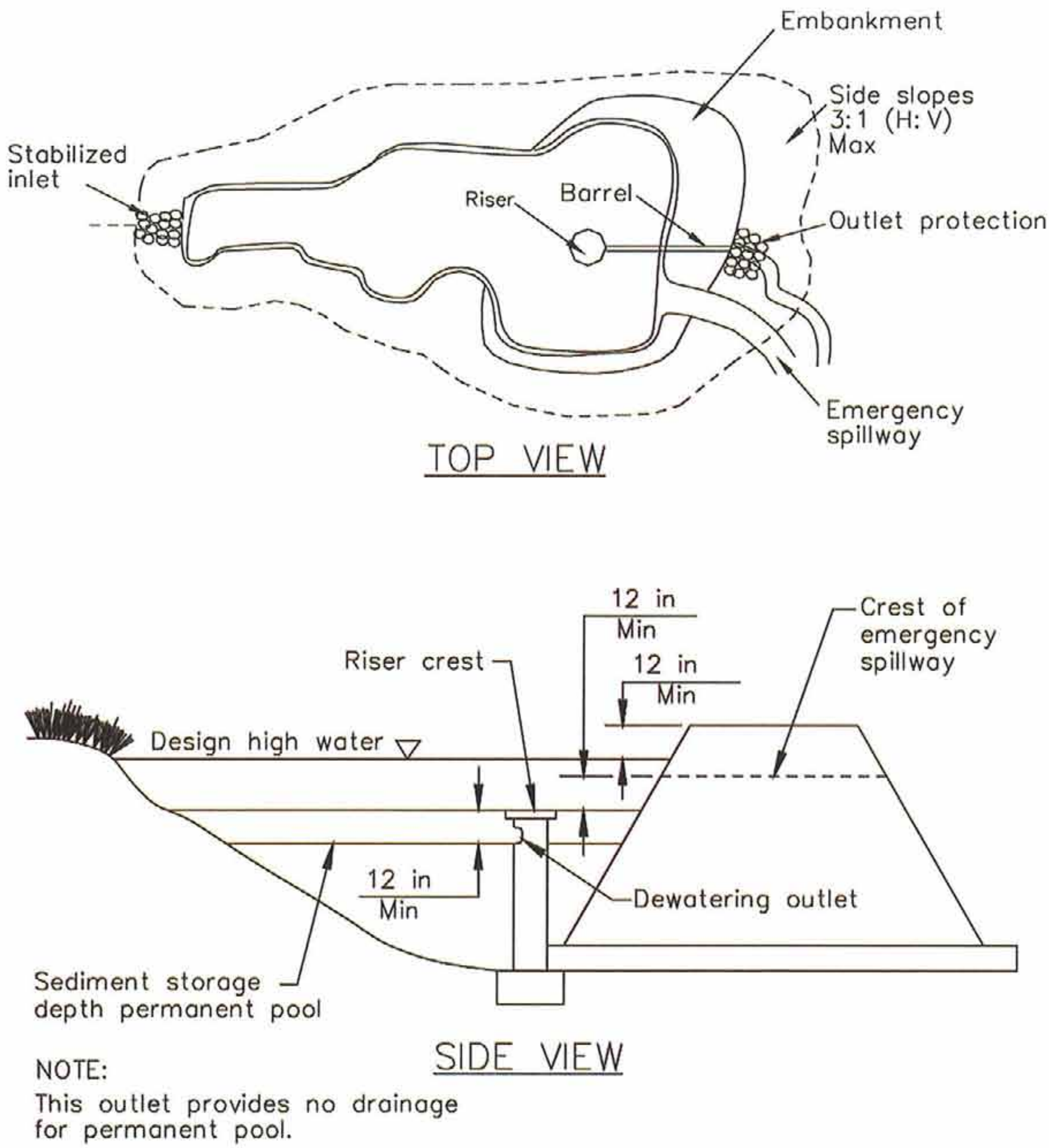
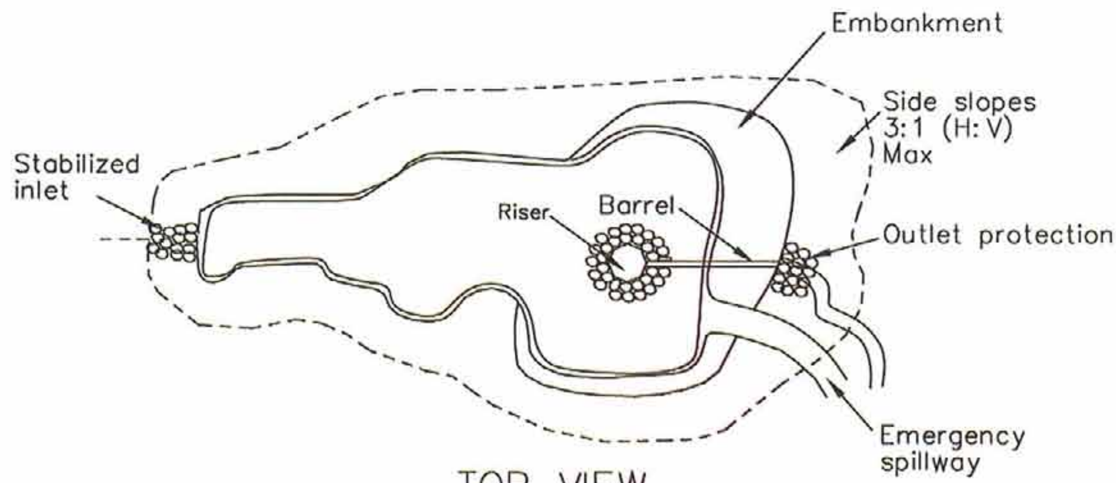
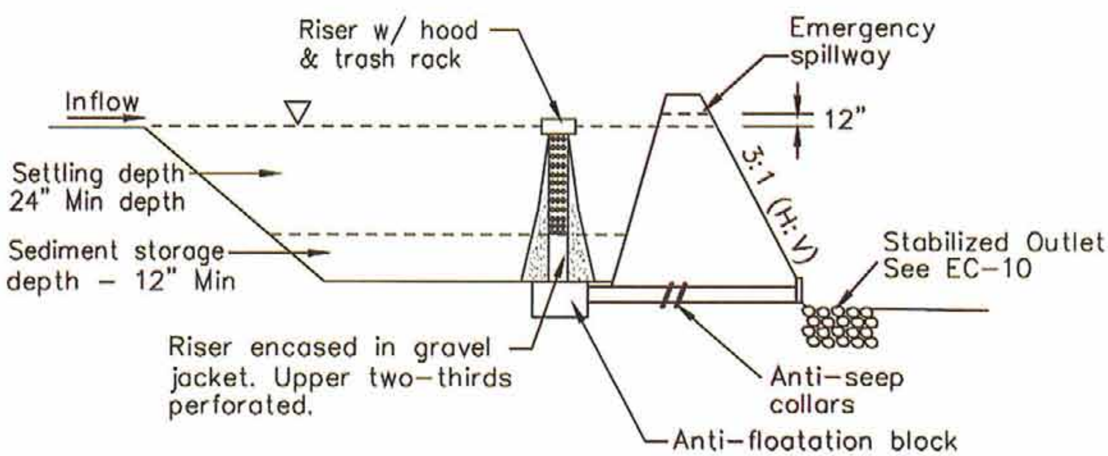


FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
SINGLE ORIFICE DESIGN
NOT TO SCALE



TOP VIEW



SIDE VIEW

FIGURE 2: TYPICAL TEMPORARY SEDIMENT BASIN
MULTIPLE ORIFICE DESIGN
NOT TO SCALE

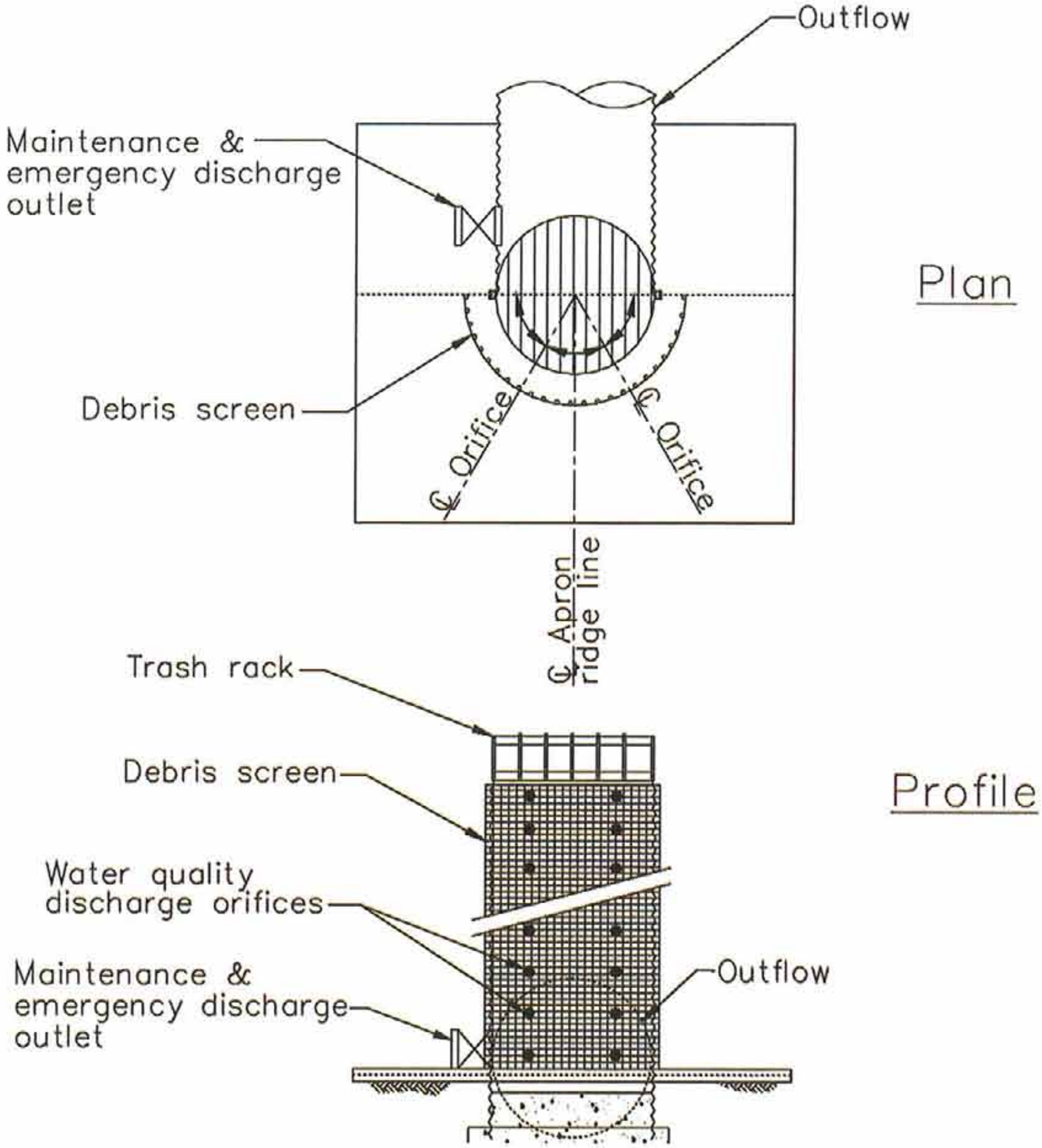
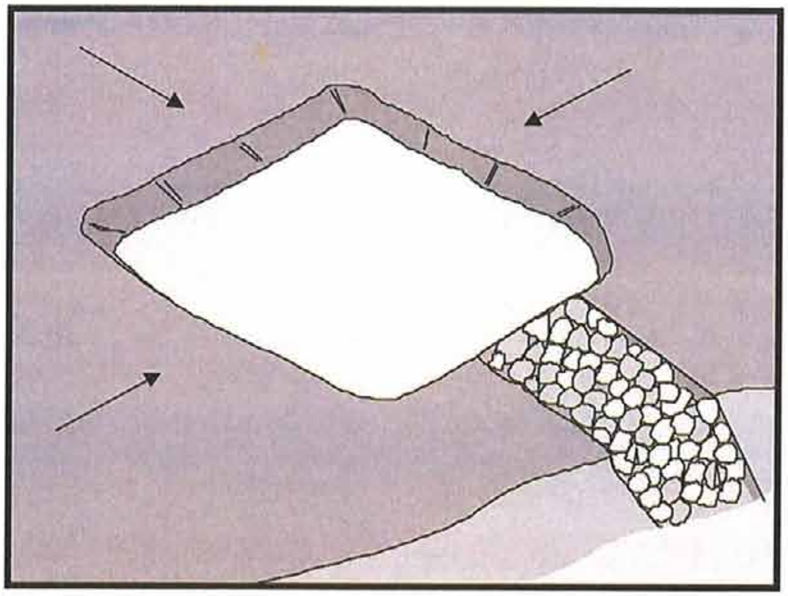


FIGURE 3: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-2 Sediment Basin (for larger areas)

Description and Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out or before the runoff is discharged. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Suitable Applications

Sediment traps should be considered for use:

- At the perimeter of the site at locations where sediment-laden runoff is discharged offsite.
- At multiple locations within the project site where sediment control is needed.
- Around or upslope from storm drain inlet protection measures.
- Sediment traps may be used on construction projects where the drainage area is less than 5 acres. Traps would be placed where sediment-laden stormwater may enter a storm drain or watercourse. SE-2, Sediment Basins, must be used for drainage areas greater than 5 acres.
- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

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Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conducive to vector production.
- Should not be located in live streams.

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SE-2, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed of, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see SE-2, Sediment Basin). As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a 2-year storm is a common design criteria for a sediment trap. The sizing criteria below assume that this runoff volume is 0.042 acre-ft/acre (0.5 in. of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California:

- Locate sediment traps as near as practical to areas producing the sediment.
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 yd^3/acre and 33 yd^3/acre of contributing drainage area, respectively, based on 0.5 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet and bypass structures.
- The outlet pipe or open spillway must be designed to convey anticipated peak flows.
- Use rock or vegetation to protect the trap outlets against erosion.
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainage ways. The following steps must be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.
- All cut-and-fill slopes should be 3:1 or flatter.
- When a riser is used, all pipe joints must be watertight.
- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin.
- When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft below the top of the embankment.

- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Costs

Average annual cost per installation and maintenance (18 month useful life) is $0.73 per ft^3 ($1,300 per drainage acre). Maintenance costs are approximately 20% of installation costs.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect outlet area for erosion and stabilize if required.
- Inspect trap banks for seepage and structural soundness, repair as needed.
- Inspect outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Inspect fencing for damage and repair as needed.
- Inspect the sediment trap for area of standing water during every visit. Corrective measures should be taken if the BMP does not dewater completely in 72 hours or less to prevent vector production.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the trap capacity. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.

References

Brown, W., and T. Schueler. The Economics of Stormwater BMPs in the Mid-Atlantic Region. Prepared for Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD, 1997.

Draft – Sedimentation and Erosion Control, an Inventory of Current Practices, USEPA, April 1990.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Metzger, M.E., D.F. Messer, C.L. Beitia, C.M. Myers, and V.L. Kramer, The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs, 2002.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

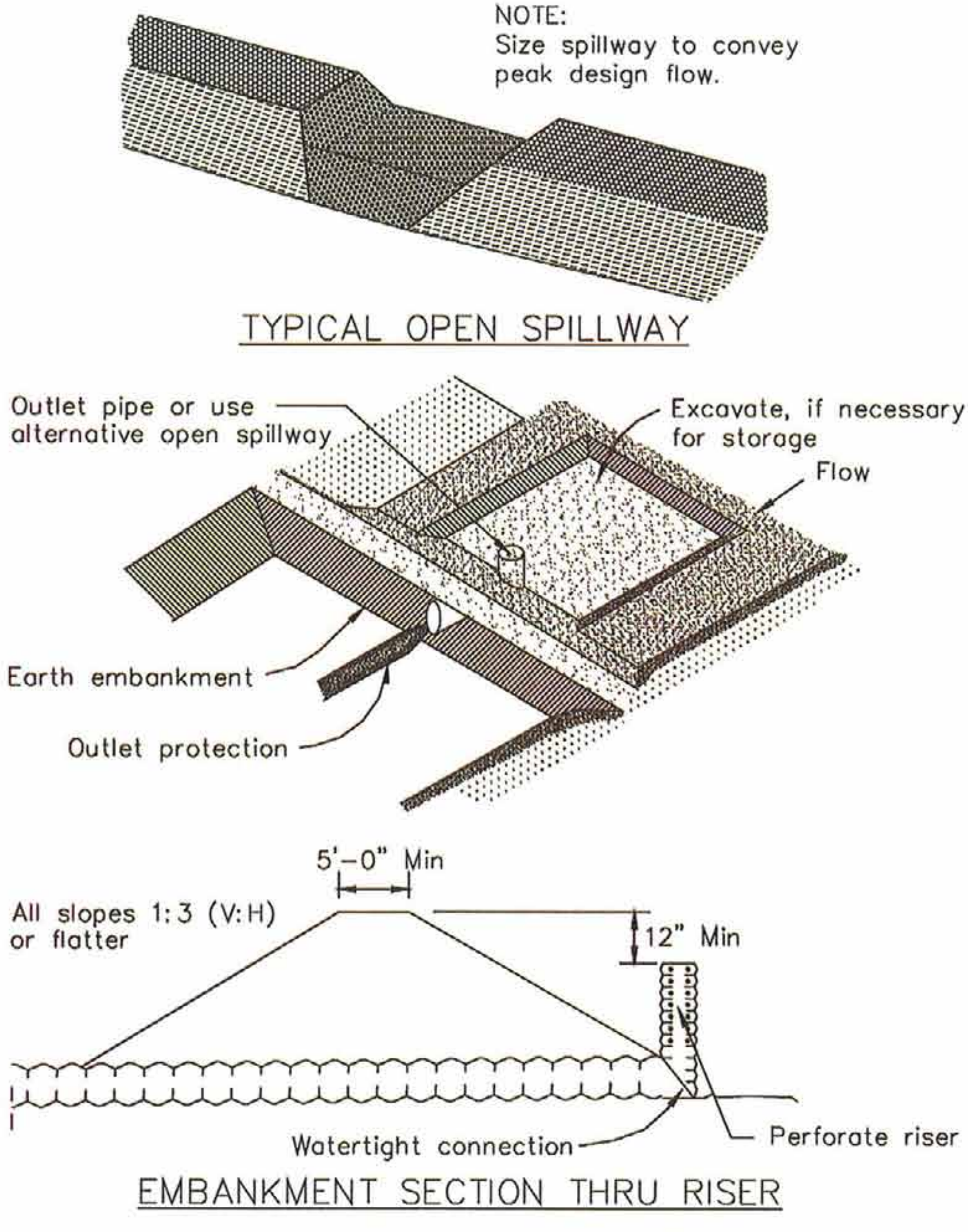
Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

U.S. Environmental Protection Agency (USEPA). Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters. EPA 840-B-9-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1993.

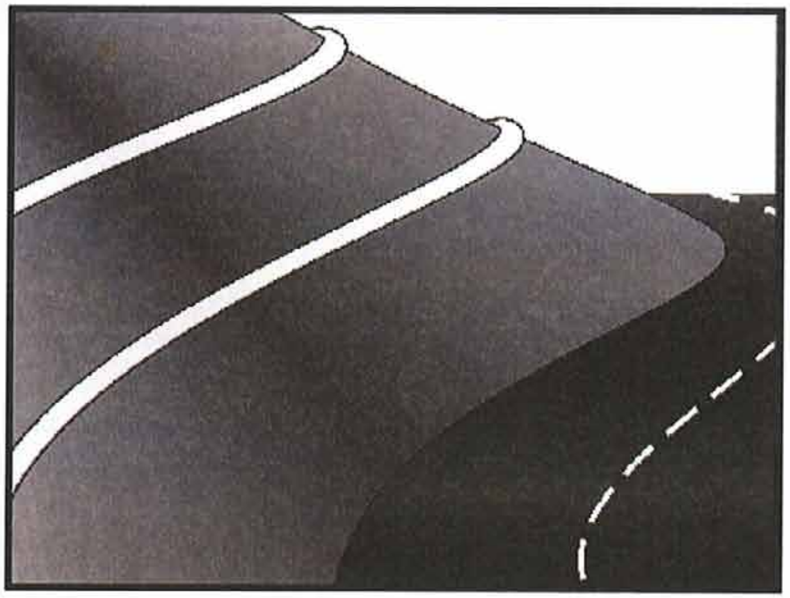
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



TYPICAL SEDIMENT TRAP
NOT TO SCALE

Fiber Rolls

SE-5



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A fiber roll consists of straw, flax, or other similar materials bound into a tight tubular roll. When fiber rolls are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the end of a downward slope where it transitions to a steeper slope
- Along the perimeter of a project
- As check dams in unlined ditches
- Down-slope of exposed soil areas
- Around temporary stockpiles

Limitations

- Fiber rolls are not effective unless trenched

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- Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.

Implementation

Fiber Roll Materials

- Fiber rolls should be either prefabricated rolls or rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 8 in. diameter.
- Bind roll at each end and every 4 ft along length of roll with jute-type twine.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.

Removal

- Fiber rolls are typically left in place.

- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

Costs

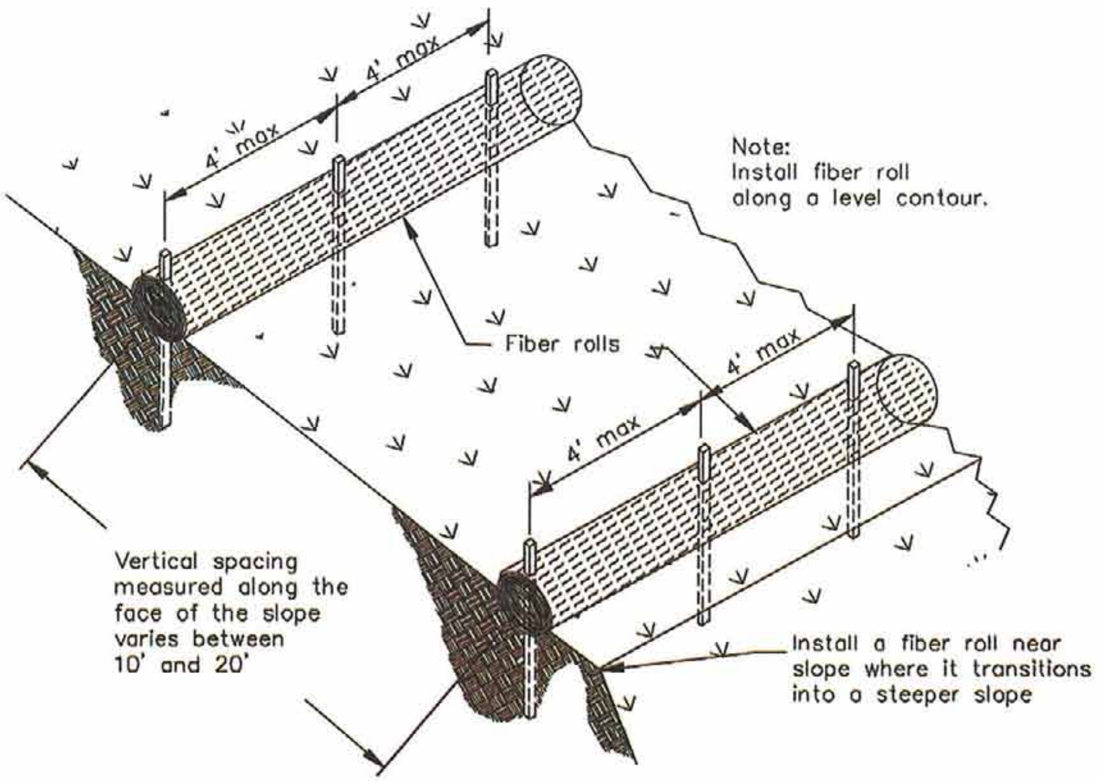
Material costs for fiber rolls range from $20 - $30 per 25 ft roll.

Inspection and Maintenance

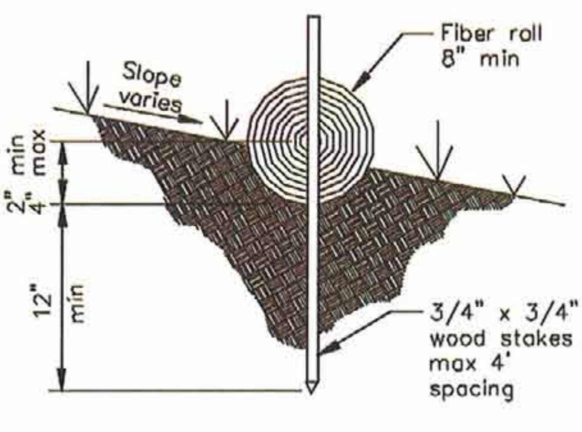
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the fiber roll and the adjacent ground surface. Sediment removed during maintenance may be incorporated into earthwork on the site of disposed at an appropriate location.
- If fiber rolls are used for erosion control, such as in a mini check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.

References

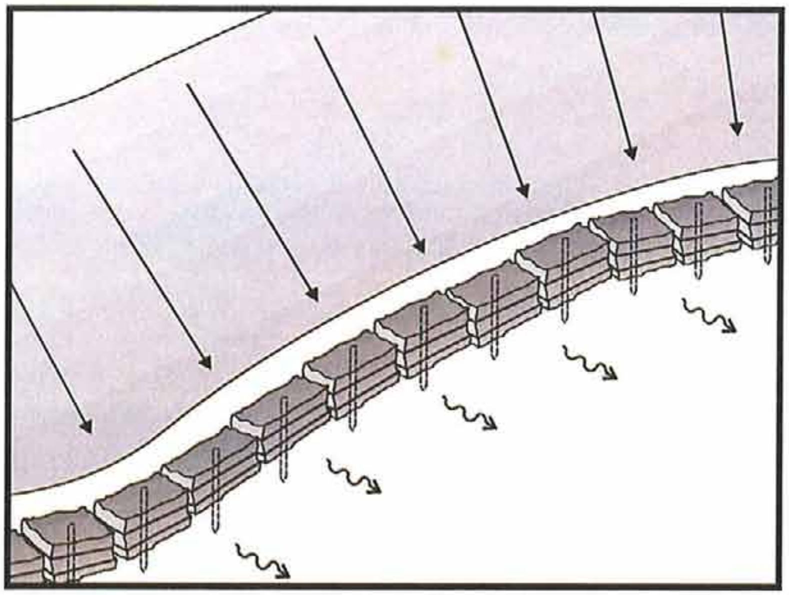
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



TYPICAL FIBER ROLL INSTALLATION
N.T.S.



ENTRENCHMENT DETAIL
N.T.S.



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

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Description and Purpose

A straw bale barrier is a series of straw bales placed on a level contour to intercept sheet flows. Straw bale barriers pond sheet- flow runoff, allowing sediment to settle out.

Suitable Applications

Straw bale barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

Straw bale barriers:

- Are not to be used for extended periods of time because they tend to rot and fall apart
- Are suitable only for sheet flow on slopes of 10 % or flatter
- Are not appropriate for large drainage areas, limit to one acre or less
- May require constant maintenance due to rotting
- Are not recommended for concentrated flow, inlet protection, channel flow, and live streams
- Cannot be made of bale bindings of jute or cotton
- Require labor-intensive installation and maintenance
- Cannot be used on paved surfaces
- Should not to be used for drain inlet protection
- Should not be used on lined ditches
- May introduce undesirable non-native plants to the area

Implementation

General

A straw bale barrier consists of a row of straw bales placed on a level contour. When appropriately placed, a straw bale barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. Straw bale barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils.

Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainage ways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow. Use of straw bale barriers in accordance with this BMP should produce acceptable results.

Design and Layout

- Locate straw bale barriers on a level contour.
  - Slopes up to 10:1 (H:V): Straw bales should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the toe of slope.
  - Slopes greater than 10:1 (H:V): Not recommended.

- Turn the ends of the straw bale barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sand bags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 1 acre, or 0.25 acre per 100 ft of barrier.
- Maximum flow path to the barrier should be limited to 100 ft.
- Straw bale barriers should consist of two parallel rows.
  - Butt ends of bales tightly
  - Stagger butt joints between front and back row
  - Each row of bales must be trenched in and firmly staked
- Straw bale barriers are limited in height to one bale laid on its side.
- Anchor bales with either two wood stakes or four bars driven through the bale and into the soil. Drive the first stake towards the butt joint with the adjacent bale to force the bales together.
- See attached figure for installation details.

Materials

- ***Straw Bale Size:*** Each straw bale should be a minimum of 14 in. wide, 18 in. in height, 36 in. in length and should have a minimum mass of 50 lbs. The straw bale should be composed entirely of vegetative matter, except for the binding material.
- ***Bale Bindings:*** Bales should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 14 gauge. Nylon or polypropylene string should be approximately 12 gauge in diameter with a breaking strength of 80 lbs force.
- ***Stakes:*** Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

Costs

Straw bales cost $5 - $7 each. Adequate labor should be budgeted for installation and maintenance.

Inspection and Maintenance

Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Straw bales degrade, especially when exposed to moisture. Rotting bales will need to be replaced on a regular basis.

- Replace or repair damaged bales as needed.

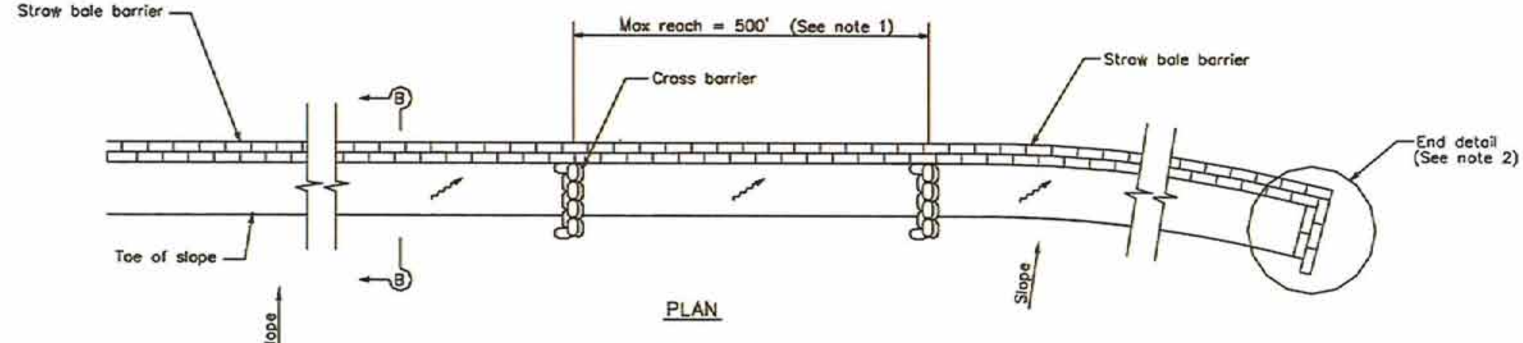
- Repair washouts or other damages as needed.

- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.

- Remove straw bales when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



PLAN

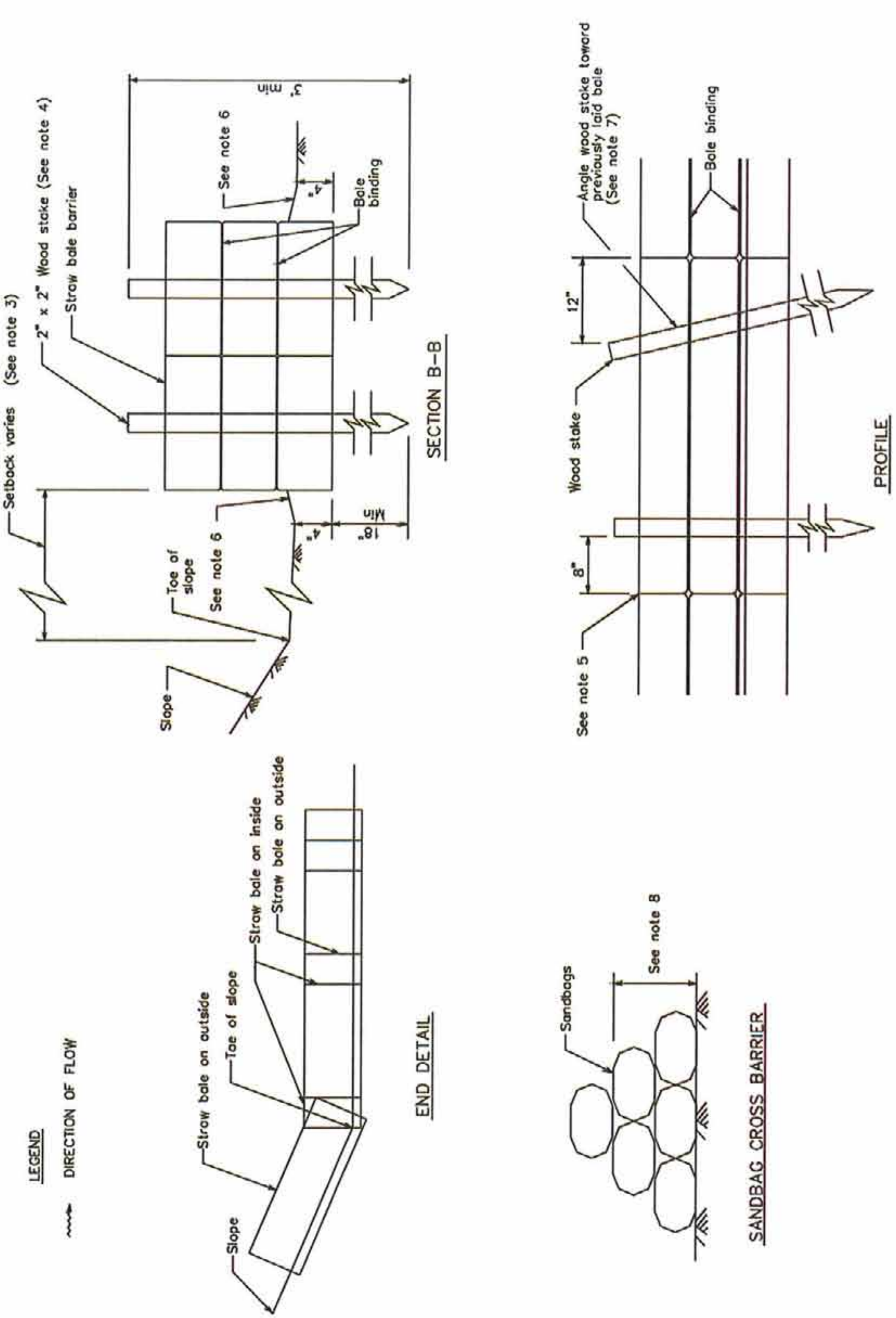
STRAW BALE BARRIER

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. The end of barrier shall be turned up slope.
3. Dimension may vary to fit field condition.
4. Stake dimensions are nominal.
5. Place straw bales tightly together.
6. Tamp embedment spoils against sides of installed bales.
7. Drive angled wood stake before vertical stake to ensure tight abutment to adjacent bale.
8. Sandbag cross barriers should be a min of 1/2 and a max of 2/3 the height of the linear barrier.
9. Sandbag rows and layers should be offset to eliminate gaps.

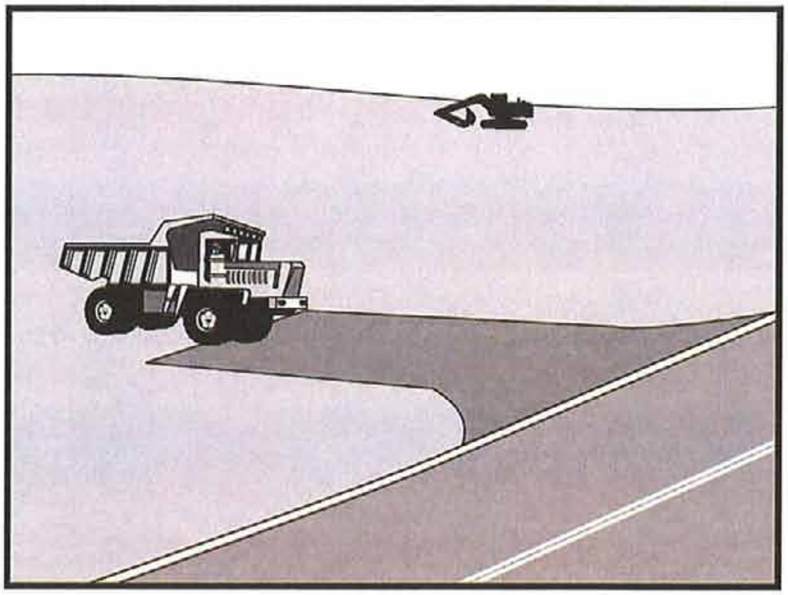
LEGEND

〰→ DIRECTION OF FLOW



Setback varies (See note 3)
2" x 2" Wood stake (See note 4)
Straw bale barrier
See note 6
3' min
4"
Bale binding
18" Min
Toe of slope
Slope
SECTION B-B
Angle wood stake toward previously laid bale (See note 7)
Bale binding
12"
Wood stake
8"
See note 5
PROFILE
LEGEND
DIRECTION OF FLOW
Slope
Straw bale on outside
Toe of slope
Straw bale on inside
Straw bale on outside
END DETAIL
Sandbags
See note 8
SANDBAG CROSS BARRIER

Stabilized Construction Entrance/Exit TC-1



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

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Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights of way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft minimum, and 30 ft minimum width.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove all sediment deposited on paved roadways within 24 hours.
- Remove gravel and filter fabric at completion of construction

Costs

Average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

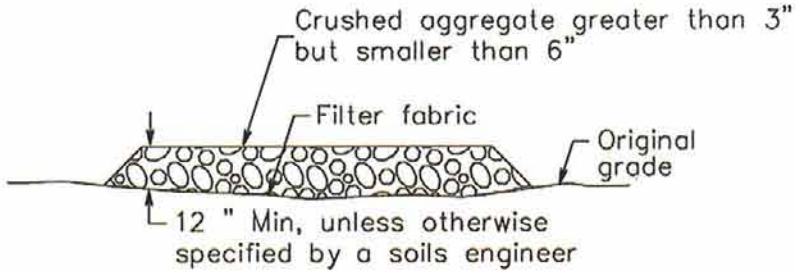
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

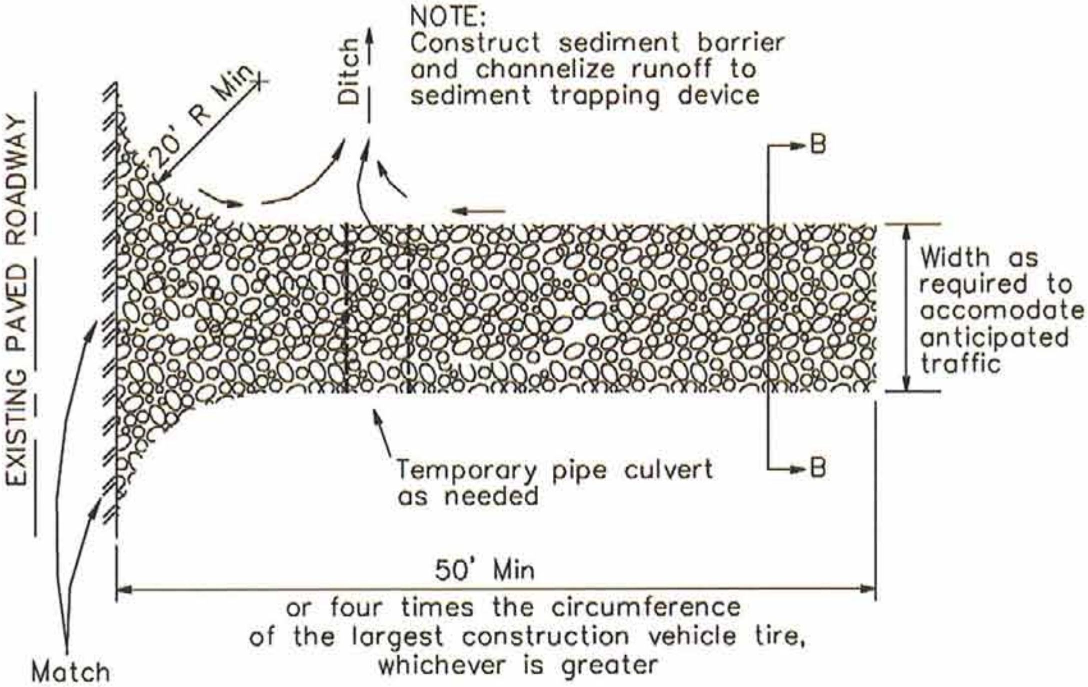
Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

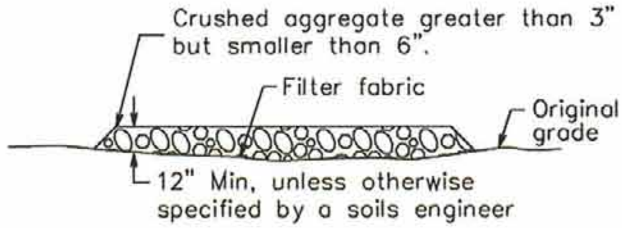
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



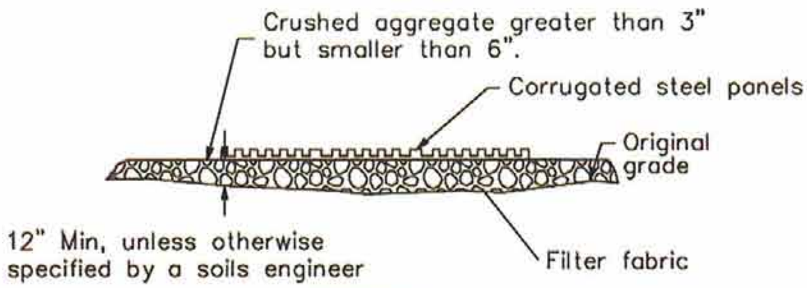
SECTION B-B
NTS



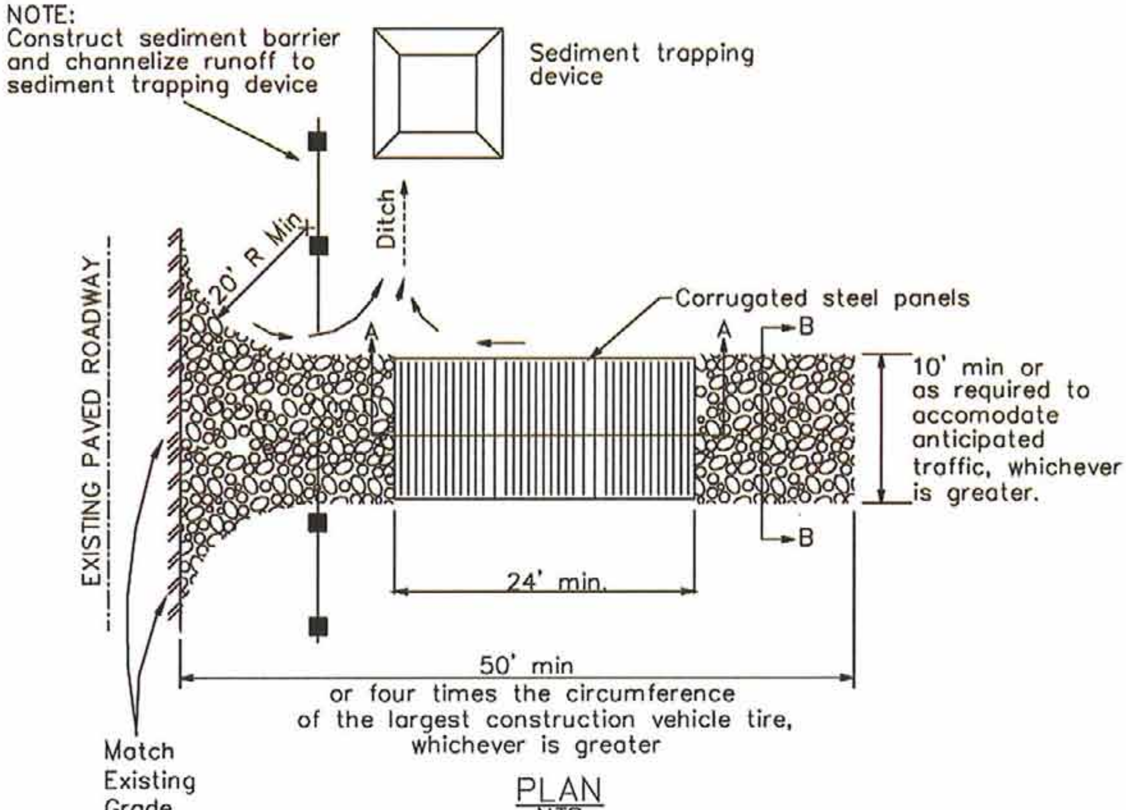
PLAN
NTS



SECTION B–B
NTS

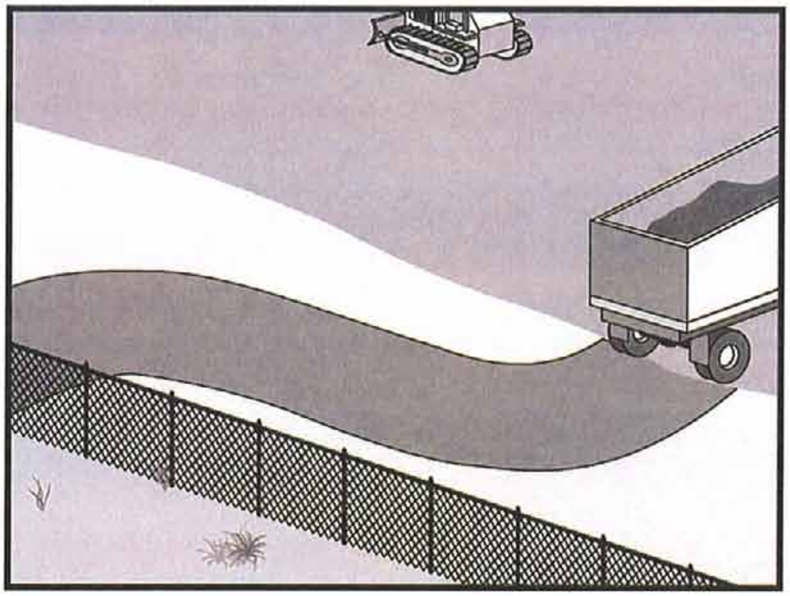


SECTION A–A
NOT TO SCALE



PLAN
NTS

Stabilized Construction Roadway TC-2



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

This BMP should be applied for the following conditions:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access
  - Construction during wet weather
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather
  - Where dust is a problem during dry weather
  - Adjacent to water bodies
  - Where poor soils are encountered

Limitations

- The roadway must be removed or paved when construction is complete.

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- Certain chemical stabilization methods may cause stormwater or soil pollution and should not be used. See WE-1, Wind Erosion Control.
- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.
- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather

Installation/Application Criteria

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system (SE-10, Storm Drain Inlet Protection). In addition, the following criteria should be considered.

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (WE-1, Wind Erosion Control).
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.

- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.

- Coordinate materials with those used for stabilized construction entrance/exit points.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, impact weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.

- Keep all temporary roadway ditches clear.

- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.

- Periodically apply additional aggregate on gravel roads.

- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Costs

Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

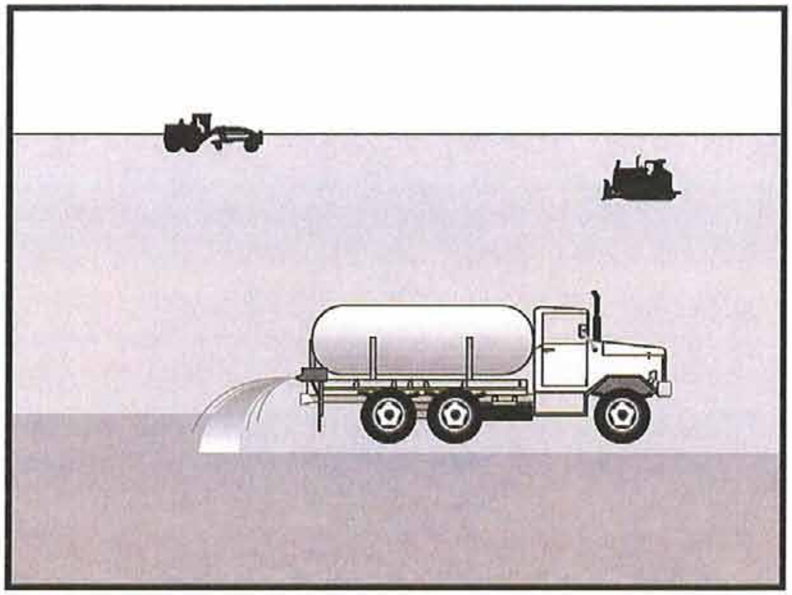
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Wind Erosion Control

WE-1



Objectives		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	☑
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

Suitable Applications

Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Sediment tracking onto paved roads
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Over watering may cause erosion.

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- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Effectiveness depends on soil, temperature, humidity, and wind velocity.
- Chemically treated sub grades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- Asphalt, as a mulch tack or chemical mulch, requires a 24-hour curing time to avoid adherence to equipment, worker shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

Implementation

General

California's Mediterranean climate, with short wet seasons and long hot dry seasons, allows the soils to thoroughly dry out. During these dry seasons, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment.

Dust control, as a BMP, is a practice that is already in place for many construction activities. Los Angeles, the North Coast, and Sacramento, among others, have enacted dust control ordinances for construction activities that cause dust to be transported beyond the construction project property line.

Recently, the State Air Resources Control Board has, under the authority of the Clean Air Act, started to address air quality in relation to inhalable particulate matter less than 10 microns (PM-10). Approximately 90 percent of these small particles are considered to be dust. Existing dust control regulations by local agencies, municipal departments, public works department, and public health departments are in place in some regions within California.

Many local agencies require dust control in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. The following are measures that local agencies may have already implemented as requirements for dust control from contractors:

- Construction and Grading Permits: Require provisions for dust control plans.
- Opacity Emission Limits: Enforce compliance with California air pollution control laws.
- Increase Overall Enforcement Activities: Priority given to cases involving citizen complaints.
- Maintain Field Application Records: Require records of dust control measures from contractor;
- Stormwater Pollution Prevention Plan: (SWPPP): Integrate dust control measures into SWPPP.

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table shows dust control practices that can be applied to site conditions that cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures would include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph, and controlling the number and activity of vehicles on a site at any given time.

SITE CONDITION	DUST CONTROIPRACTICES								
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Silt Fences	Temporary Gravel Construction Entrances/Equipment Wash Down	Haul Truck Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	X	X	X	X	X				X
Disturbed Areas Subject to Traffic			X	X	X		X		X
Material Stock Pile Stabilization			X	X		X			X
Demolition			X				X	X	
Clearing/ Excavation			X	X		X			X
Truck Traffic on Unpaved Roads			X	X	X		X	X	
Mud/Dirt Carry Out					X		X		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (EC-1, Scheduling).
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.

- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality Control Board requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."
- Materials applied as temporary soil stabilizers and soil binders also generally provide wind erosion control benefits.
- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for wet suppression or chemical stabilization of exposed soils.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas.
- Stabilize inactive construction sites using vegetation or chemical stabilization methods.
- Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater.

Costs

Installation costs for water and chemical dust suppression are low, but annual costs may be quite high since these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Check areas protected to ensure coverage.
- Most dust control measures require frequent, often daily, or multiple times per day attention.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

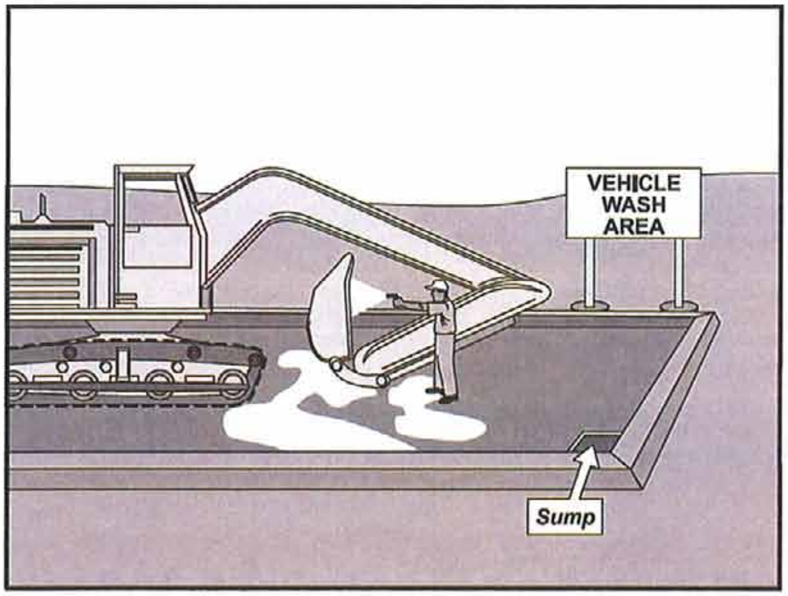
California Air Pollution Control Laws, California Air Resources Board, 1992.

Caltrans, Standard Specifications, Sections 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative".

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Vehicle and Equipment Cleaning NS-8



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

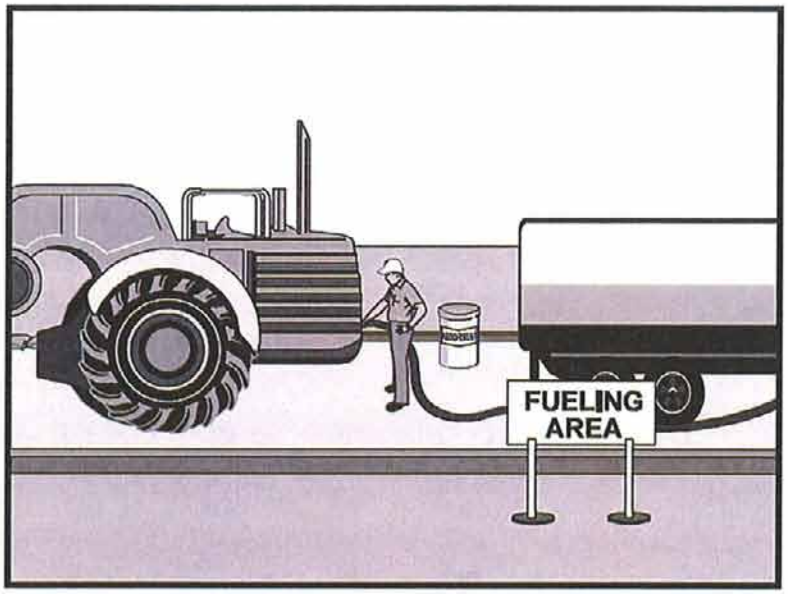
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

Vehicle and Equipment Fueling NS-9



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.

- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should be disposed of properly after use.

- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.

- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.

- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.

- Train employees and subcontractors in proper fueling and cleanup procedures.

- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.

- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.

- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.

- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.

- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).

- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.

- Keep ample supplies of spill cleanup materials onsite.

- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

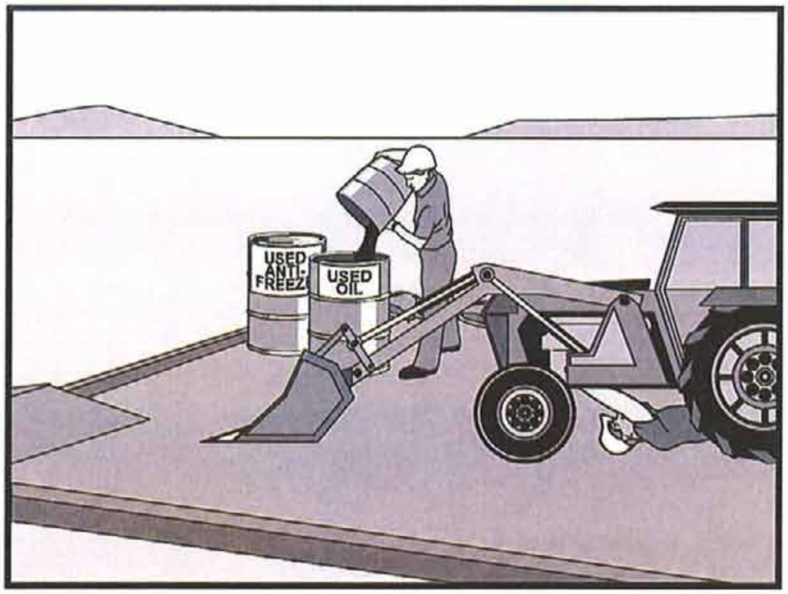
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle & Equipment Maintenance NS-10



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and Equipment Fueling.

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Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.
- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,- trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

NS-10 Vehicle & Equipment Maintenance

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Keep ample supplies of spill cleanup materials onsite.

- Maintain waste fluid containers in leak proof condition.

- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.

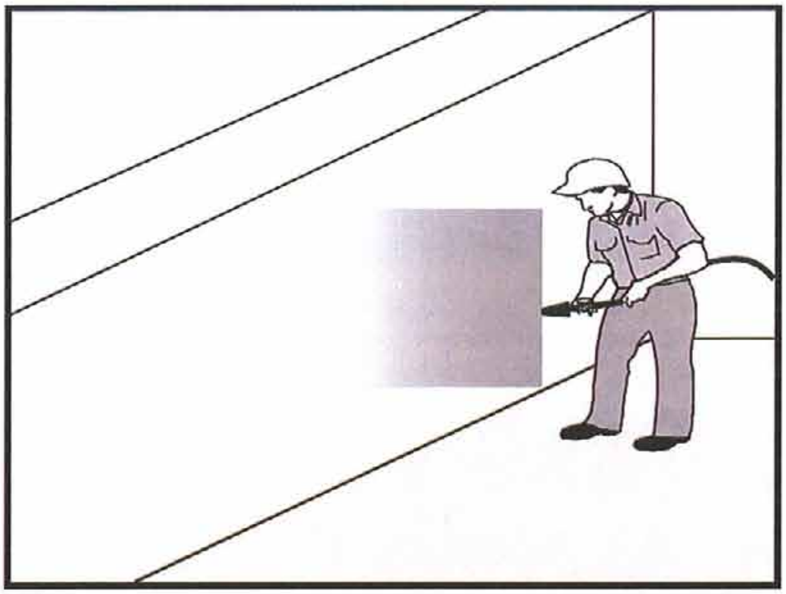
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Concrete curing is used in the construction of structures such as bridges, retaining walls, pump houses, large slabs, and structured foundations. Concrete curing includes the use of both chemical and water methods. Discharges of stormwater and non-stormwater exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines. Proper procedures reduce or eliminate the contamination of stormwater runoff during concrete curing.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

Limitations

None identified.

Implementation

Chemical Curing

- Avoid over spray of curing compounds.
- Minimize the drift of chemical cure as much as possible by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.

- Use proper storage and handling techniques for concrete curing compounds. Refer to WM-1, Material Delivery and Storage.
- Protect drain inlets prior to the application of curing compounds.
- Refer to WM-4, Spill Prevention and Control.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- Direct cure water away from inlets and watercourses to collection areas for infiltration or other means of removal in accordance with all applicable permits.
- Collect cure water at the top of slopes and transport or dispose of water in a non-erodible manner. See EC-9 Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Costs

All of the above measures are generally low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect cure containers and spraying equipment for leaks.

References

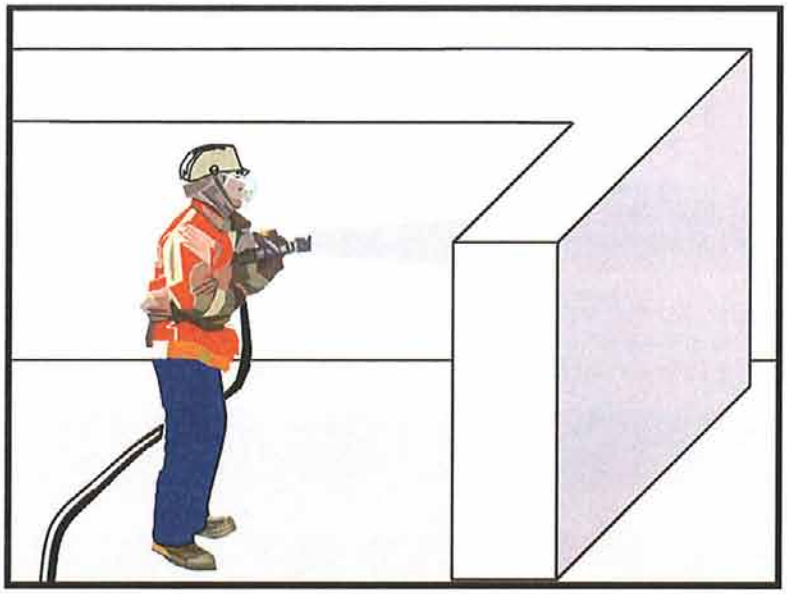
Blue Print for a Clean Bay-Construction-Related Industries: Best Management Practices for Stormwater Pollution Prevention; Santa Clara Valley Non Point Source Pollution Control Program, 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Concrete Finishing

NS-13



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high pressure water blasting. Stormwater and non-stormwater exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines. Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on stormwater and non-stormwater discharges.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Limitations

None identified.

Implementation

- Collect and properly dispose of water from high-pressure water blasting operations.
- Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control. Refer to EC-9, Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.

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- Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering). Refer to NS-2 De-Watering Operations.
- Protect inlets during sandblasting operations. Refer to SE-10, Storm Drain Inlet Protection.
- Refer to WM-8, Concrete Waste Management for disposal of concrete based debris.
- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- When blast residue contains a potentially hazardous waste, refer to WM-6, Hazardous Waste Management.

Costs
These measures are generally of low cost.

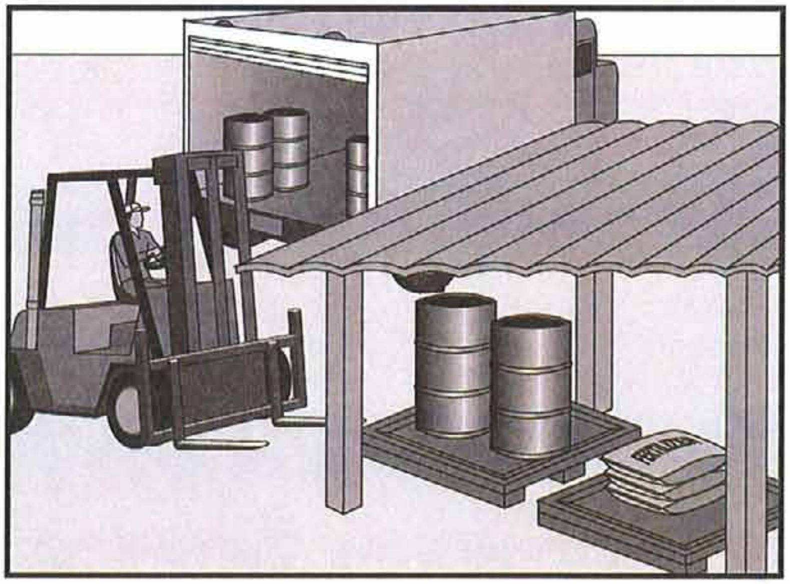
Inspection and Maintenance
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sweep or vacuum up debris from sandblasting at the end of each shift.
- At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.

References
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Material Delivery and Storage WM-1



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease
- Asphalt and concrete components

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- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored.
- Construction site areas should be designated for material delivery and storage.
- Material delivery and storage areas should be located near the construction entrances, away from waterways, if possible.
  - Avoid transport near drainage paths or waterways.
  - Surround with earth berms. See EC-9, Earth Dikes and Drainage Swales.
  - Place in an area which will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- An up to date inventory of materials delivered and stored onsite should be kept.
- Hazardous materials storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the rainy season, consider storing materials in a covered area. Store materials in secondary containments such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.

- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.
- Chemicals should be kept in their original labeled containers.
- Employees and subcontractors should be trained on the proper material delivery and storage practices.
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Throughout the rainy season, each temporary containment facility should be covered during non-working days, prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.

- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill clean up material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous materials.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.

Cost

- The largest cost of implementation may be in the construction of a materials storage area that is covered and provides secondary containment.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep an ample supply of spill cleanup materials near the storage area.
- Keep storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Stockpile Management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other materials.

Limitations

None identified.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

- Locate stockpiles a minimum of 50 ft away from concentrated flows of stormwater, drainage courses, and inlets.
- Protect all stockpiles from stormwater runon using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbag, gravel bags, or straw bale barriers.

- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.
- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.
- Place bagged materials on pallets and under cover.

Protection of Non-Active Stockpiles

Non-active stockpiles of the identified materials should be protected further as follows:

Soil stockpiles

- During the rainy season, soil stockpiles should be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times.
- During the non-rainy season, soil stockpiles should be covered or protected with a temporary perimeter sediment barrier prior to the onset of precipitation.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- During the rainy season, the stockpiles should be covered or protected with a temporary perimeter sediment barrier at all times.
- During the non-rainy season, the stockpiles should be covered or protected with a temporary perimeter sediment barrier prior to the onset of precipitation.

Stockpiles of "cold mix"

- During the rainy season, cold mix stockpiles should be placed on and covered with plastic or comparable material at all times.
- During the non-rainy season, cold mix stockpiles should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Stockpiles/Storage of pressure treated wood with copper, chromium, and arsenic or ammonical, copper, zinc, and arsenate

- During the rainy season, treated wood should be covered with plastic or comparable material at all times.
- During the non-rainy season, treated wood should be covered with plastic or comparable material at all times and cold mix stockpiles should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Protection of Active Stockpiles

Active stockpiles of the identified materials should be protected further as follows:

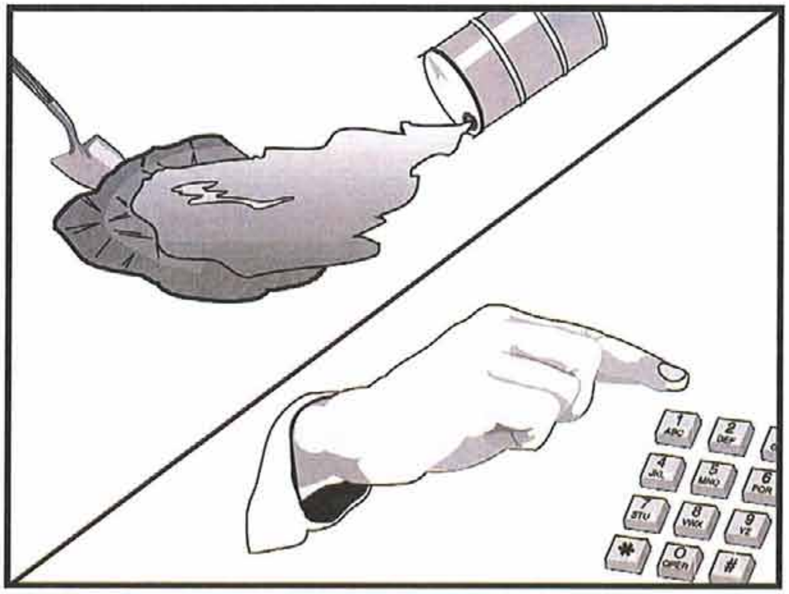
- All stockpiles should be protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Costs
All of the above are low cost measures.

Inspection and Maintenance
- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation

- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.

References
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

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- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:

  - Contain spread of the spill.

  - Notify the project foreman immediately.

  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.

  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.

  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:

  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.

  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.

  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.

  - Notification should first be made by telephone and followed up with a written report.

  - The services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.

  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.

- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/ or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

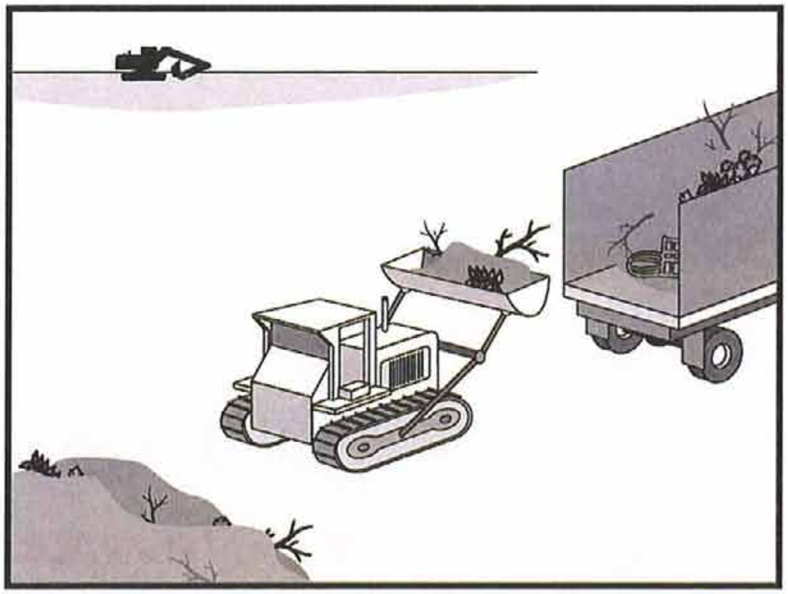
- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Solid waste management procedures and practices are designed to prevent or reduce the discharge of pollutants to stormwater from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for construction sites where the following wastes are generated or stored:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction
- Packaging materials including wood, paper, and plastic
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces and masonry products
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes
- Construction wastes including brick, mortar, timber, steel and metal scraps, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials

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- Highway planting wastes, including vegetative material, plant containers, and packaging materials

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce stormwater pollution:

- Select designated waste collection areas onsite.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- Clean up immediately if a container does spill.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Stormwater runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

References

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

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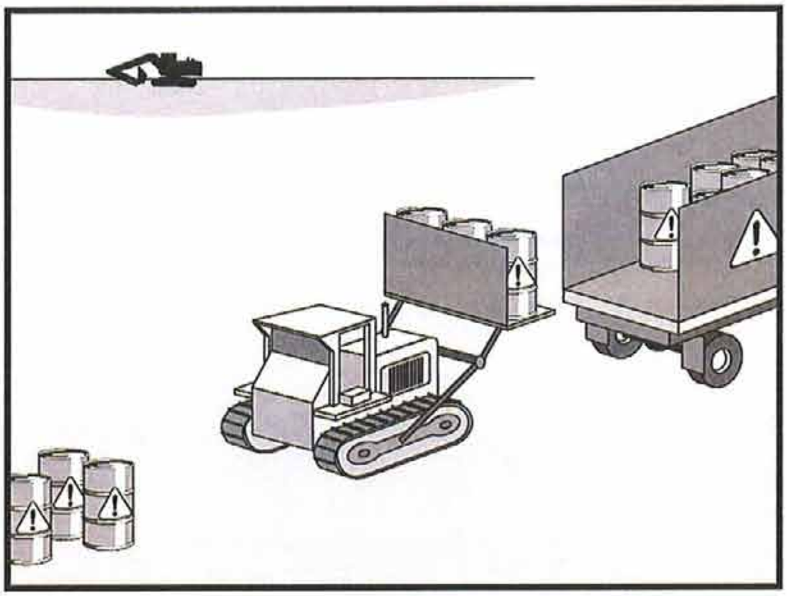

Objectives		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Asphalt Products
- Concrete Curing Compounds
- Pesticides
- Palliatives
- Acids
- Septic Wastes
- Paints
- Stains
- Solvents
- Wood Preservatives
- Roofing Tar
- Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302

In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with federal, state, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints
- Asbestos
- PCBs (particularly in older transformers)

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172, 173, 178, and 179.
- All hazardous waste should be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
  - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours.
  - Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

  - Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.

  - Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.

- Drums should not be overfilled and wastes should not be mixed.

- Unless watertight, containers of dry waste should be stored on pallets.

- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with federal and state regulations.

- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.

- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.

- The following actions should be taken with respect to temporary contaminant:

  - Ensure that adequate hazardous waste storage volume is available.

  - Ensure that hazardous waste collection containers are conveniently located.

  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.

  - Minimize production or generation of hazardous materials and hazardous waste on the job site.

  - Use containment berms in fueling and maintenance areas and where the potential for spills is high.

  - Segregate potentially hazardous waste from non-hazardous construction site debris.

  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.
- Use all of the product before disposing of the container.
- Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.

Disposal Procedures

- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services certified laboratory should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Hazardous waste should be regularly collected.
- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.
- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.

- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302. Also notify the Governors Office of Emergency Services Warning Center at (916) 845-8911.

- A copy of the hazardous waste manifests should be provided.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

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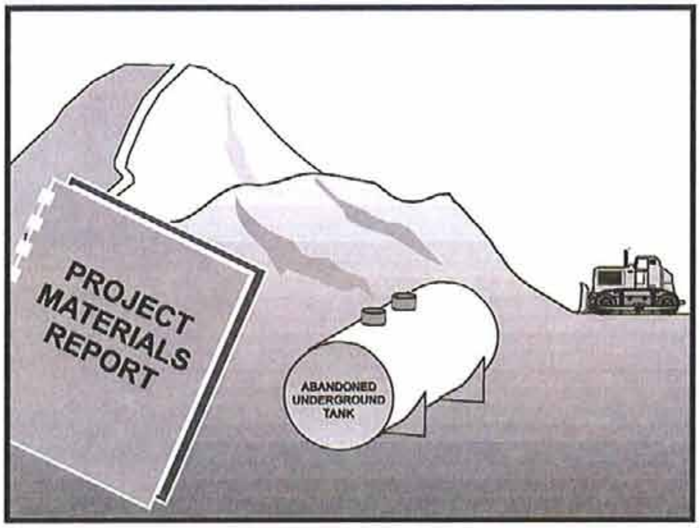

Objectives

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TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that cannot be treated onsite must be disposed of offsite by a licensed hazardous waste hauler. The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the SWPPP. The contractor should review applicable reports and investigate appropriate call-outs in the plans, specifications, and

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SWPPP. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities
  - Detected or undetected spills and leaks
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
  - Suspected soils should be tested at a certified laboratory.

Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.

- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations. All hazardous waste storage will comply with the requirements in Title 22, CCR, Sections 66265.250 to 66265.260.
- Test suspected soils at an approved certified laboratory.
- Work with the local regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps.
  - Install a berm around the stockpile to prevent runoff from leaving the area.
  - Do not stockpile in or near storm drains or watercourses.
- Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT)
  - United States Environmental Protection Agency (USEPA)
  - California Environmental Protection Agency (CAL-EPA)

- California Division of Occupation Safety and Health Administration (CAL-OSHA)
- Local regulatory agencies

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal, state, and local agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the local agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal, state, and local laws.

Costs

Prevention of leaks and spills is inexpensive. Treatment or disposal of contaminated soil can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal, state, and local agencies.

- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

References

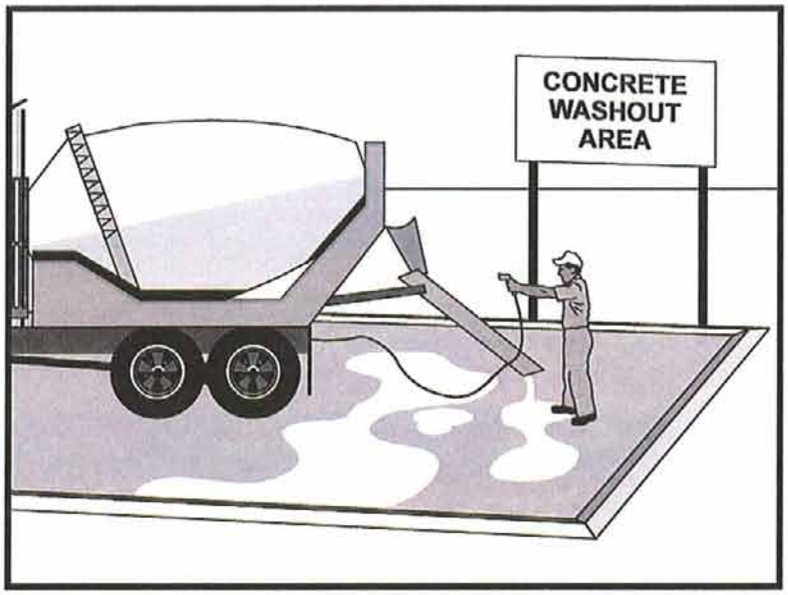
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Concrete Waste Management WM-8



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout offsite, performing onsite washout in a designated area, and training employee and subcontractors.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result form demolition activities
- Slurries containing portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition
- Concrete trucks and other concrete-coated equipment are washed onsite
- Mortar-mixing stations exist
- See also NS-8, Vehicle and Equipment Cleaning

Limitations

- Offsite washout of concrete wastes may not always be possible.

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made.
- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amounts of fresh concrete.
- Perform washout of concrete trucks offsite or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- For onsite washout:
  - Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
  - Wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed properly.
- Avoid creating runoff by draining water to a bermed or level area when washing concrete to remove fine particles and expose the aggregate.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.
- Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility.
- A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

- Below grade concrete washout facilities are typical. Above grade facilities are used if excavation is not practical.

- A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.

- Saw-cut PCC slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement. See also NS-3, Paving and Grinding Operations; and WM-10, Liquid Waste Management.

- Slurry residue should be vacuumed and disposed in a temporary pit (as described in OnSite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allowed to dry. Dispose of dry slurry residue in accordance with WM-5, Solid Waste Management.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 ft from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.

- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.

- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.

- Washout of concrete trucks should be performed in designated areas only.

- Only concrete from mixer truck chutes should be washed into concrete wash out.

- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of offsite.

- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per WM-5, Solid Waste Management. Dispose of hardened concrete on a regular basis.

- Temporary Concrete Washout Facility (Type Above Grade)

  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.

- Straw bales, wood stakes, and sandbag materials should conform to the provisions in SE-9, Straw Bale Barrier.

- Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

- Temporary Concrete Washout Facility (Type Below Grade)

  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.

  - Lath and flagging should be commercial type.

  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of.

- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.

- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and disposed of.

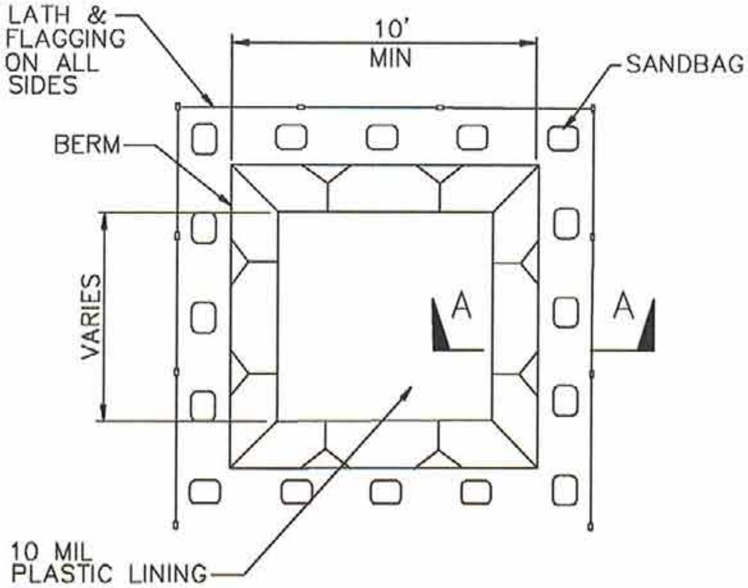
- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

References

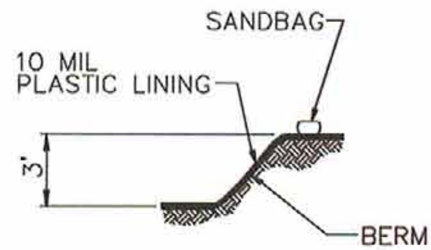
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

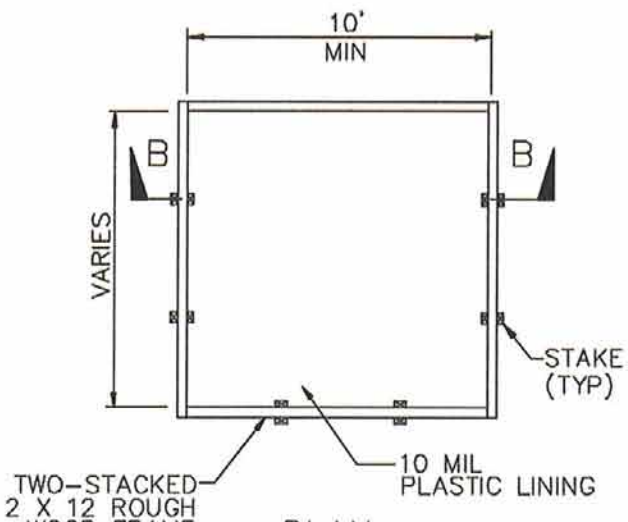
Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.



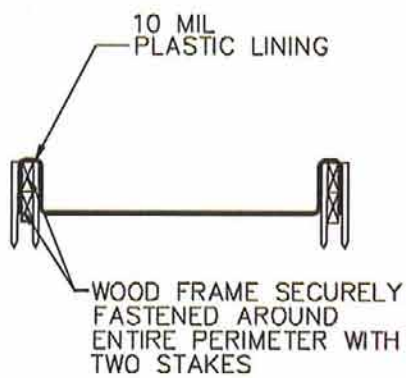
PLAN
NOT TO SCALE
TYPE "BELOW GRADE"



SECTION A–A
NOT TO SCALE



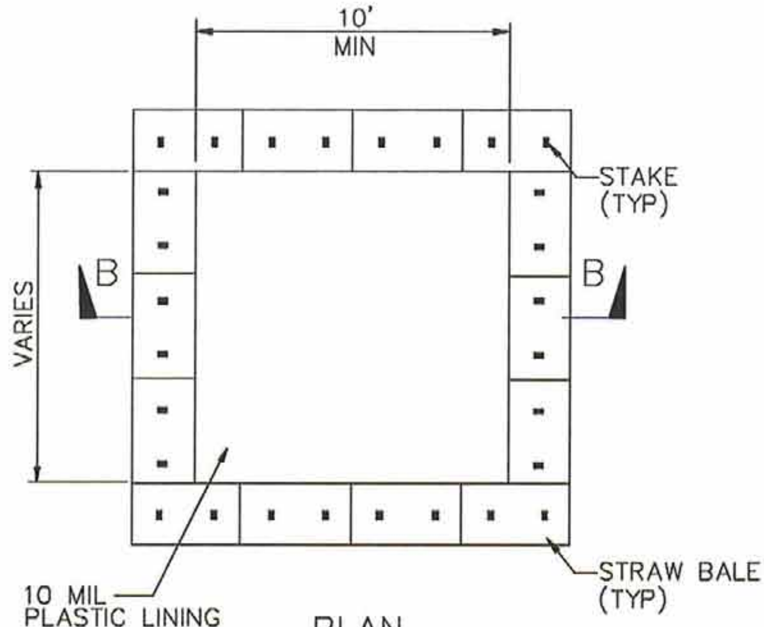
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"



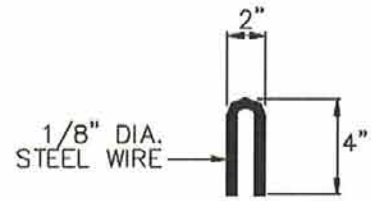
SECTION B–B
NOT TO SCALE

NOTES

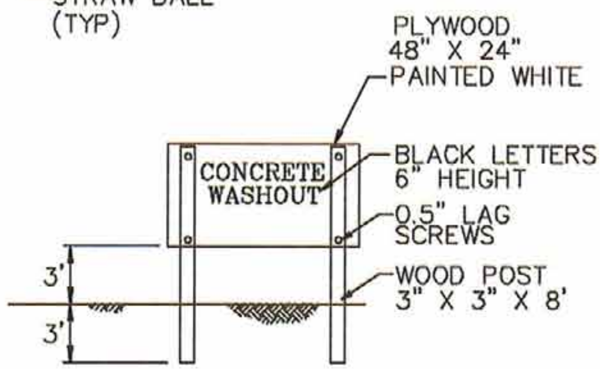
1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.



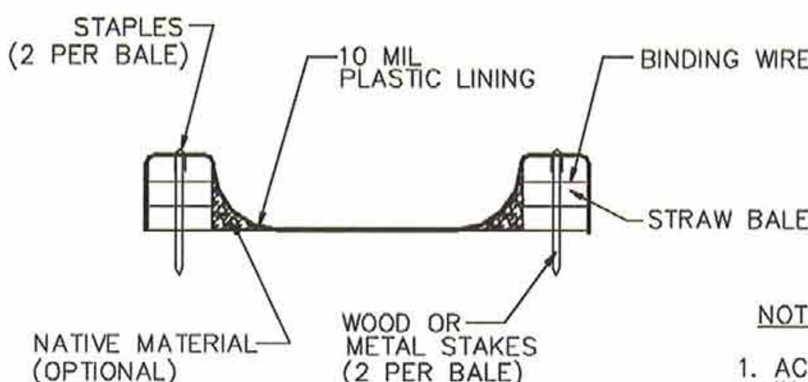
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE" WITH STRAW BALES



STAPLE DETAIL



CONCRETE WASHOUT SIGN DETAIL (OR EQUIVALENT)

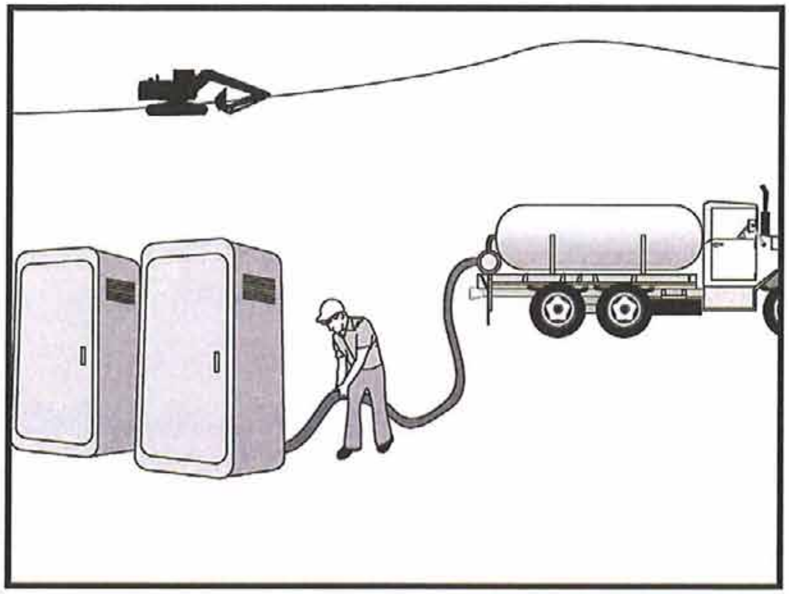


SECTION B–B
NOT TO SCALE

NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

Sanitary/Septic Waste Management WM-9



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ Primary Objective

☒ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to stormwater from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with state and local requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.
- Wastewater should not be discharged or buried within the project site.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- Only reputable, licensed sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Untreated raw wastewater should never be discharged or buried.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an onsite disposal system (OSDS), such as a septic system, local health agency requirements must be followed.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a licensed service.
- Regular waste collection by a licensed hauler should be arranged before facilities overflow.

Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Arrange for regular waste collection.
- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

12.3 Preliminary Groundwater Supply Wells, Pipeline, and Operating Costs: Eagle Mountain Pumped Storage Project

Eagle Mountain Pumped Storage Project – Preliminary Groundwater Supply Wells, Pipeline, and Operating Costs

Prepared by: Nick Miller, P.E., and Richard Westmore, P.E., GEI Consultants, Inc.

April 9, 2009

Eagle Crest Energy Company (ECEC) is proposing to use groundwater wells in the Desert Center area as water supply for its Pumped Storage Project (Project). ECEC will need water to initially fill the Project reservoirs and provide annual make-up water from evaporation and seepage. Based on preliminary analysis, three groundwater wells will be used to provide water for filling the Project reservoirs. This technical memorandum presents the analysis to estimate pipe and pump sizes, construction costs, and power costs. Additional information regarding seepage from the Project reservoirs and groundwater supply pumping effects can be found in the technical memorandums listed in the references.

The locations of the three groundwater wells is uncertain at this time, however, six potential properties have been identified. The potential properties have been separated into Primary and Alternate Well Properties, which are shown on Figure 1. Based on the water supply pipeline alignments shown on Figure 1, we have evaluated several alternatives and developed estimates of pipe material, pipe sizes, pumping head, pumping costs, and construction costs for each. After review of several alternate system configurations a preferred system design was selected to minimize construction costs and power requirements.

Using the Primary Well Properties the preferred groundwater supply well system would consist of the following main components:

- 3 – 2,000 gpm; 1,000 horsepower Vertical Turbine Pumps
- 3.9 miles of 12” diameter steel pipe
- 0.7 miles of 18” diameter steel pipe
- 10.7 miles of 24” diameter steel pipe

The total construction cost opinions for the groundwater supply well system are based on preliminary designs and current Project understandings. The construction cost estimates are based on our evaluation of significant construction items, materials and installation unit prices. No allowances have been made for easement and property acquisition, construction contingencies, mobilization, bonds, insurance, design, or legal and administrative costs. These additional costs can be significant and should be included in the total cost for budgeting purposes. The total construction cost opinion for the groundwater supply well system was estimated to be about $19.9 million.

Pump sizing and power estimates for the groundwater supply well system are based on preliminary designs and current Project understandings. Pipe friction losses were estimated using the Swamee-Jain equation. Minor losses were assumed to be 20 percent of the total pipe friction losses. The pump sizes were limited to a maximum total dynamic head (TDH) of 1,500 feet. Pump efficiency was assumed to be 80 percent. Pumping power costs were estimated using $0.08 per kilowatt hour. The total estimated power required for initially filling the Project reservoirs was estimated to be about 61.4 GW-hrs, costing approximately $4.9 million.

The total construction costs opinions for the groundwater supply well system and pumping power costs to initially fill the Project reservoirs was estimated to be about $24.8 million. Additionally, the annual pumping costs required to replace evaporation losses after the initial filling were developed assuming the two wells furthest from the Project would be decommissioned. Based on this assumption, the annual cost for pumping the water lost to evaporation was estimated to be approximately $173,000.

Using the Alternate Well Properties the preferred groundwater supply well system would consist of the following main components:

- 3 – 2,000 gpm; 1,000 horsepower Vertical Turbine Pumps
- 2.6 miles of 12” diameter steel pipe
- 5.6 miles of 18” diameter steel pipe
- 10.7 miles of 24” diameter steel pipe

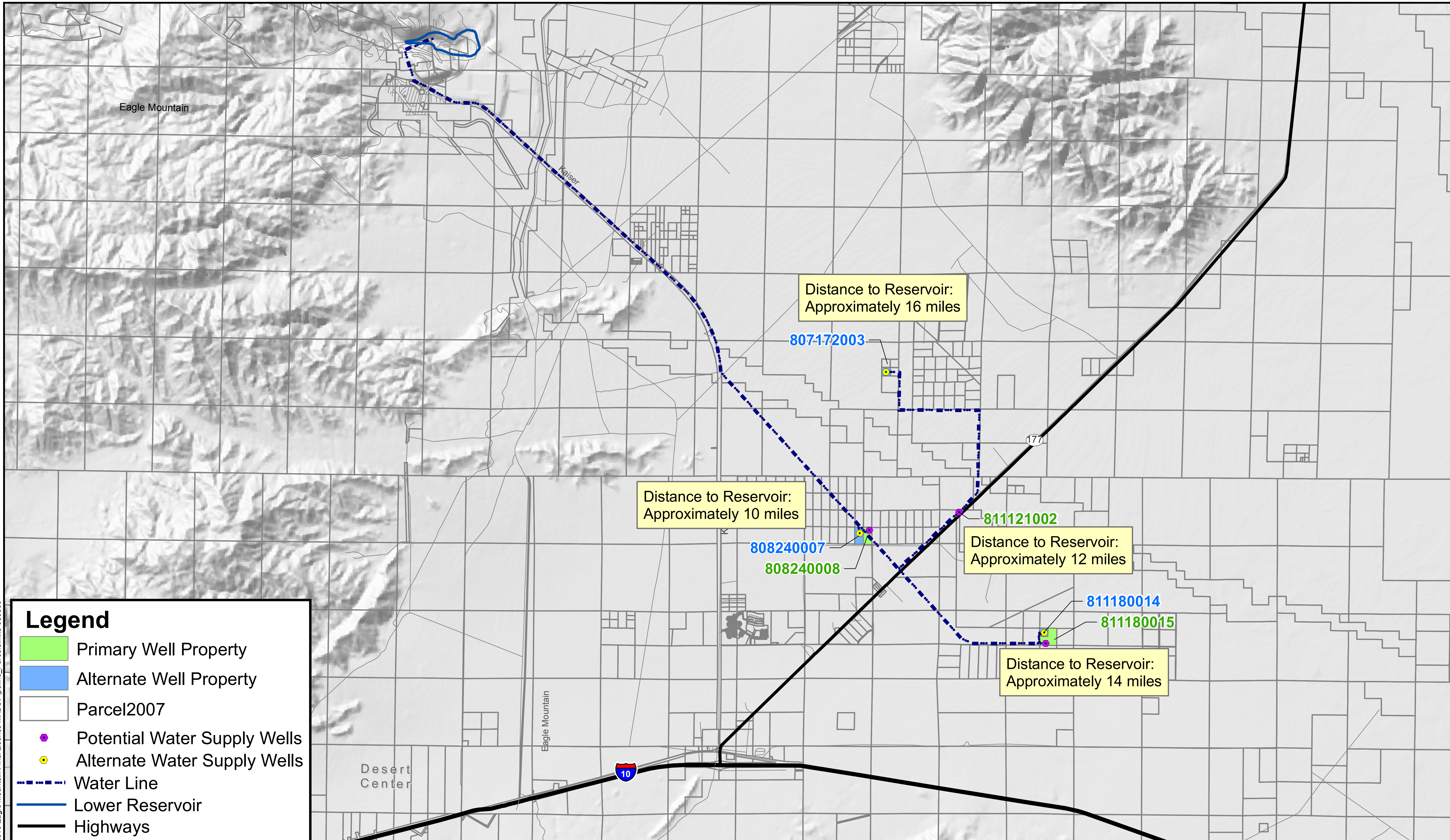
Based on the same assumptions listed above, the total construction cost opinion for the groundwater supply well system was estimated to be about $22.2 million or about $2.3 million more than the Primary Well Properties alignments. The total estimated power required for initially filling the Project reservoirs and for annual evaporation replacement did not change considerably. Based on the Alternate Well Properties alignments, the total construction costs opinions for the groundwater supply well system and pumping power costs to initially fill the Project reservoirs was estimated to be about $27.1 million.

Detailed calculations and alternate system configurations are presented in Attachment 1.

References

GEI, 2009. Eagle Mountain Pumped Storage Project: Seepage Analyses for Upper and Lower Reservoirs. Produced for ECEC.

GEI 2009. Groundwater Supply Pumping Effects: Eagle Mountain Pumped Storage Project. Produced for ECEC.



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0 0.75 1.5 Miles

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NO.	DATE	ISSUE/REVISION	DES	DRN	CHK	APP

Eagle Crest Energy Company

EAGLE CREST ENERGY COMPANY

GEI PROJECT 080473

EAGLE MOUNTAIN PUMPED STORAGE PROJECT
EAGLE MOUNTAIN, CALIFORNIA

POTENTIAL WATER SUPPLY WELLS

FIGURE 1

March 2009

ATTACHMENT 1

EAGLE MOUNTAIN
PUMPED STORAGE PROJECT

GROUNDWATER SUPPLY WELL SYSTEM DESIGN

GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

[highlighted box] = Recommended Design

RESULTS

Pipe Section	Pipe Material	Discharge (gpm)	Pipe Diameter (in)	Total Dynamic Pumping Head (ft)	Required Power (GW-hrs)
1A	Steel	2,000	12	1,470	21.8
2A	Steel	4,000	18		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,184	21.0
1C	Steel	2,000	12	1,049	18.6
				TOTAL FILLING PUMPING COST =	**$ 4,915,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 24,777,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	18	1,247	18.5
2A	Steel	4,000	18		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,186	21.1
1C	Steel	2,000	12	1,049	18.6
				TOTAL FILLING PUMPING COST =	**$ 4,654,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 24,907,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	18	1,223	18.1
2A	Steel	4,000	24		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,175	20.9
1C	Steel	2,000	12	1,052	18.7
				TOTAL FILLING PUMPING COST =	**$ 4,614,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 25,480,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	24	1,197	17.7
2A	Steel	4,000	24		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,175	20.9
1C	Steel	2,000	12	1,052	18.7
				TOTAL FILLING PUMPING COST =	**$ 4,584,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 27,659,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	18	1,072	15.9
2A	Steel	4,000	18		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,100	19.5
1C	Steel	2,000	12	963	17.1
				TOTAL FILLING PUMPING COST =	**$ 4,203,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 28,010,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**

GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

= Recommended Design

1A	Steel	2,000	18	1,048	15.5
2A	Steel	4,000	24		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,089	19.3
1C	Steel	2,000	12	966	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,162,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 28,592,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	24	1,022	15.1
2A	Steel	4,000	24		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,089	19.3
1C	Steel	2,000	12	966	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,132,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 30,771,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	24	1,017	15.0
2A	Steel	4,000	30		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,087	19.3
1C	Steel	2,000	12	967	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,123,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 31,013,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	30	1,011	15.0
2A	Steel	4,000	30		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,087	19.3
1C	Steel	2,000	12	967	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,117,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 31,895,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	12	1,463	21.7
2A	Steel	4,000	12		
3A	Steel	6,000	36		
1B	Steel	2,000	12	1,172	20.8
1C	Steel	2,000	12	911	16.2
				TOTAL FILLING PUMPING COST =	**$ 4,695,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 35,169,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 168,000**

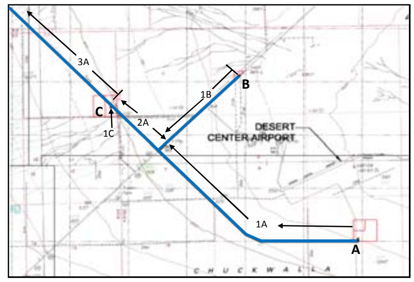
Note:
All system designs assume a maximum pumping total dynamic head (TDH) of 1,500 feet.

GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

Purpose: Determine required pipe size for the Eagle Mountain Pumped Storage Project water supply pipeline.

Reference: Civil Engineering Reference Manual, 11th Ed., Lindenburg, 2008.

SKETCH:



Assumptions:
1. Swamee-Jain Equation for pipe friction loss calculations.
2. Assume minor loss are equal to 20% of friction head.

$$f = \frac{0.25}{\left(\log_{10}\left(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right)^2} \qquad h_f = \frac{fLv^2}{D2g}$$

Pipe Material: Steel
Specific Roughness, e, ft: 0.0002
Kinematic Viscosity, v = 0.0000121 @ 60 degrees
Target Discharge, gpm = 6,000 13.37 cfs

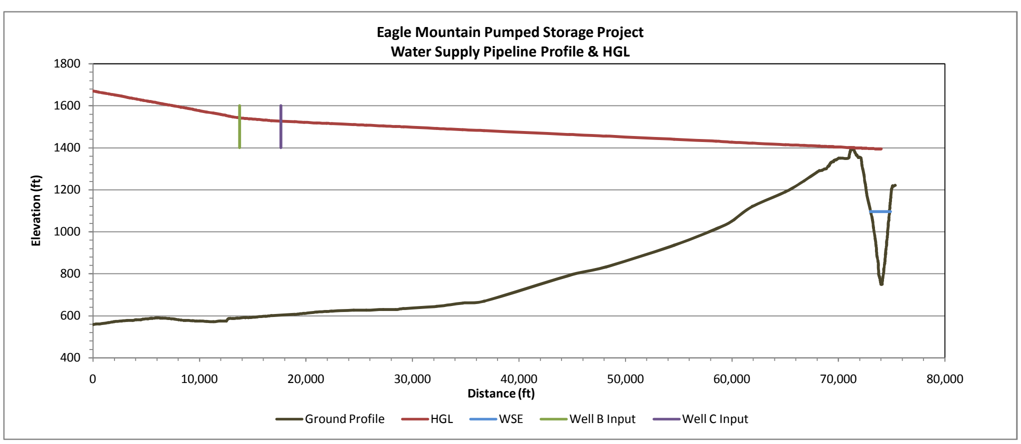
Pipe Section Number	Starting Station	Ending Station	Length (ft)	Discharge (gpm)	Discharge (cfs)	Pipe Diameter (in)	Area (ft^2)	Velocity (ft/s)	Reynolds #	Friction Factor *f*	Friction Losses (ft)	Fitting Losses (ft)	Total Head Loss (ft)	Head Loss Per Foot (ft/ft)
1A	0	13775	13775	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	107.4	21.5	128.9	0.0094
2A	13775	17637	3862	4,000	8.91	18	1.77	5.044	6.3E+05	0.0145	14.8	3.0	17.7	0.0046
3A	17637	74020	56383	6,000	13.37	24	3.14	4.255	7.0E+05	0.0139	110.6	22.1	132.7	0.0024
1B	0	6555	6555	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	51.1	10.2	61.3	0.0094
1C	0	200	200	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	1.6	0.3	1.9	0.0094

Avg. Daily Pump Time, hrs: 20
Cost Per Kilowatt, $: 0.08
Pump Efficiency, N, %: 80

Pump Label:	A	B	C
Pump Elevation, ft:	560	550	605
Assumed Ground Water Elevation, ft:	480	480	480

Pipe Section Number	Initial Pumping Head Above Ground (ft)	Total Dynamic Pumping Head (ft)	Required Pump Horse Power (HP)	Minimum Continuous Pumping Time (days)	Required Power (GW-hrs)	Total Initial Fill Pumping Costs ($)	Installed Pipe Unit Cost ($/ft)	Total Pipe Cost ($)	Pump Cost (assume $500/HP) ($)	Well Installation ($)	TOTAL COST ($)
1A	1,110	1,470	929	1,568	21.76	1,741,000	78	1,080,000	470,000	413,800	**3,704,800**
2A							112	432,000			**432,000**
3A							273	15,389,000			**15,389,000**
1B	1,052	1,184	748	1,568	21.03	1,683,000	78	514,000	380,000	413,800	**2,990,800**
1C	921	1,049	663	1,568	18.63	1,491,000	78	16,000	340,000	413,800	**2,260,800**
				TOTAL =	**61.42**	**4,915,000**				**TOTAL COST =**	**24,777,400**

PROFILE PLOT:



GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

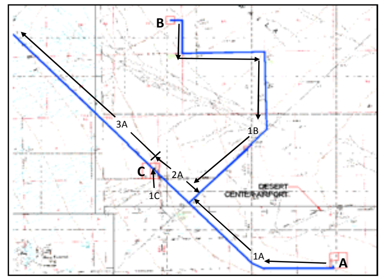
Purpose: Determine required pipe size for the Eagle Mountain Pumped Storage Project water supply pipeline.

Reference: Civil Engineering Reference Manual, 11th Ed., Lindenburg, 2008.

Assumptions:
1. Swamee-Jain Equation for pipe friction loss calculations.
2. Assume minor loss are equal to 20% of friction head.

$$f = \frac{0.25}{\left(\log_{10}\left(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right)^2} \qquad h_f = \frac{fLv^2}{D2g}$$

SKETCH:



Pipe Material: Steel
Specific Roughness, e, ft: 0.0002
Kinematic Viscosity, v = 0.0000121 @ 60 degrees
Target Discharge, gpm = 6,000 13.37 cfs

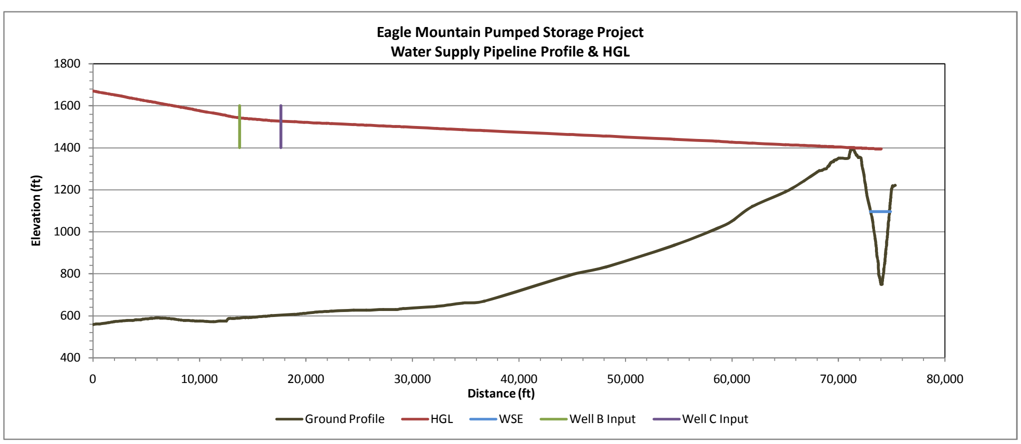
Pipe Section Number	Starting Station	Ending Station	Length (ft)	Discharge (gpm)	Discharge (cfs)	Pipe Diameter (in)	Area (ft^2)	Velocity (ft/s)	Reynolds #	Friction Factor *f*	Friction Losses (ft)	Fitting Losses (ft)	Total Head Loss (ft)	Head Loss Per Foot (ft/ft)
1A	0	13775	13775	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	107.4	21.5	128.9	0.0094
2A	13775	17637	3862	4,000	8.91	18	1.77	5.044	6.3E+05	0.0145	14.8	3.0	17.7	0.0046
3A	17637	74020	56383	6,000	13.37	24	3.14	4.255	7.0E+05	0.0139	110.6	22.1	132.7	0.0024
1B	0	25530	25530	2,000	4.46	18	1.77	2.522	3.1E+05	0.0157	26.3	5.3	31.6	0.0012
1C	0	200	200	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	1.6	0.3	1.9	0.0094

Avg. Daily Pump Time, hrs: 20
Cost Per Kilowatt, $: 0.08
Pump Efficiency, N, %: 80

Pump Label:	A	B	C
Pump Elevation, ft:	560	550	605
Assumed Ground Water Elevation, ft:	480	480	480

Pipe Section Number	Initial Pumping Head Above Ground (ft)	Total Dynamic Pumping Head (ft)	Required Pump Horse Power (HP)	Minimum Continuous Pumping Time (days)	Required Power (GW-hrs)	Total Initial Fill Pumping Costs ($)	Installed Pipe Unit Cost ($/ft)	Total Pipe Cost ($)	Pump Cost (assume $500/HP) ($)	Well Installation ($)	TOTAL COST ($)
1A	1,110	1,470	929	1,568	21.76	1,741,000	78	1,080,000	470,000	413,800	**3,704,800**
2A							112	432,000			**432,000**
3A							273	15,389,000			**15,389,000**
1B	1,023	1,124	710	1,568	19.97	1,598,000	112	2,856,000	360,000	413,800	**5,227,800**
1C	989	1,117	706	1,568	19.84	1,588,000	78	16,000	360,000	413,800	**2,377,800**
				TOTAL =	**61.57**	**4,927,000**				**TOTAL COST =**	**27,131,400**

PROFILE PLOT:



GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

EVAPORATION REPLACEMENT WATER PUMPING CALCULATIONS ONLY

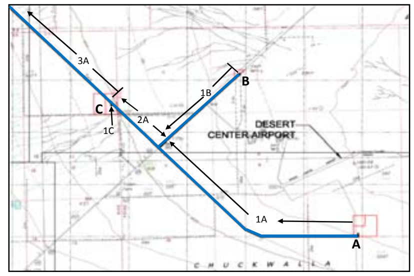
Purpose: Determine required pipe size for the Eagle Mountain Pumped Storage Project water supply pipeline.

Reference: Civil Engineering Reference Manual, 11th Ed., Lindenburg, 2008.

Assumptions:
1. Swamee-Jain Equation for pipe friction loss calculations.
2. Assume minor loss are equal to 20% of friction head.

$$f = \frac{0.25}{\left(\log_{10}\left(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right)^2} \qquad h_f = \frac{fLv^2}{D2g}$$

SKETCH:



Pipe Material: Steel
Specific Roughness, e, ft: 0.0002
Kinematic Viscosity, v = 0.0000121 @ 60 degrees
Target Discharge, gpm = 2,000 4.46 cfs

Pipe Section Number	Starting Station	Ending Station	Length (ft)	Discharge (gpm)	Discharge (cfs)	Pipe Diameter (in)	Area (ft^2)	Velocity (ft/s)	Reynolds #	Friction Factor *f*	Friction Losses (ft)	Fitting Losses (ft)	Total Head Loss (ft)	Head Loss Per Foot (ft/ft)
1C	0	200	200	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	1.6	0.3	1.9	0.0094
3A	200	56578	56378	2,000	4.46	24	3.14	1.418	2.3E+05	0.0160	14.1	2.8	16.9	0.0003

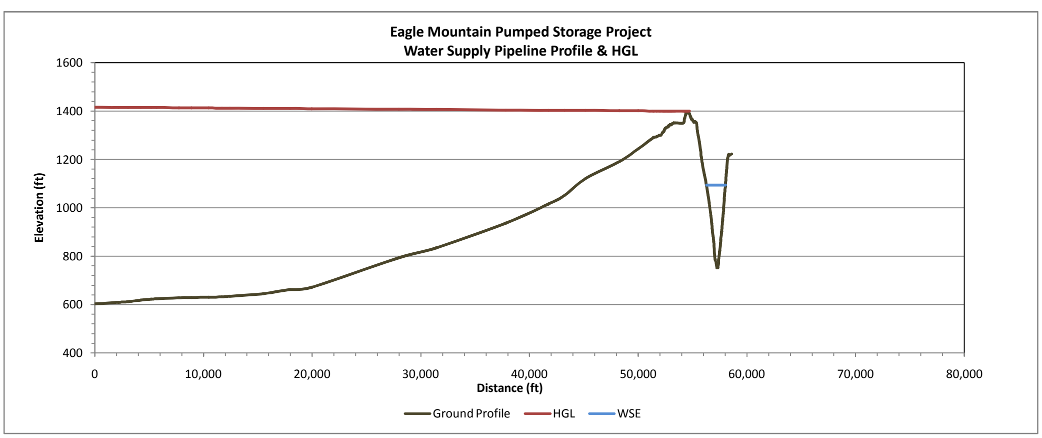
Avg. Daily Pump Time, hrs: 20
Cost Per Kilowatt, $: 0.08
Pump Efficiency, N, %: 80

Evaporation Volume: 1763 ac-ft

Pump Label: C
Pump Elevation, ft: 605
Assumed Ground Water Elevation, ft: 480

Pipe Section Number	Initial Pumping Head Above Ground (ft)	Total Dynamic Pumping Head (ft)	Required Pump Horse Power (HP)	Minimum Continuous Pumping Time (days)	Required Power (GW-hrs)	Total Evaporation Pumping Costs ($)					
1C	811	956	604	239	2.16	173,000					
	0										
	0										
				TOTAL =	**2.16**	**173,000**				**TOTAL COST =**	**0**

PROFILE PLOT:



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080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

Daily Pumping Duration, t:	20	hrs
Pumping Rate, Q:	6,000	gpm
Pumping Rate, Q:	13.37	cfs
Pumping Rate, Q:	8066	AF/yr
Annual Seepage:	1628	AF/yr
Annual Evaporation:	1763	AF/yr

Year	Water Pumped (AF)	Losses (AF)	Volume in Reservoir (AF)	Days
1	8066	3391	4675	365
2	8066	1763	10977	365
3	8066	1763	17280	365
4	8066	1763	23582	365
5	2381	1763	24200	108

Days for Fill to Full Operating Capacity =	**1568**	Days
	4.3	Years
	224	Weeks

Notes:
1.) First year pumping assumes fillling reservoirs, evaporation, and seepage. In subsequent years, seeped water will be returned to reservoirs by seepage recovery wells.
2.) Seepage estimates from Miller and Westmore Seepage Memo, 2009. Assuming a 5-foot thick line is installed.
3.) Evaporation estimates from ECEC Draft License Application 2008. Assuming 7.5 feet per year evaporation rate.
4.) Pumping duration is estimated assuming 24 hours/day during Oct-May, and 12 hours/day during Jun-Sept.

GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

Pipe Installed Cost Table

Pipe Costs $/foot										
	Diameter (in)	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**
1	**Plastic (PVC, ABS)**	$ 33.85	$ 59.85	$ 99.43	$ 153.08	$ 220.31	$ 294.62	$ 372.00	$ 458.96	$ 555.00
2	**Steel**	$ 78.35	$ 111.85	$ 272.93	$ 338.08	$ 464.31	$ 535.62	$ 607.00	$ 673.46	$ 740.00
3	**Concrete**	$ 120.85	$ 138.85	$ 156.93	$ 178.58	$ 200.31	$ 255.12	$ 310.00	$ 364.96	$ 420.00

RS Means 2009
Excavation, trench, common earth, 1.0 CY excavator 31 23 16.13 0090 (4' to 6' deep) & 0510 (6' to 10' deep)
Bedding, no compaction, 50' haul sand & gravel, 200 HP F.E. Loader 31 23 23.14 4000
Backfill, no compaction, 50' haul common earth, 200 HP F.E. loader, 31 23 23.14 4020
Compaction, sheepsfoot roller, 12" lifts, 2 passes 31 23 23.23 5680
Trench size estimate:
Trench width is 4' wider than the pipe diameter
Bedding is 1' below the pipe + up to spring line
Backfill is 3' deep

Plastic 33 11 13.25 3010 - 3200

	material & install	trench size		excavation			bedding			backfill			TOTAL	TOTAL
DIA (in)	unit rate ($/LF)	depth (ft)	width (ft)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	cost ($/LF)	cost ($/in dia)
12	$29.00	5.0	5.0	0.9	$4.10	$3.80	0.25	$0.76	$0.19	0.7	$1.22	$0.87	$33.85	$2.82
18	$54.00	5.5	5.5	1.1	$4.10	$4.59	0.29	$0.76	$0.22	0.9	$1.22	$1.04	$59.85	$3.33
24	$92.50	6.0	6.0	1.3	$4.10	$5.47	0.33	$0.76	$0.25	1.0	$1.22	$1.21	$99.43	$4.14
30	$145.00	6.5	6.5	1.6	$4.10	$6.42	0.36	$0.76	$0.27	1.1	$1.22	$1.39	$153.08	$5.10
36	$211.00	7.0	7.0	1.8	$4.10	$7.44	0.39	$0.76	$0.29	1.3	$1.22	$1.58	$220.31	$6.12
42	$284.00	7.5	7.5	2.1	$4.10	$8.54	0.41	$0.76	$0.31	1.4	$1.22	$1.77	$294.62	$7.01
48	$360.00	8.0	8.0	2.4	$4.10	$9.72	0.42	$0.76	$0.32	1.6	$1.22	$1.96	$372.00	$7.75
54	$445.50	8.5	8.5	2.7	$4.10	$10.97	0.43	$0.76	$0.33	1.8	$1.22	$2.16	$458.96	$8.50
60	$540.00	9.0	9.0	3.0	$4.10	$12.30	0.44	$0.76	$0.33	1.9	$1.22	$2.37	$555.00	$9.25

Black Steel Pipe 33 11 13.40 1010-1140

	material & install	trench size		excavation			bedding			backfill			TOTAL	TOTAL
DIA (in)	unit rate ($/LF)	depth (ft)	width (ft)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	cost ($/LF)	cost ($/in dia)
12	$73.50	5.0	5.0	0.9	$4.10	$3.80	0.25	$0.76	$0.19	0.7	$1.22	$0.87	$78.35	$6.53
18	$106.00	5.5	5.5	1.1	$4.10	$4.59	0.29	$0.76	$0.22	0.9	$1.22	$1.04	$111.85	$6.21
24	$266.00	6.0	6.0	1.3	$4.10	$5.47	0.33	$0.76	$0.25	1.0	$1.22	$1.21	$272.93	$11.37
30	$330.00	6.5	6.5	1.6	$4.10	$6.42	0.36	$0.76	$0.27	1.1	$1.22	$1.39	$338.08	$11.27
36	$455.00	7.0	7.0	1.8	$4.10	$7.44	0.39	$0.76	$0.29	1.3	$1.22	$1.58	$464.31	$12.90
42	$525.00	7.5	7.5	2.1	$4.10	$8.54	0.41	$0.76	$0.31	1.4	$1.22	$1.77	$535.62	$12.75
48	$595.00	8.0	8.0	2.4	$4.10	$9.72	0.42	$0.76	$0.32	1.6	$1.22	$1.96	$607.00	$12.65
54	$660.00	8.5	8.5	2.7	$4.10	$10.97	0.43	$0.76	$0.33	1.8	$1.22	$2.16	$673.46	$12.47
60	$725.00	9.0	9.0	3.0	$4.10	$12.30	0.44	$0.76	$0.33	1.9	$1.22	$2.37	$740.00	$12.33

GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
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Pipe Installed Cost Table

Pipe Costs $/foot										
	Diameter (in)	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**
1	**Plastic (PVC, ABS)**	$ 33.85	$ 59.85	$ 99.43	$ 153.08	$ 220.31	$ 294.62	$ 372.00	$ 458.96	$ 555.00
2	**Steel**	$ 78.35	$ 111.85	$ 272.93	$ 338.08	$ 464.31	$ 535.62	$ 607.00	$ 673.46	$ 740.00
3	**Concrete**	$ 120.85	$ 138.85	$ 156.93	$ 178.58	$ 200.31	$ 255.12	$ 310.00	$ 364.96	$ 420.00

Concrete 33 11 13.10 3000 - 3060

	material & install	trench size		excavation			bedding			backfill			TOTAL	TOTAL
DIA (in)	unit rate ($/LF)	depth (ft)	width (ft)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	cost ($/LF)	cost ($/in dia)
12	$116.00	5.0	5.0	0.9	$4.10	$3.80	0.25	$0.76	$0.19	0.7	$1.22	$0.87	$120.85	$10.07
18	$133.00	5.5	5.5	1.1	$4.10	$4.59	0.29	$0.76	$0.22	0.9	$1.22	$1.04	$138.85	$7.71
24	$150.00	6.0	6.0	1.3	$4.10	$5.47	0.33	$0.76	$0.25	1.0	$1.22	$1.21	$156.93	$6.54
30	$170.50	6.5	6.5	1.6	$4.10	$6.42	0.36	$0.76	$0.27	1.1	$1.22	$1.39	$178.58	$5.95
36	$191.00	7.0	7.0	1.8	$4.10	$7.44	0.39	$0.76	$0.29	1.3	$1.22	$1.58	$200.31	$5.56
42	$244.50	7.5	7.5	2.1	$4.10	$8.54	0.41	$0.76	$0.31	1.4	$1.22	$1.77	$255.12	$6.07
48	$298.00	8.0	8.0	2.4	$4.10	$9.72	0.42	$0.76	$0.32	1.6	$1.22	$1.96	$310.00	$6.46
54	$351.50	8.5	8.5	2.7	$4.10	$10.97	0.43	$0.76	$0.33	1.8	$1.22	$2.16	$364.96	$6.76
60	$405.00	9.0	9.0	3.0	$4.10	$12.30	0.44	$0.76	$0.33	1.9	$1.22	$2.37	$420.00	$7.00

Water Supply Wells 33 21 13.10 0500

40' deep, incl. gravel & casing, complete, 24" diameter casing x 18" diameter screen = $72,500

Unit Cost/ft =	1800	$/ft
Depth Multiplier =	2.0	
Total Unit Cost =	**3600**	**$/ft**

GEI Consultants, Inc.

Client: Eagle Crest Energy

Project: Eagle Mountain Pumped Storage Project

Purpose: Estimate Construction Costs for Water Supply Line Extraction Wells

Project Manager: G. Gillin/R. Shatz

Cost for **THREE** wells

Item No.	Item	Unit	Quantity	Unit Cost	Item Cost
1	Mobilization/Demobilization	LS	1	$35,000	$35,000
2	Mobalization/Demobalization Site-to-Stie	LS	2	$20,000	$40,000
3	Site Work	LS	3	$20,000	$60,000
4	Electrical Connection	LS	3	$50,000	$150,000
5	Conductor Casing and Sanitary Seal	LF	150	$500	$75,000
6	18" Borehole Drilling	LF	2400	$80	$192,000
7	Geophysical (E-Logs & Gamma-Logs)	LS	3	$2,500	$7,500
8	34" Borehole Drilling	LF	2400	$40	$96,000
9	X-Y Caliper Survey	LS	6	$2,000	$12,000
10	20" Dia. (Nominal) x 3/8-inch Wall Blank Steel Well Casing or 20" Dia. (Nominal) x 5/16-inch Wall Blank 0.2% Copper Bearing Steel Well Casing	LF	1170	$80	$93,600
11	20" Dia. (Nominal) carbon steel wire wrapped screen, 0.070 slot	LF	1197	$190	$227,430
12	Gravel Feed Pipe	LF	645	$10	$6,450
13	Gravel Envelop	LF	1770	$50	$88,500
14	Install Annular and Transition Seals	LF	630	$45	$28,350
15	Preliminary Development	HR	201	$260	$52,260
16	Furnish and install Test Pump	LF	750	$25	$18,750
17	Pump Development	HR	72	$200	$14,400
18	Step-Drawdown and Constant Rate Aquifer Testing	HR	108	$200	$21,600
19	Plmbness and Alignment Tests	LS	3	$2,500	$7,500
20	Well Disinfection	LS	3	$1,000	$3,000
21	Video Camera Surveys	LS	6	$1,500	$9,000
22	Borehole Abandomnent	LF	300	$5	$1,500
23	Stand-by Time	HR	12	$130	$1,560

Estimate (3) wells **$1,241,400**

Estimate (1) well **$413,800**

GEI Consultants, Inc.
EM Pumped Storage Project
Well Materials Estimate

Item #	Description	Unit	Quantity	Well 1	Well 2	Well 3
				Unit Quantity	Unit Quantity	Unit Quantity
1	Mobilization/Demobilization	LS	1	1		
2	Mobalization/Demobalization Site-to-Stie	LS	2		1	1
3	Conductor Casing and Sanitary Seal	LF	150	50	50	50
4	18" Borehole Drilling	LF	2400	800	800	800
5	Geophysical (E-Logs & Gamma-Logs)	LS	3	1	1	1
6	34" Borehole Drilling	LF	2400	800	800	800
7	X-Y Caliper Survey	LS	6	2	2	2
8	20" Dia. (Nominal) x 3/8-inch Wall Blank Steel Well Casing or 20" Dia. (Nominal) x 5/16-inch Wall Blank 0.2% Copper Bearing Steel Well Casing	LF	1170	390	390	390
9	20" Dia. (Nominal) carbon steel wire wrapped screen, 0.070 slot	LF	1197	399	399	399
10	Gravel Feed Pipe	LF	645	215	215	215
11	Gravel Envelop	LF	1770	590	590	590
12	Install Annular and Transition Seals	LF	630	210	210	210
13	Preliminary Development	HR	201	67	67	67
14	Furnish and install Test Pump	LF	750	250	250	250
15	Pump Development	HR	72	24	24	24
16	Step-Drawdown and Constant Rate Aquifer Testing	HR	108	36	36	36
17	Plmbness and Alignment Tests	LS	3	1	1	1
18	Well Disinfection	LS	3	1	1	1
19	Video Camera Surveys	LS	6	2	2	2
20	Borehole Abandomnent	LF	300	100	100	100
21	Stand-by Time	HR	12	4	4	4

Pump Data Sheet - National Pump Company

NATIONAL PUMP COMPANY, LLC

Company:
Name:
Date: 4/7/2009

Pump:

Size: M14XXHC (14 stage)

Type: VERT.TURBINE
Synch speed: 1800 rpm

Speed: 1770 rpm
Dia: 11.4075 in

Curve: CVM14XXH4P6C

Impeller:

Specific Speeds:

Ns: 2315
Nss: 5172

Dimensions:

Suction: 10 in
Discharge: 12 in

Pump Limits:

Temperature: 180 °F
Pressure: 321 psi g
Sphere size: 0.64 in

Power: ---
Eye area: 25.4 in²

Search Criteria:

Flow: 2000 US gpm

Head: 1500 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: ---

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Standard: NEMA
Enclosure: WP-1

Speed: ---
Frame: ---

Sizing criteria: Max Power on Design Curve

Pump Selection Warnings:

Pump shutoff dP exceeds limit for the pump.

---- Data Point ----

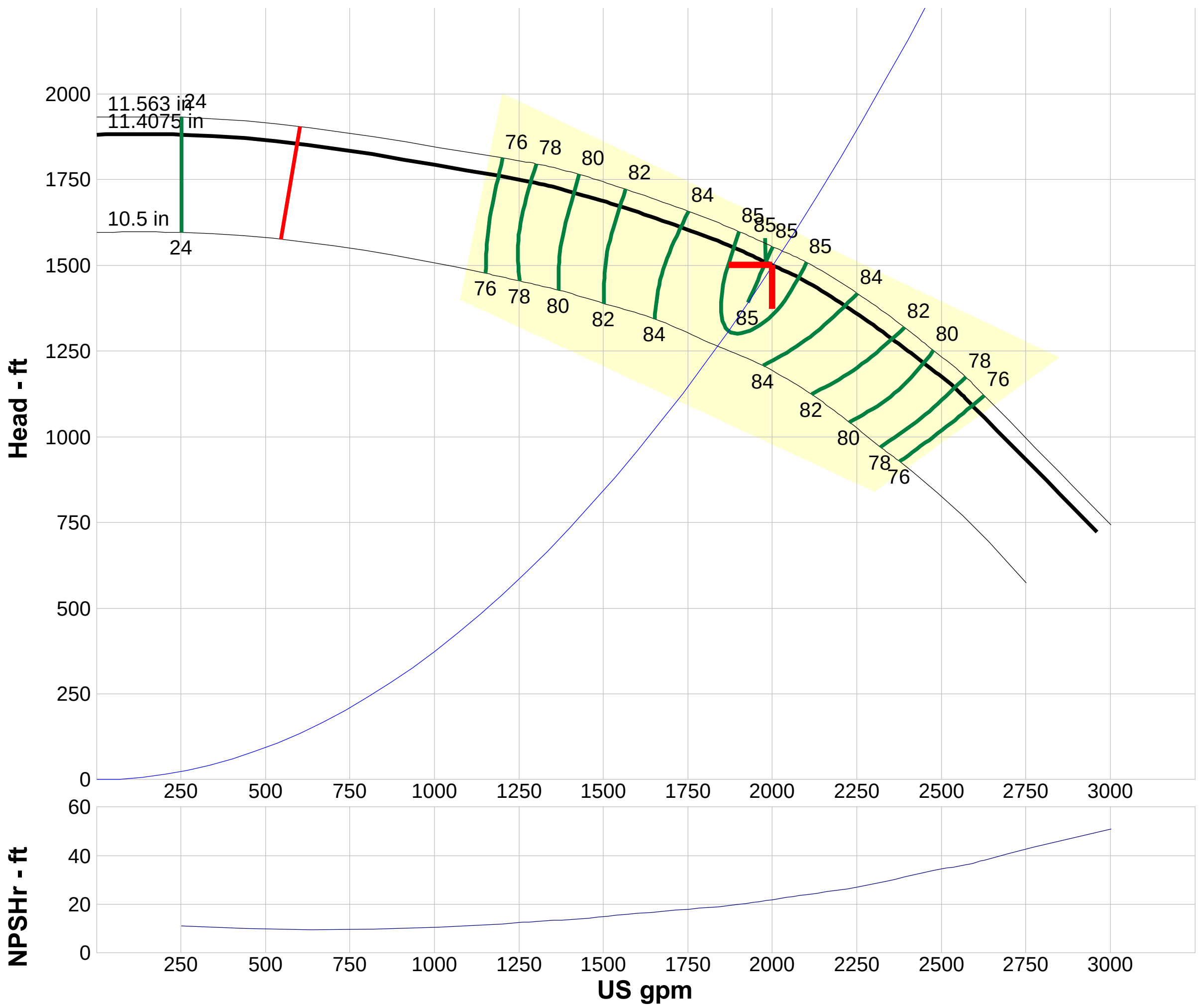
Flow: 2000 US gpm
Head: 1500 ft
Eff: 85%
Power: 890 hp
NPSHr: 22 ft

---- Design Curve ----

Shutoff head: 1882 ft
Shutoff dP: 813 psi
Min flow: 594 US gpm
BEP: 85% @ 1979 US gpm
NOL power:
939 hp @ 2538 US gpm

-- Max Curve --

Max power:
978 hp @ 2475 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
2400	1770	1250	81	935	31.5
2000	1770	1500	85	890	22
1600	1770	1654	83	809	16.3
1200	1770	1759	76	699	12
800	1770	1811	54	612	11.6

Selected from catalog: National Pump Company.60 Vers: 60cy0331

12 Appendix C – Technical Memoranda

12.4 Groundwater Supply Pumping Technical Memorandum

Table of Contents

Eagle Mountain Pumped Storage Project – Revised Groundwater Supply Pumping Effects

Prepared by: David Fairman, Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

May 12, 2009 Revised: October 23, 2009 and July 11, 2011

Introduction

Eagle Crest Energy (ECE) is preparing a license application for submittal to the Federal Energy Regulatory Commission (FERC). As a part of the licensing process, ECE is required to receive water quality certification from the State Water Resources Control Board (SWRCB). ECE is proposing to use groundwater in the Desert Center area as the water supply for its Pumped Storage Project (Project). ECE will need water for the initial fill of the reservoirs and annual make-up water to replace losses from evaporation and seepage. The SWRCB has expressed concerns about groundwater impacts to the Chuckwalla Valley Groundwater Basin. In addition, the Metropolitan Water District (Metropolitan) responded to the draft license application and requested that potential impacts to the Colorado River Aqueduct (CRA) be evaluated.[1]

This technical memorandum (TM) presents the analysis of the projected impacts of Project water supply pumping on groundwater levels along the CRA. Drawdown from pumping the water supply wells and the amount of drawdown that could occur beneath the CRA was estimated using analytical models. The results were compared to projected drawdown that may have occurred as a result of:

- Kaiser Steel Corporation (Kaiser) groundwater pumping in the upper Chuckwalla Valley over a 17-year period from 1965 to 1981.
- Agricultural pumping near Desert Center between 1981 and 1986.

If the ECE water supply pumping drawdown is in the range of historic pumping, the potential to create subsidence beneath the CRA would be low; at less than significant levels since there was no documented subsidence during historic pumping. Numeric drawdown targets are proposed for project pumping.

A water balance was also created to assess the basin-wide effects of the Project pumping and cumulative effects on the perennial yield of the basin. The water balance evaluates the change-in-storage during the Project and predicts the time for the basin to recover to pre-Project levels.

[1] This TM evaluates potential effects of groundwater pumping for water supply on the CRA. Potential effects of reservoir seepage on the CRA are evaluated in a separate TM.

Project Location

The Project site is located in the Eagle Mountains on a bedrock ridge along the northwestern margins of the Chuckwalla Valley watershed. The central portions of the watershed contain the Palen and Chuckwalla Valleys, with thick accumulations of alluvial sediments that comprise the Chuckwalla Valley Groundwater Basin (DWR, 2003). Figure 1 shows the location of the Chuckwalla Valley Groundwater Basin.

Existing Wells

Existing wells in the area were located, to the extent possible, using drillers well logs obtained from the California Department of Water Resources and maps contained in various reports (CH2MHill, 1996 and Greystone 1994). Figure 1 shows locatable wells in and near the Chuckwalla Valley Groundwater Basin. Other agricultural or domestic wells may be present but could not be located because their locations are not well documented in the records, and some older wells – in some cases dating back to the early 1900s – may have been destroyed.

Most domestic and agricultural areas are located in the western portions of the basin near Desert Center, about six miles south of the Project site. Four wells located in the upper portions of the Chuckwalla Valley were used to supply water to the former Eagle Mountain iron mine and may be used to supply water to the proposed landfill. East of Desert Center near the Corn Springs exit off Interstate 10 there is a large agricultural area of palm and citrus that uses wells to supply water. The Chuckwalla Valley and Ironwood State prisons about 30 miles east of Desert Center also use groundwater as their source of supply.

Location of Proposed Water Supply Wells

Figure 2 shows the location of properties near Desert Center on which Project wells are proposed to be constructed (WSdc). The wells are designed to be spaced about one-mile apart to minimize overlapping cones of depression which would create additional drawdown.

Number of Wells Required

The Project will use groundwater supplies initially to fill the reservoirs and annually to make up for losses due to evaporation and seepage. Table 1 shows that 24,200 acre-feet (AF) of water is needed to fill the reservoirs to full operating capacity. Table 2 shows the annual make-up water requirements. Initially annual make-up water will replenish losses due to seepage and evaporation. In subsequent years, only evaporation will need to be replaced because seepage recovery wells will capture the water lost to seepage and recycle it to the reservoirs. Seepage recovery is addressed in a separate technical memorandum.

During the initial fill, three supply wells will be used. Historic aquifer tests in the area showed wells could produce 2,300 gpm at each well (Greystone, 1994). However, long term use of wells usually results in slightly lower pumping rates. For this analysis the Project water supply wells were assumed to pump 2,000 gpm. At this pumping rate, and assuming the wells will be pumped for 24 hours a day during October through May which have low power system demand and twelve hours a day during June through September which have high demand, a maximum of 8,066 acre-feet per year (AFY) will be produced, as shown in Table 3. As shown in Table 4, the reservoirs will be filled to minimum operating capacity in 1.3 years and full operating capacity in 4.1 years. After the initial fill, one to two wells will be used to make up for evaporation. Make-up pumping durations are shown in Table 5 and pumping for the entire license period of the project is shown in Table 6.

Hydrogeology

The Chuckwalla Valley Groundwater Basin is filled with quaternary alluvium and continental deposits. Figure 2 in Attachment A, a technical analysis of alluvial hydraulic properties in the area, shows the geologic units in the basin. The alluvium (Qal) consists of fine to coarse sand interbedded with gravel, silt, and clay. The alluvium likely comprises the most substantial aquifer in the area (DWR, 1963). Locally windblown sand deposits (Qs) cover the alluvium. The alluvium is underlain by Quaternary continental deposits (Qc) (Jennings, 1967). The continental deposits are exposed around the fringes of the basin. These deposits are composed of semi-consolidated coarse sand and gravel (fanglomerates), clay and some interbedded basalts.

Geologic profiles of the valley, contained in Attachment A, were developed to show the types of sediments and their distribution. The well logs did not distinguish between the Qal and Qc so all contacts are approximate. Figure 3 of Attachment A shows geologic profile A-A', which runs along the east-west axis of the Chuckwalla Valley Groundwater Basin to have about 900 feet of sand and gravel with some thin clay and silt layers near Desert Center. The saturated sediments are about 600 feet thick near Desert Center. In the central portion of the valley, east of Desert Center, a relatively thick layer of clay has accumulated. Near the eastern portion of the valley the coarse sediment increases to up to 1,200 feet thick.

Figures 4 and 5 of Attachment A, geologic profiles B-B' and C-C', show the sediments in the Upper Chuckwalla Valley Groundwater Basin, from Desert Center north to the Pinto Basin, in the vicinity of the Project. The alluvial sediments were deposited on an irregular bedrock surface. Geophysical surveys suggest the bedrock surface is a large bowl opposite the Project site (GeoPentech, 2003). The southern edge of the bowl aligns with a narrow bedrock ridge that juts easterly into the basin.

The alluvium filling the Upper Chuckwalla Valley consists of about 300 feet thickness of sand and gravel with a few discontinuous layers of silt and clay. About 150 feet of the alluvium is saturated. Underlying the coarse grained sediments are lake deposits consisting primarily of clay. The lakebed thickness varies and may be thinner near the margins of the basin and thicken towards the central portions of the basin based on geophysical surveys (gravity). However, no wells have fully penetrated the lakebeds to determine their actual thickness. One well (CW-1) penetrated over 900 feet of clayey lakebed deposits before being terminated. The coarse-grained sediments were deposited above the bowl rim and are in hydraulic continuity with the coarse grained sediments found near Desert Center, whereas the lakebed sediments are below the rim. The coarse grained sediments extend northward and connect with sediments in the Pinto Valley Groundwater Basin where inflow into the Chuckwalla Valley Groundwater Basin occurs. A basalt flow and several faults are present, as shown on Geologic Profile B-B', but have an unknown effect on groundwater levels.

The lakebed deposits are potentially underlain by coarser sediments, based on geophysical surveys, but there are no wells to confirm the presence of this layer (GeoPentech, 2003). The sediments are likely to have a lower permeability than the coarse grained sediments above the lakebeds.

The profiles show that the upper coarse grained sediments are continuous throughout the basin and because they appear to be hydraulically connected, there is only one aquifer in the valley. The last reliable groundwater levels from 1963 and 1964 were plotted on the geologic profiles to show the saturated sediments. Based upon the geologic conditions, the aquifer characteristics, and water levels, the aquifer appears to be unconfined in the Upper Chuckwalla Valley from the Pinto Basin through the Desert Center area. In the central portion of the valley, east of Desert Center, the aquifer may be semi-confined to confined because of the accumulation of a rather thick layer of clay.

Geologic profile C-C', shows the relationship of the sediments in the Chuckwalla and Pinto Valley Groundwater Basins. A subsurface volcanic dike may be at shallow elevation and limits the hydraulic connection of the aquifers in the Pinto and Chuckwalla Valley basins such that groundwater would have to flow over and potentially under the dike to enter the Chuckwalla Valley Groundwater Basin.

Groundwater Levels

Groundwater models are typically calibrated to groundwater levels. Figure 3 shows the locations of wells with groundwater level measurements. The groundwater level data need to be distributed throughout the area to be modeled and occur during a period of stress and relaxation (pumping and recovery) to fully calibrate a model. Groundwater level measurements near the area of interest, in this case near the CRA in the Upper Chuckwalla basin, are necessary to confirm the accuracy of the predictions.

There are only a few wells with groundwater level measurements in the Upper Chuckwalla basin and all are located near Desert Center, about six miles south of the Project site. Wells 5S/16E-7P1 and -7P2 provide the longest period of record, but with significant gaps. Generally the well was measured annually between 1981 and 1992. Since that time only one measurement was made in 2002, which does not allow for any assessment of whether water levels are increasing or decreasing. Figure 4 shows the hydrograph for these wells. A groundwater level was obtained in a nearby well in 2007 and may be representative of the groundwater levels. Pump turbine oil was present in the well on top of the water surface and produces additional uncertainty but it is the only measurement currently available in the area.

The nearest well to the Project site, other than in Desert Center, with a historic record is about six miles north of the Project site, in the Pinto Valley Groundwater Basin. Well 3S/15E-4J1 has groundwater level measurements from the early 1950s through 1985. Since that time only one measurement is available in 2007, which again does not allow for any assessment of whether water levels are increasing or decreasing. Figure 4 shows the hydrograph for this well.

Near the Project site there are monitoring wells but their records do not overlap with wells described above. These monitoring wells were constructed for the landfill project but only two years of measurements are available between 1992 and 1993. A few monitoring wells had one additional measurement in 1995. The wells show water levels declined by various amounts, between 0.5 and 11 feet. During this period water levels were also reported for the Eagle Mountain iron mine water supply wells.

Overall, groundwater levels are lacking with which to calibrate a numeric groundwater model, especially when there are few measurements near the Project site and the CRA. No water level measurements are available for the Orocopia Groundwater Basin where the CRA also overlies alluvium. It is unknown whether the alluvium is saturated beneath the CRA in the Orocopia Valley.

Aquifer Hydraulic Characteristics

Limited reliable aquifer hydraulic characteristics are available in the Chuckwalla Valley Groundwater Basin. The highest quality data is from aquifer tests that measured drawdown in observation wells, of which only two have been performed in the basin near Desert Center, where the proposed water supply wells will be located. After construction of a well the drillers typically perform a pumping test to demonstrate the capacity of the well. These tests were occasionally recorded on the well driller's logs and are of lesser quality and value for purposes of this analysis than the tests performed with observation wells. Using a combination of these records aquifer characteristics were estimated using a polynomial expression of the Theis equation. A range of hydraulic characteristics were developed based on varying the different storativities. Aquifer characteristics were also estimated from three monitoring wells constructed in the alluvium for the landfill. Attachment A, Figure 6 and Table 1 contain the locations of wells with test information and a summary of the aquifer characteristics. The aquifer characteristics can vary, not only due to the types of sediments present but also due to the depth of the well and well efficiency.

The most representative hydraulic characteristics for the sediments near Desert Center where Project water supply wells will be constructed were determined from two long duration aquifer tests in which the drawdown was measured in observation wells (Greystone, 1994). As shown in Attachment A, Table 3 the analysis produced storativities that were outside of published ranges, raising some uncertainty of the validity of the associated hydraulic characteristics. Table 7 summarizes hydraulic characteristics where storativities were within acceptable ranges. These characteristics were averaged to derive a hydraulic conductivity (K) of between 100 and 125 feet per day (feet/day), saturated aquifer thickness (b) of 300 feet, and a storativity/storage coefficient (S) of 0.05 and were used for drawdown projections for the Project's water supply wells near Desert Center.

Representative aquifer hydraulic characteristics for the upper portions of the Chuckwalla Valley Groundwater Basin, near the Project site, were estimated from the Eagle Mountain iron mine water supply wells (CW-1 to CW-4). The characteristics were estimated from test results recorded on the well logs. Table 7 summarizes the estimates. No actual groundwater measurements were available to calibrate the aquifer characteristics, so to be conservative, the values used were a K of 50 feet/day, b of 150 feet, S of 0.05, and T of 56,000 gpd/ft for drawdown projections of historic pumping at the Kaiser wells.

Near the Project site the hydraulic conductivities appear to be lower. Hydraulic characteristics of the sediments overlying the lakebeds were estimated during the investigation for the landfill. The K was estimated to be between 0.02 and 7.1 feet per day. Descriptions of the fanglomerate from monitoring well construction describe the sediments as ranging from boulders to coarse sand, and therefore the estimated K appear to be too low. Typical K values for well-sorted sand and gravel are from 3 to 180 feet/day (Fetter, 1988). Because the fanglomerate are part of older continental deposits and could be weathered and compacted, a conservative K of 25 feet per day and an S of 0.05 were used in the model.

Model Setup

Given the constraint of available hydraulic data and water level measurements required for calibration of a numerical groundwater model (i.e., Modflow, or equivalent), it was determined that such modeling to evaluate water supply pumping effects would not provide a more precise estimate of effects than analytical models. Therefore, an analytical model was selected to assess water supply pumping effects that uses a Taylor series approximation of the Theis non-equilibrium well function (Theis, 1935). Using the aquifer characteristics described above, the model adds the drawdown from each pumping well to each observation point. The model assumes that the aquifer is homogeneous, isotropic, and infinite in nature. The model is equipped to simulate annually variable pumping rates, but does not allow variable aquifer characteristics. The method does not predict recovery accurately and is assumed to occur instantaneously where recovery will typically take about the same amount of time as the pumping duration.

Figure 2 shows the area being modeled along with the location of the proposed Project water supply wells near Desert Center (WSdc) and observation points (OW) used for the analysis. Figure 5 shows the location of the Kaiser wells in the upper Chuckwalla Valley (WSuc) where historic pumping is likely to have lowered groundwater levels beneath the CRA. The pumping of multiple wells was approximated by using a single well at the geographic center (centroid) of the pumping wells (CW). Figures 2 and 5 also show that the aquifer is not infinite and that impermeable bedrock surrounds the Chuckwalla Valley Groundwater Basin aquifers. Drawdown near no-flow boundaries (bedrock) such as these can be simulated by the placement of an image well (IW) perpendicular to the bedrock surface, at an equal distance from the boundary as the “real” well, and pumping the image wells at the same rate as the “real” well or in this case the centroid well (CW) (Ferris, 1962). Two image wells (IWuc) were used for the historic pumping (Kaiser wells) analysis in the upper valley, and three (IWdc) were used for the Project well and agricultural pumping near Desert Center. Each image well could be compensated by adding additional image wells to improve the predictive nature of the calculations but with each addition the effects reduce the ultimate drawdown to a level that is less than significant. Only one set of image wells were used for these calculations, as multiple iterations would not significantly improve the analysis.

Observation wells were simulated within the model area to record the drawdown at locations throughout the basin. Fourteen observation wells (OW01 through OW-14) were positioned along the CRA, at spacings of approximately one mile, in the upper Chuckwalla Valley Groundwater Basin. Two observation wells (OW15 and OW19) were positioned in the Orocopia valley, on or near the CRA. One observation point (OW18) was positioned in the Pinto basin to simulate groundwater levels as recorded by well 3S/15E-4J1. Three observation wells (OW16, OW17 and OW 20) were placed in the Chuckwalla Valley Groundwater Basin east of the Project wells to provide more definition of the water levels in this area. Well OW17 was also used to simulate pumping by the large palm and citrus grower east of Desert Center.

Historic Drawdown and Model Calibration

Historically, groundwater in the Chuckwalla Valley Groundwater Basin has been used to supply water to the Eagle Mountain iron mine and for agriculture. This historic pumping likely created drawdown beneath the CRA, but is not known to have caused any subsidence. If Project pumping were to be within the range of historic pumping then it is reasonable to assume that there is little or no potential to create subsidence. However, only two wells have measurements to provide the historic lows so the groundwater low has to be estimated for other areas close by, specifically near the CRA. The historic pumping may also provide some validation of the analytical approach where water level measurements are available.

Historic Pumping in Upper Chuckwalla Valley

Kaiser pumped groundwater from seven wells in the Pinto and upper Chuckwalla Valley Groundwater Basins for about 40 years to supply water to the Eagle Mountain Mine. Three of these wells (No.1-3) are located in the Pinto basin. The other four wells (CW-1 through

CW-4, labeled as WSuc1 through WSuc4) are located in the upper Chuckwalla Valley. Figure 5 shows the locations of WSuc1 through WSuc4. Between 1965 and 1981, a 17-year period, the annual production from the Chuckwalla Basin was relatively consistent and was therefore selected for simulation of historic drawdown beneath the CRA. Table 8 lists the annual production from the wells measured in acre-feet per year (AFY) (Mann, 1986). Table 9 converts the annual production into gallons per minute.

Drawdown within the upper Chuckwalla Valley Groundwater Basin was projected using a K of 50 feet/day, b of 150 feet, S of 0.05, and T of 56,000 gpd/ft and the historic annual pumping rates from Kaiser's Chuckwalla wells. Figure 6 shows about 9 to 19 feet of drawdown occurred beneath the CRA as a result of Kaiser's pumping. Figure 7 presents hydrographs for the key wells. Attachment B contains the calculations. The calculations also indicate about 1 foot of drawdown may have occurred within the Orocopia basin, but this is unlikely due to the distance from the pumping wells and the hydraulic conductivity being greater in that portion of the basin.

Groundwater levels during this period were available for well 3S/15E-4J1 located in the Pinto Basin as shown in the hydrograph on Figure 8. The red dashed line approximates the drawdown at the well contributed by pumping from the Pinto wells and the blue dashed line represents drawdown as a result of pumping of both the Pinto and Chuckwalla wells. The difference between these lines indicates that 8 feet of drawdown was contributed by the Chuckwalla wells after 17 years of pumping. The model predicts 7.0 feet of drawdown after 17 years of pumping at observation well (OW18), which is located at well 3S/15E-4J1, very similar to the historic measurements and indicating that the model predictions are reasonably accurate.

Historic Pumping in Desert Center Area

After 1981 Kaiser pumping significantly decreased, but pumping for agricultural uses (primarily jojoba and asparagus) near Desert Center increased to levels above what Kaiser had pumped for a period of about 6 years. After 1986, pumping decreased significantly to levels below the annual yield of the basin and groundwater levels rose. In recent years pumping has increased with new endeavors in palm and citrus production, but most of these activities are located east of Desert Center near OW17. Table 10 shows the annual groundwater pumping for agricultural uses between 1981 and 2007, when agricultural surveys were made. Table 11 shows the estimates of agricultural and domestic pumping since 1981.

The effect of 27 years (1981-2007) of pumping was projected using the analytical model. A centroid well (CWdc) was used to accumulate all of the pumping to one well near Desert Center and OW17 was used to simulate pumping associated with the palm and citrus operations east of Desert Center. The model was run with a K of 100 feet/day and 125 feet/day. The model results were compared to groundwater levels measured in well 5S/16E-7P1 and -7P2 to assess the accuracy of the model predictions. Figure 4 shows that a K of 125 feet/day provides a reasonable simulation of actual measured groundwater levels in Desert Center. Groundwater levels in Pinto Basin did not produce comparable results when assuming a static water level from 1981. The model predicted levels to drop by 5.5 feet, while actual measurements showed a rise of 4 feet. The difference is related to the groundwater levels recovering from the heavy pumping by Kaiser in the upper portions of the basin. If the static water level from 1960, prior to the Kaiser pumping, is used as the static water level, the modeled drawdown is within one foot of the measured water levels in 2007, a reasonable calibration. Figure 9 shows a graph of the modeled groundwater levels using a K of 125 feet/day versus actual groundwater level measurements as a result of pumping in the area. There is a strong correlation with an R squared value close to one; therefore a K of 125 feet/day was used in subsequent modeling efforts. Attachment B contains the model calculations.

The maximum amount of drawdown created by agricultural (including municipal and domestic) pumping near Desert Center was estimated for the high production period between 1981 and 1986. Figure 10 shows maximum drawdown at locations throughout the basin. Figure 11 shows the hydrographs of the key wells. The analysis indicates that pumping would have created about 10 to 17 feet of drawdown beneath the CRA in the upper Chuckwalla valley, less than what was produced during the 17-years of pumping by the Kaiser wells. The agricultural pumping effects also appear to have extended into the Orocopia valley and would have created about 6 to 10 feet of drawdown beneath the CRA.

Sensitivity

To assess the potential drawdown associated with variable aquifer hydraulic characteristics the drawdown calculations for the 6-years of agricultural pumping were simulated by changing the hydraulic conductivity from 125 feet/day to 50 feet/day simulating the upper Chuckwalla valley and 25 feet/day to simulate the area near the Project site. A similar approach was used for the 17 years of pumping by Kaiser, reducing the hydraulic conductivities from 50 feet/day to 25 feet/day. Attachment C contains the calculations.

The results showed the drawdown in both pumping wells would have exceeded the total thickness of the saturated alluvium at the well, therefore higher hydraulic conductivities must exist near the wells. The drawdown becomes concentrated near the pumping wells and for the most part pumping effects do not extend far from the well. For example, the 6-year pumping drawdown simulations at hydraulic conductivities of 25 and 50 feet/day resulted in about 1 foot of drawdown at OW03 and OW18 where in contrast with the 125 feet/day the drawdowns were 8 to 15 feet. The aquifer characteristics used to project the maximum drawdown as a result of the 6-years of agricultural pumping are conservative.

In contrast changing the hydraulic characteristics for the 17-year projection from 50 feet/day to 25 feet/day resulted in the drawdown at OW03 changing from 11.7 to 13.4 feet. The increase is due to the proximity of the pumping well to the observation well. In this case the observation well was within the concentrated drawdown near the pumping well.

Overall, the selected aquifer characteristics are producing conservative results of the maximum drawdown.

Project Water Supply Pumping Simulations

The pumping rates for the Project water supply wells will change with time. Construction of the Project facility will take about three years to complete and will start in 2012. Only one well will be needed to supply construction water as shown on Table 6. During the third year of facility construction, in 2014, the reservoirs will also begin to be filled. Three wells will be pumped between 12 to 24 hours per day as shown on Table 3. Thereafter, only one to two wells will be pumped for a maximum of 13 hours per day as shown on Table 5. The variable annual pumping rates shown on Table 6 were used in the model to estimate the drawdown over the proposed 50-year life of the project. Values for hydraulic conductivity (K) of 125 feet per day (feet/day), saturated thickness (b) of 300 feet, storativity (S) of 0.05, and transmissivity (T) of 280,000 gallons per day per foot (gpd/ft) were used for drawdown projections.

Drawdown based on these pumping rates was assessed at durations of 7, 25, and 50 years to simulate drawdown near the end of the initial fill when the maximum drawdown will occur, halfway through the project life, and at the end of project, respectively. Figures 12 through 14 show the estimated drawdown and wells that could be affected. Attachment B presents the calculations. Figure 15 shows hydrographs at the pumping centroid well near Desert Center (CWdc), beneath the CRA (OW03), in Orocopia valley (OW15), and at the mouth of the Pinto basin (OW18).

The maximum drawdown from Project pumping at OW03, OW15 and OW18, at the end of the 50 year license period (after 48 years of pumping):

- under the CRA in the Upper Chuckwalla Basin is 4.2 feet;
- under the CRA in Orocopia Valley is 3.5 feet;
- at the mouth of Pinto Basin is 3.3 feet.

The drawdown near Desert Center, at the centroid well, reaches its maximum of about 50 feet after the initial fill. At a distance of one mile, the drawdown will be about 6 feet. After the initial fill pumping water levels will rebound to about 11 feet of drawdown about 8 years after pumping starts. By the end of the project there will be 14 feet of drawdown.

Drawdown under the CRA east of the Coxcomb Mountains was not simulated due to the proximity of the image well, which would result in an over-prediction of the drawdown. Observation wells OW01 and OW02 were not representative as the CRA at these locations is underlain by unsaturated alluvium overlying bedrock. Assigning additional observation wells into the Pinto basin could result in similar over-prediction of drawdown as the result of the image wells unless the observation wells were placed far into the basin where drawdown effects are not likely to be present anyway.

Projecting the drawdown regionally by use of a centroid well is an accepted modeling approach but may locally over predict the drawdown at the pumping well and underestimate the affected area. Figure 16 shows the effects of distributing the pumping to three wells rather than accumulating the drawdown at one centroid well. The maximum drawdown after the initial fill in the separate pumping wells is about 24 feet, much less than if the drawdown is accumulated to the centroid well. In some areas the drawdown may be about 10 feet one mile from the pumping wells. As with the centroid method after the initial fill the drawdown will be less. At a distance from the individual wells the drawdown would become similar to that projected by the centroid well.

Cumulative Effects

Project pumping along with existing pumping and future pumping by proposed solar energy generators and the landfill were projected to assess the cumulative impacts of the project. A stepped approach was used to project the cumulative effects. Drawdown projections from existing pumpers were assessed first to establish baseline conditions, and then project pumping was added to the drawdown. Distribution of the pumping is presented in Attachment E. Pumping by future projects, solar and the landfill, were then added to the previous analysis. The Project is planned to start pumping for construction in 2012 and to start filling of the reservoirs in 2014. Figure 17 shows the proposed solar projects. Figures 18 through 24 show the projected drawdown distribution in the valley and hydrographs for key wells. The maximum historic drawdowns are also shown on each hydrograph along with available groundwater level drawdown measurements from wells in the vicinity.

Values for hydraulic conductivity (K) of 125 feet per day (feet/day), saturated thickness (b) of 300 feet, storativity (S) of 0.05, and transmissivity (T) of 280,000 gallons per day per foot (gpd/ft) were used for drawdown projections. Attachment B presents the calculations.

Model results were compared to groundwater level measurements from the Pinto Basin well 3S/15E-4J1 (OW18) and 5S/16E-7P1 and -7P2 (near CWdc). Groundwater level measurements were for the most part made on an annual basis up through 1988, but since that time only one water level measurement is available for each well in recent years, one in 2000 and the other in 2007. The current trend of water levels is unknown (whether the basin is recharging creating an upward trend or is trending downward due to local pumping or recharge).

Existing Pumping
Projections for pumping by agricultural and domestic users in the Chuckwalla Valley Groundwater subbasin were assumed to be similar to those estimated for water use in 2007 as shown on Table 12. Near Desert Center (CWdc), about 3,200 acre feet per year (AFY) is pumped while the large palm and citrus grower east of Desert Center (near OW17) is pumping about 4,600 AFY as shown on Table 12. Both locations have rather significant new plantings of citrus trees and date palms. The projected water use for the new plantings is conservatively as it assumes these areas are covered with mature trees.

Although cumulative impacts were only needed to be addressed for the 50 year Project period, pumping for agricultural uses began in 1981 at a much higher rate and then was reduced to its current level. Initial drawdown related to existing agricultural pumping actually occurred in 1981. Accounting for the longest license period for any project in the subbasin, an 89 year model run was selected.

The historic and existing pumping data were distributed on a separate basis to accurately portray geographic distribution. Historic pumping was concentrated near Desert Center (CWdc) while existing pumping is partially near Desert Center (CWdc) and to the east, at the large date and citrus farm as simulated by OW17. Pumping at OW17 was not simulated with image wells as it is in a wide portion of the valley were most ridges are protruding parallel to the flow direction and would therefore have limited barrier effects.

Figure 18 shows the model predictions of drawdown from pumping by existing pumping over the 50 years (2010 to 2060) that the Project will be active. The drawdown by the existing pumping will result in about 4 feet of drawdown within the modeled area over the 50 year Project life. This uniform amount is because most of the drawdown associated with the pumping occurred in the early 1980s.

Figures 21 through 24 show the total drawdown from existing pumping since 1981 at the key wells. The model results show that the baseline conditions are changing and pumping drawdown will continue. The rate of change is about 0.1 foot per year. Figure 22 shows that existing pumping could exceed the projected historic drawdown in the Orocopia Valley (OW15) beneath the CRA. Existing pumping will not exceed the historic pumping drawdown at the other wells.

Existing Conditions with Project Pumping
Projected drawdown from existing pumping (shown on Figure 18), and 50 years of Project water supply pumping (Figure 14), and Project seepage recovery well pumping, were combined to assess potential cumulative effects. Figure 19 shows the projected drawdown as a result of this combined pumping. Figures 21 through 24 show hydrographs of the key wells.

During the initial fill the cumulative pumping will lower groundwater levels by between 2 and 5 feet beneath the CRA (OW03), in Orocopia Valley (OW15) and at the mouth of Pinto Basin (OW18) as shown on Figures 21 through 23. After 50 years of Project pumping the drawdown will be between 7 and 11 feet at these wells, as shown on Figure 13.The model predicts that drawdown from existing and Project pumping will be below the historic low groundwater levels as follows:

- beneath the CRA in the upper Chuckwalla valley (OW03) by about 4 feet;
- within the Orocopia valley (OW15) by about 4 feet.

As shown on Figures 23 and 24, the projected drawdown near Desert Center and in the Pinto basin would be above their historic maximum drawdown levels.

Pumping of Project wells during the four year initial fill will create about 50 feet of drawdown near the well which will decrease to about 10 feet one mile away from the centroid well. Thereafter, the pumping will be reduced and the drawdown in the pumping well will be less than 20 feet for the remaining 43 years of the Project life. About ten existing wells could experience drawdown greater than 10 feet, which may require mitigation, as shown on Figure 16.

Existing Conditions, Project, and Proposed Pumping
Many portions of the Chuckwalla Valley Groundwater Basin are being proposed for development of solar power projects (BLM, 2009) as shown on Figure 17. Potential water needs will vary significantly for the type of solar power facility. Table 13 provides the water use for the different types of solar facilities, and their annual water use estimates. Attachment E contains a detailed projection of the construction and annual water use and their distribution over their 30 year license period. Over 70 percent of the solar water use is occurring near Ford Dry Lake and in the Lower Chuckwalla valley area. For modeling purposes, groundwater pumping for the solar facilities was split between the centroid well (CWdc) near Desert Center, in the upper Chuckwalla Valley (CWuc), at the simulated well near the large citrus and palm grower east of Desert Center (OW17), and at a simulated well near Ford Dry Lake (OW20) as shown on Table 12.

In addition to the solar facilities, the proposed landfill was assumed to begin operations in 2020 and would continue for the 50 year license period. The annual water demand varies throughout the project period and is summarized in Attachment E. The average annual water demand for that facility is about 820 AFY as shown in Table 12. Pumping will be in the upper Chuckwalla Valley so pumping was simulated at the centroid well (CWuc).

Drawdown from existing, Project, and proposed pumping was combined to assess the cumulative effects. Figure 20 shows the distribution of pumping effects within the basin. Overall pumping by the solar, Chuckwalla Valley raceway, and landfill projects will add about 3 to 10 feet of additional drawdown in the areas of the basin where water is being pumped. Figures 21 through 24 show hydrographs of key wells. The results show that the maximum historic drawdown will be exceeded as follows:

- beneath the CRA in the upper Chuckwalla valley (OW03) by about 7 feet;
- within the Orocopia Valley by about 6 feet;
- at the mouth of Pinto Basin by about 1 foot.

The pumping of existing, Project, and proposed wells will create about 60 feet of drawdown near the Project water supply well but will diminish to less than 10 feet about 1.5 miles away from the well. Thereafter the pumping will be reduced and the drawdown in the Project supply wells will be about 20 feet through the life of the solar facilities and by about 20 feet for the remaining 10 years of the Project life.

Post Project Groundwater Levels

After the 50-year Project license period, pumping will cease and the groundwater levels will recover, but only to the extent that other uses continue to withdraw groundwater. Initial recovery of the groundwater levels will be rather quick near the pumping wells. Thereafter the recovery will slow for the area affected by the Project pumping. In theory, recovery is converse to pumping and full recovery time is approximately equal to the pumping duration. For example, as shown on Figure 4, groundwater levels rebounded by about 60 feet (about 50 percent) in three years after the six years of heavy agricultural pumping in the early 1980s. A fair estimate of the duration for the water levels to recover can be estimated from a water balance, especially basin wide.

The water balance for the entire Chuckwalla Valley Groundwater Basin is shown on Table 14. Table 15 provides a summary of the calculations. The water balance accounts for the cumulative impacts of all pumpers. Recharge to the basin had been previously estimated by several authors to range from 10,000 to 20,000 AFY. Additional studies suggest the recharge is about 12,700 AFY (Attachment F).

The water balance shows that the basin overall is currently positive, with more water entering the basin than leaving. During the initial fill Project pumping, along with pumping by the proposed solar facilities, will exceed the inflow capacity to the basin. This condition will continue for about the next 30 years, until the end of the solar facilities license periods. For the next 10 years, through the end of the Project license period, the inflow will approximately equal outflow. After the landfill stops pumping, the basin recovers at a greater rate. . By 2094, about 34 years after the Project ends, groundwater storage will be equal to the pre-Project pumping.

The maximum depletion in storage, as a result of all projects, would occur in 2046 and would be about 95,000 acre-feet. There is between 9,100,000 and 15,000,000 AF of groundwater in storage (DWR, 1973). This depletion in storage would be about one percent or less of the total groundwater in storage in the basin.

Potential Effects on the Pinto Basin

Subsurface inflow from the Pinto Basin has historically been estimated to be about 2,500 AFY (Mann, 1986) based on the perennial yield, but could be greater based on recent recharge estimates. The National Park Service expressed concerns in the National Environmental Protection Act (NEPA) scoping process that Project pumping could affect groundwater in the Pinto basin. The estimates presented above show that Project pumping may cause groundwater levels to decline by 3 to 4 feet at the end of the 50 year Project license period. The cumulative effects of existing, Project, and proposed facilities show the drawdown may be as much as 9 feet.

The potential effects of Project and cumulative pumping on the subsurface inflow from the Pinto Basin were assessed assuming there will be an effect of lowering the water levels by 4 and 9 feet. The inflow is based on estimates of the hydraulic conductivity, the area that water can flow through, and the groundwater gradient.

There are no groundwater level measurements that can be used to estimate the groundwater gradient before pumping in the Pinto and Chuckwalla Valley Groundwater Basins began. It was assumed that the groundwater gradient was parallel to ground surface, and elevations were obtained from USGS topographic maps to simulate observation points at OW-18 and OW-10 as shown on Figure 2. The groundwater gradient after 50 years of both Project and cumulative pumping was estimated by taking the surface elevations and subtracting the projected groundwater drawdown. The results show that Project pumping will have little effect on the groundwater gradient, changing it from 0.00576 to 0.00583, which is beyond detection (beyond the accuracy of the measurements).

The area where groundwater can flow from the Pinto Basin into the Chuckwalla Basin was estimated based on geophysical studies (GeoPentech, 2003). The geophysical studies show the inflow area is partially blocked by a basalt flow, which for purposes of this investigation is considered to be impermeable. Alluvial sediments are present both above and below the basalt where groundwater can flow. The area above and below the basalt was estimated. The area (height) was reduced by 4 and 9 feet to simulate the affects after 50 years of pumping. A hydraulic conductivity of 50 feet per day was used to simulate flow for sediments above the basalt layer. The hydraulic conductivity was reduced to 25 feet per day to conservatively simulate groundwater flow below the basalt layer where the sediments may be more consolidated, weathered, or cemented. The use of slightly higher hydraulic conductivities would result in the subsurface inflow more closely matching the revised recharge estimates contained in Attachment E.

The results of the calculations show inflow from the Pinto basin prior to pumping is about 3,173 AFY. After 50 years of Project pumping the inflow would decrease to about 3,143 AFY, a reduction of about 30 AFY. A similar result was found with the cumulative pumping and showed the inflow would decrease by about 100 AFY. Although the groundwater gradient is slightly steeper with Project and cumulative pumping, the decrease in the area has a greater affect on the inflow and is causing the reduction of groundwater subsurface inflow. Attachment D contains these calculations.

Conclusions

Use of the analytical modeling approach correlated favorably with the available groundwater level measurements. Drawdown projections for the 27 years of agricultural pumping near Desert Center between 1981 and 2007 matches water levels measured in wells 5S/16E-7P1 and -7P2, using a hydraulic conductivity of 125 feet/day and a storage coefficient of 0.05. Maximum drawdown projections in 1986 was within 7 feet of measured drawdown, and projections in 2007, at the end of the calibration period, were within one foot, indicating accurate calibration.

The modeling also calibrated well when comparing the 17-year historic Kaiser well pumping to water level measurements from well 3S/15E-4J1 (OW18), located at the mouth of the Pinto basin, using a hydraulic conductivity of 50 feet/day and a storage coefficient of 0.05. Comparison of the existing pumping near Desert Center to groundwater levels at (OW18) showed a reasonable comparison but the model is under-predicting the drawdown by about 1 foot.

The modeling approach could not simulate the variable hydraulic characteristics present in the upper Chuckwalla valley. Higher hydraulic conductivities are present near Desert Center where the Project water supply wells are located, and was used for the modeling. Sensitivity analysis show using lower hydraulic conductivities would predict less drawdown, confirming that the analysis is a conservative (worst-case) condition.

Historic pumping in the Chuckwalla Valley created drawdown. Historic groundwater level measurements at wells 3S/15E-4J1 (about 15 feet) and at 5S/16E-7P1 and -7P2 (about 130 feet) provide firm confirmation of the maximum drawdown at simulated wells OW18 and CWdc. The maximum drawdowns from documented groundwater level drawdown and modeling of the historic pumping are given in the table below:

Maximum Historic Drawdown (Actual or Predicted)

Well Used in Modeling: (State Well Number)	Maximum Actual Drawdown[1] (feet)	Maximum Predicted Drawdown (feet)
OW03	NM	12
OW15	NM	10
OW18 (3S/15E-4J)	15[2]	8
CWdc (5S/16E-7P1 and -7P2)	130[3]	137

NM = Not measured, no well in the vicinity
[1] Measured by USGS
[2] Includes pumping by Kaiser wells in the Pinto basin. Static water level from 1960.
[3] Static water level from 1980.

The modeling predicts Project water supply pumping alone will cause drawdown of the groundwater levels in the Chuckwalla Valley Groundwater Basin. During the initial fill the modeling predicts about 50 feet of drawdown will be created near the centroid pumping well for about 4 years, but thereafter the drawdown will be reduced to less than 14 feet. At distances of less than one quarter mile from the pumping wells the drawdown will be less than ten feet and the greatest drawdown will typically occur after 50 years of pumping. The drawdown created by just Project pumping will be about 3 to 5 feet beneath the CRA in the upper Chuckwalla (OW03) and Orocopia (OW18) valleys. Groundwater levels will be lowered by about 4 feet at the mouth of the Pinto basin. Project pumping by itself would not exceed the maximum historic drawdowns.

Existing pumping is creating variable baseline conditions. Projections suggest the groundwater levels locally are declining by about 0.1 foot per year due to pumping. The existing pumping is lowering groundwater levels and will exceed the maximum historic drawdown in the Orocopia valley by 2057.

Cumulative impacts (existing, Project, and proposed pumping) predicted by the modeling show the drawdown, will exceed the historic maximum drawdown as follows:

Cumulative Drawdown Compared to Maximum Historic Drawdown

Well Used in Modeling: (State Well Number)	Maximum Historic Drawdown Actual or Predicted (feet)	Maximum Cumulative Predicted Drawdown (feet) *	Exceedance of Historic Maximum Drawdown (feet)
OW03	12	14	7
OW15	10	9	6
OW18 (3S/15E-4J)	15	10	1
CWdc (5S/16E-7P1 and -7P2)	130	60 (0 to 7 years) 18 (7 to 50 years)	None

It is important to note that the maximum historic drawdown is only being exceeded in this conservative "worst-case" modeling because of the variable baseline conditions caused by existing pumping. Any delay in implementation of the future landfill, or of the proposed solar projects (projected to contribute 3 to 5 feet of the total drawdown) and the potential to manage seepage from the reservoirs (projected to counteract the drawdown effects at the CRA by +3 feet at OW03) could reduce the drawdown in the Pinto Basin and Chuckwalla Valley beneath the CRA to within historic levels.

In other areas of the State, with verified subsidence related to groundwater extraction, the subsidence is being caused by dewatering of thick clays by pumping of confined aquifers. These are not the geologic conditions beneath the CRA in the upper Chuckwalla or Orocopia Valleys. Groundwater levels beneath the CRA in the upper Chuckwalla Valley have historically fluctuated between 1 to 15 feet between 1965 and 1986 as a result of historic Kaiser and agricultural pumping.

Because the water levels have been lowered over multiple years, inelastic subsidence – to the extent it would occur – should have already occurred, without affecting the tight tolerance of one quarter inch of drop per 200 linear feet of the CRA (MWD, 2008). Projected worst-case cumulative effects could lower water levels by about 7 feet below this maximum historic drawdown over a 50 year period. It is concluded that the geologic conditions favorable for subsidence related to groundwater extraction are not prevalent based upon historic effects of pumping, and it is therefore unlikely that lowering of water levels by as much as an additional 7 feet will have a significant effect. Nonetheless, subsidence monitoring should be implemented to confirm that drawdown effects remain within the projected drawdown and that significant inelastic subsidence does not occur.

Groundwater in the Pinto Basin will not be significantly affected by Project or cumulative pumping. Based upon this worst-case analysis, Project pumping could decrease the inflow from the Pinto Basin by about 30 to 100 AFY, predominately by a reduction of the inflow area. Groundwater level monitoring of the inflow area will be performed to confirm that potential impacts remain at less than significant levels.

*The cumulative drawdown is from the start of the Project to the end of the Project as shown on Figures 23 and 24.

Overall the project drawdown affects are small in comparison to the saturated thickness of the alluvium. In the upper Chuckwalla Valley about 150 feet of saturated alluvium is present. Cumulative impacts show groundwater levels, mostly due to localized pumping by the future landfill and solar projects, will only lower groundwater levels by about 10 to 18 feet over a 50 year period, leaving over 130 feet of saturated alluvium to continue to supply water to wells.

In the Desert Center area, there is about 600 feet of saturated alluvium and the maximum drawdown during the initial fill will only reduce the water levels in the area of each well by 60 feet for a period of about 4 years. Thereafter, the pumping will be significantly reduced, and water levels will recover with a drawdown of about 18 feet by the end of the project. A few surrounding wells may experience lower pumping levels, but most or all of these wells were operational during the historic low groundwater levels produced in 1981 through 1985, and have experienced the same level of variable operational pumping levels in the past. Therefore the effects are deemed to be less than significant. If surrounding wells do go dry, they will be deepened or replaced.

Pumping will cause localized drawdown of about 18 feet after 50 years. After Project pumping ceases, groundwater levels will recover. The water balance (Table 15) shows the Chuckwalla Valley Groundwater Basin will recover to its pre-Project storage by 2094, within 34 years after the end of the licensing period of the Project. Part of the delay of the recovery is due to use by the landfill until 2070.

Mitigation Measures

Mitigation WS-1: Groundwater

A groundwater level monitoring network will be developed to confirm that Project pumping is maintained at levels that are in the range of historic pumping. The monitoring network will consist of both existing and new monitoring wells to assess changes in groundwater levels beneath the CRA, as well as in the Pinto Basin, and in areas east of the water supply wells. Table 16 lists the proposed monitoring network and Figure 25 shows their proposed locations. In addition to the proposed monitoring wells, groundwater levels, water quality, and production will be recorded at the Project pumping wells.

Mitigation WS-2: Groundwater

Two extensometers shall be constructed to measure potential inelastic subsidence that could affect operation of the CRA; one in the upper Chuckwalla Valley near OW-3 and the other in the Orocopia valley near OW15. Figure 25 shows the locations of the extensometers.

Mitigation WS-3: Groundwater

Wells on neighboring properties whose water production may be impaired by Project groundwater pumping will be monitored during the initial fill pumping period. If it is determined in consultation with SWRCB staff that Project pumping is adversely affecting those wells, the Project will either replace or lower the pumps, deepen the existing well, construct a new well, and/or compensate the well owner for increased pumping costs to maintain water supply to those neighboring properties.

Mitigation WS-4: Groundwater

Groundwater level monitoring shall be performed on a quarterly basis for the first four years of Project pumping and thereafter may be extended from quarterly to bi-annually depending upon the findings. Extensometer monitoring should be recorded on a daily basis initially to evaluate natural elastic subsidence and rebound. Thereafter the monitoring should continue on a quarterly basis. Annual reports will be prepared and submitted to both FERC and the SWRCB to confirm actual drawdown conditions.

References

Bureau of Land Management, internet 2009, Proposed solar projects locations and description.

Ferris et al, 1962. Theory of Aquifer Tests. Geological Survey Water Supply Paper 1536E.

Fetter, C.W., 1988. Applied Hydrogeology.

GeoPentech, 2003. Upper Chuckwalla Groundwater Basin Storage, Draft Report. Produced for Metropolitan Water District.

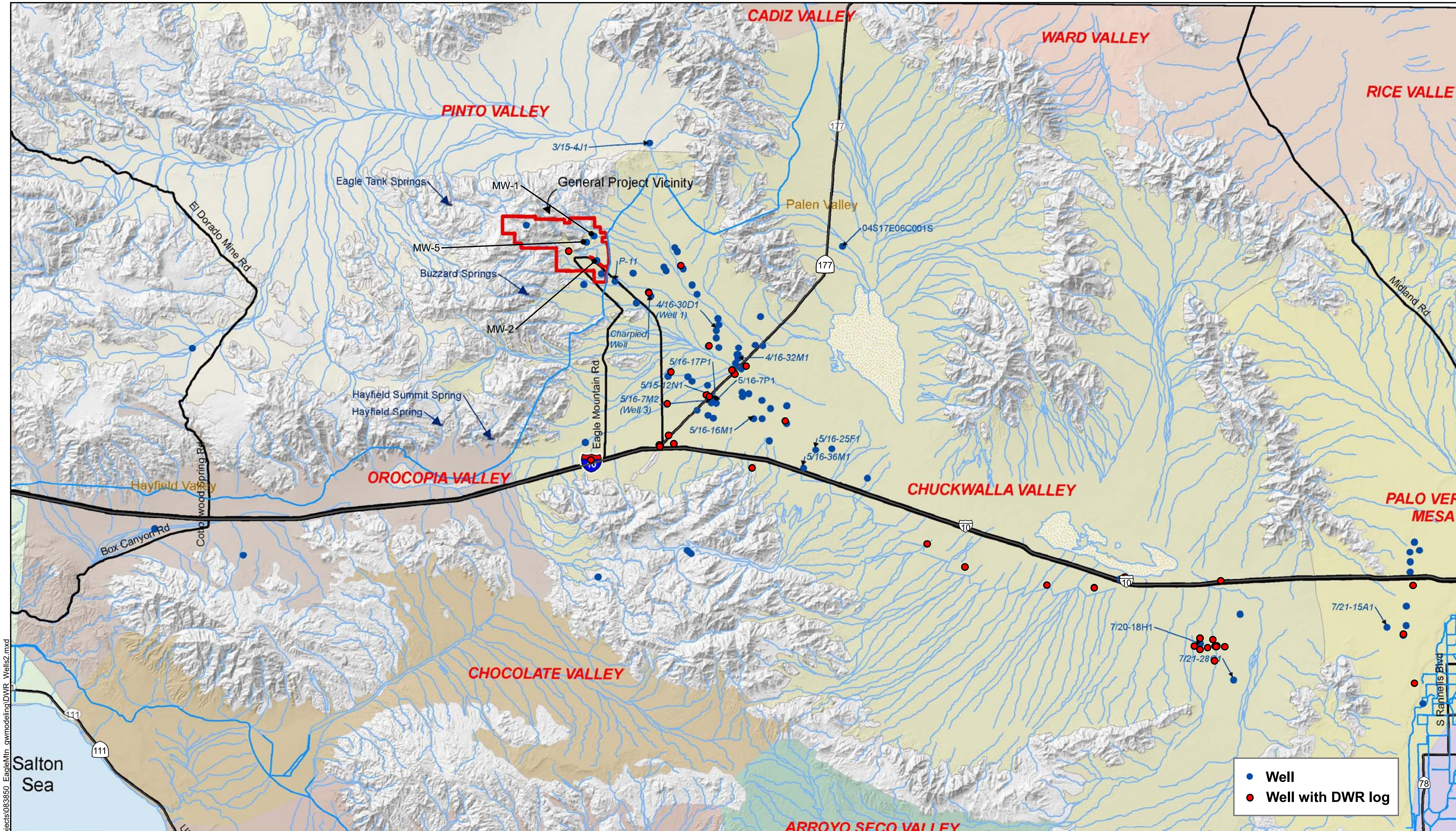
Greystone, 1994. Eagle Mountain Pumped Storage License Application. Produced for Eagle Crest Energy Company.

Mann, 1986. Ground Water Conditions in the Eagle Mountain Area.

Metropolitan Water District of Southern California, September 15, 2008. Metropolitan Water District of Southern California's Comments to Draft License Application.

Theis, 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16.

Figures



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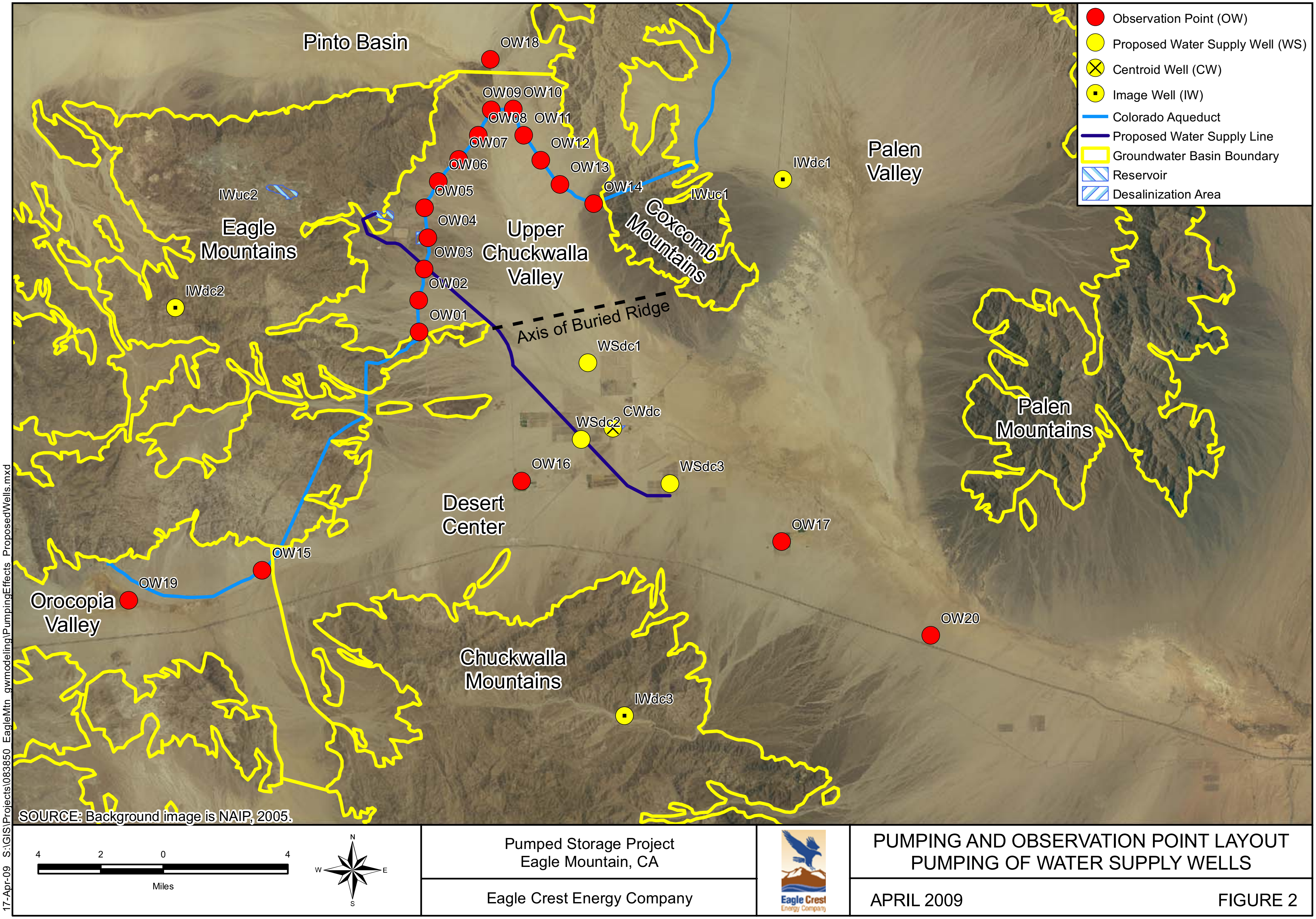
Pumped Storage Project
Eagle Mountain, California

Eagle Crest Energy Company

WELL LOCATIONS

APRIL 2009

FIGURE 1



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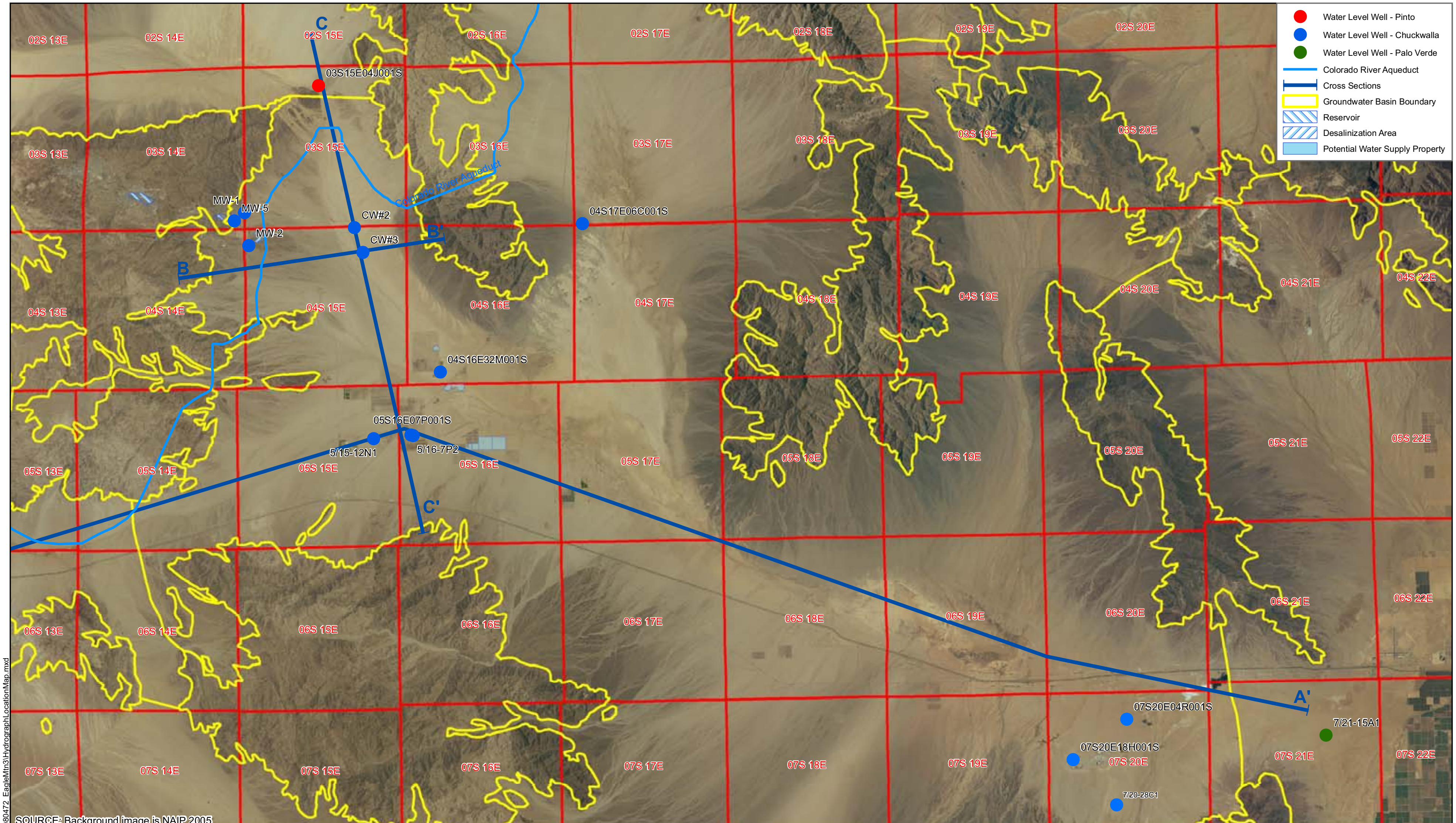
Pumped Storage Project Eagle Mountain, CA		PUMPING AND OBSERVATION POINT LAYOUT PUMPING OF WATER SUPPLY WELLS
Eagle Crest Energy Company		APRIL 2009 FIGURE 2



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Eagle Mountain Pumped Storage
Eagle Mountain, California

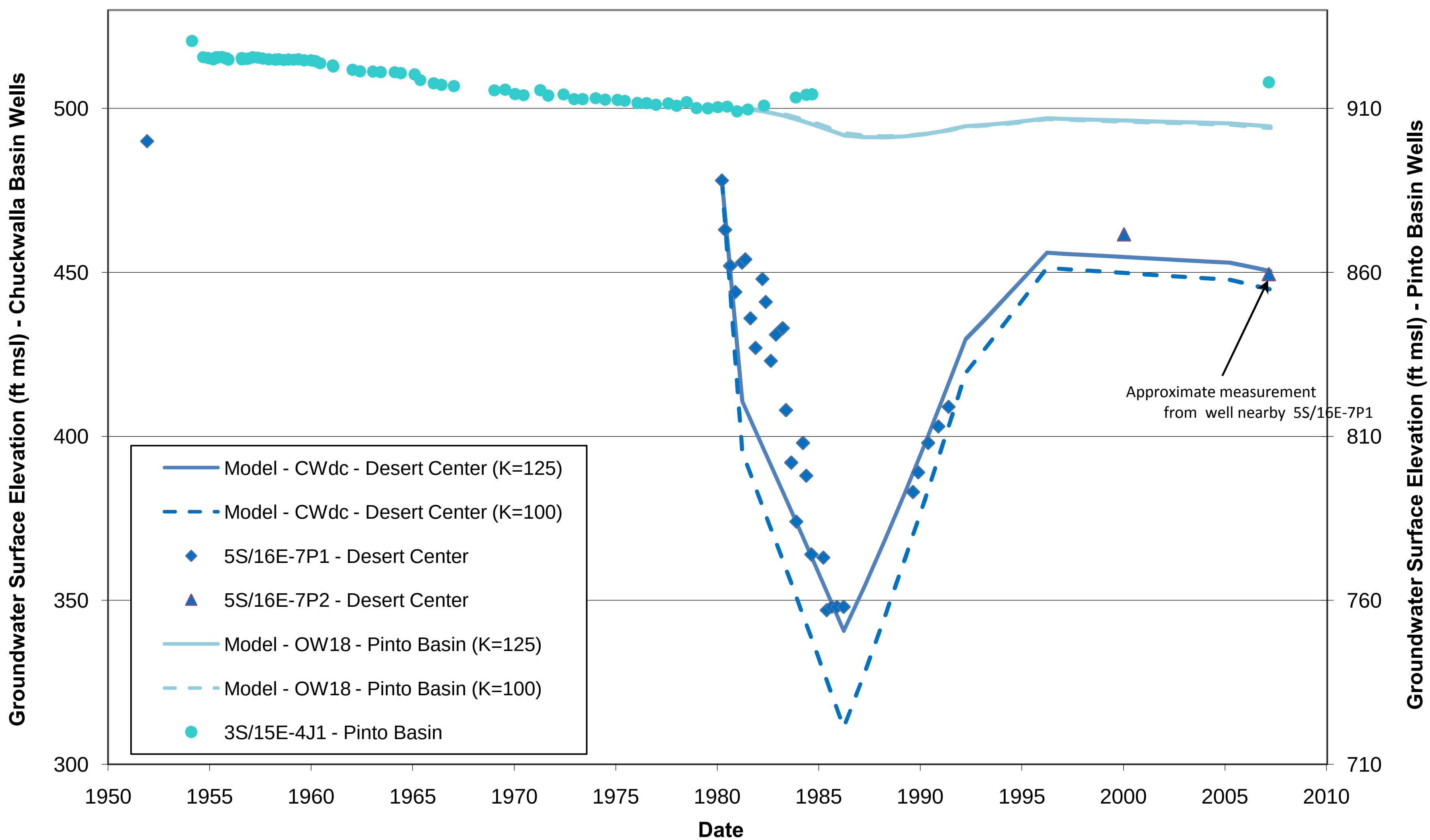
Eagle Crest Energy Company

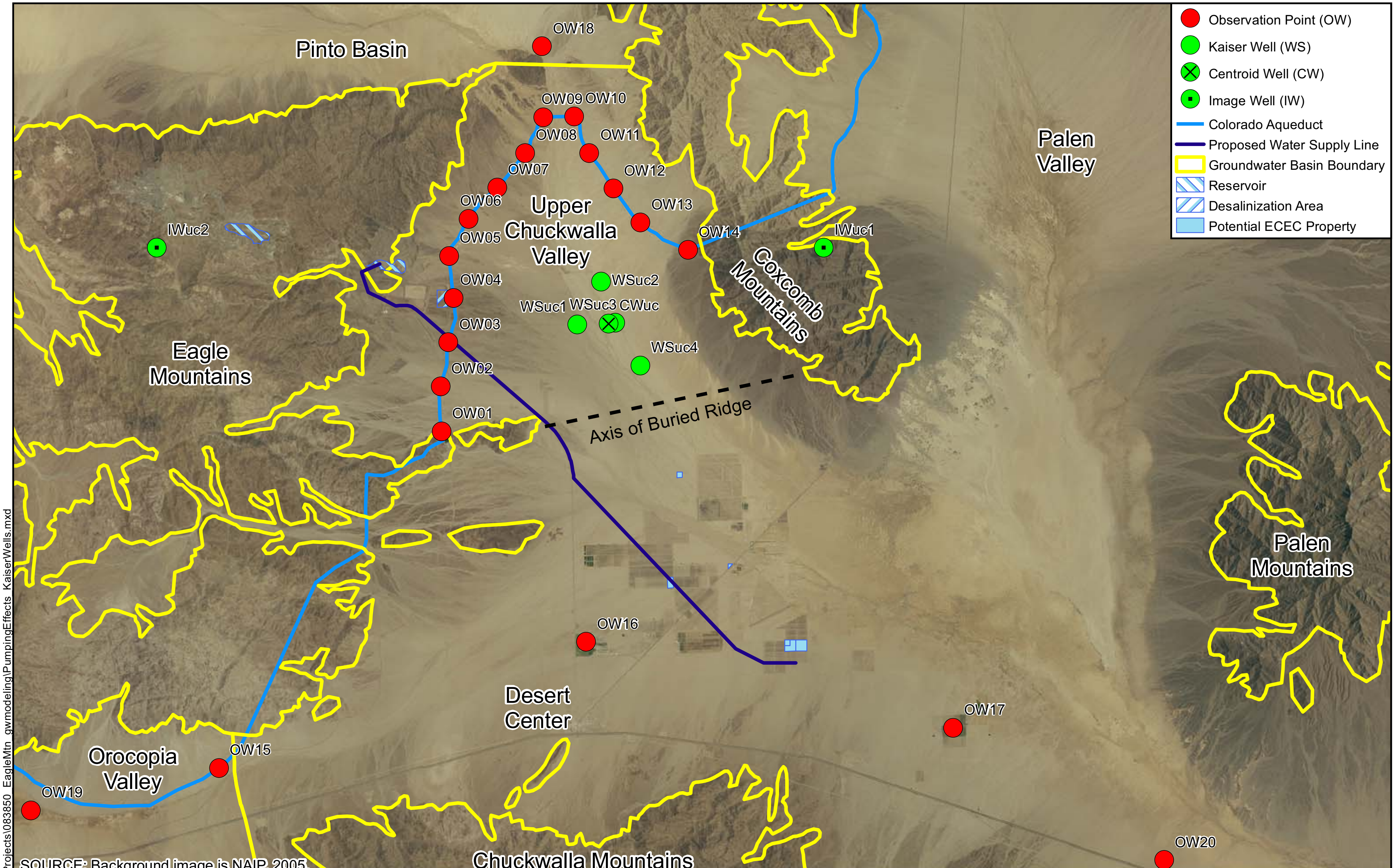
LOCATION OF WELLS WITH WATER LEVEL DATA

APRIL 2009

FIGURE 3

FIGURE 4
GROUNDWATER LEVELS AND MODEL CALIBRATION





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Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

PUMPING AND OBSERVATION POINT LAYOUT
HISTORIC PUMPING OF KAISER WELLS

APRIL 2009

FIGURE 5

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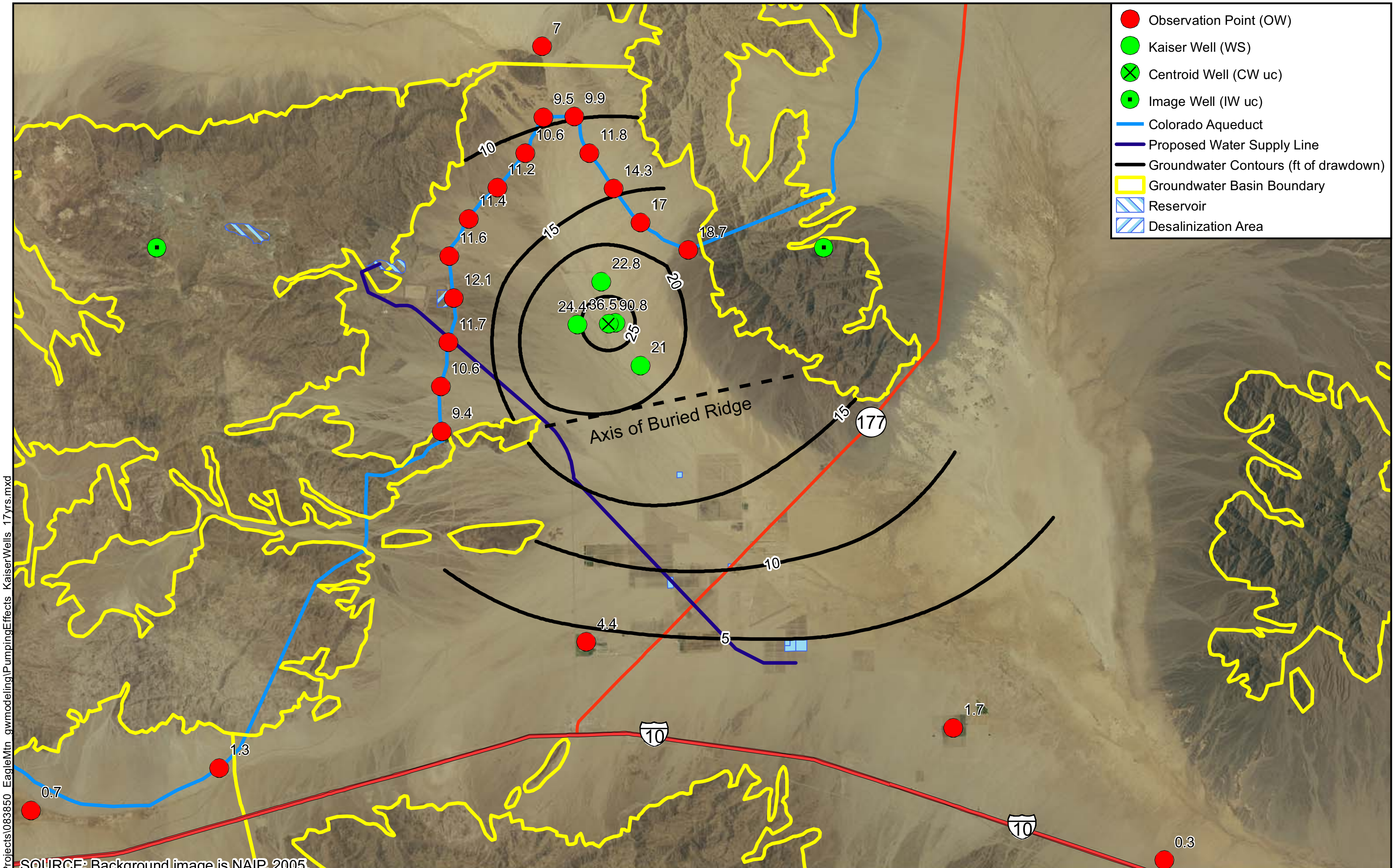

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DRAWDOWN AFTER 17 YEARS OF PUMPING KAISER WELLS

APRIL 2009

FIGURE 6

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FIGURE 7
17-YEAR PROJECT PUMPING AFFECTS BY KAISER

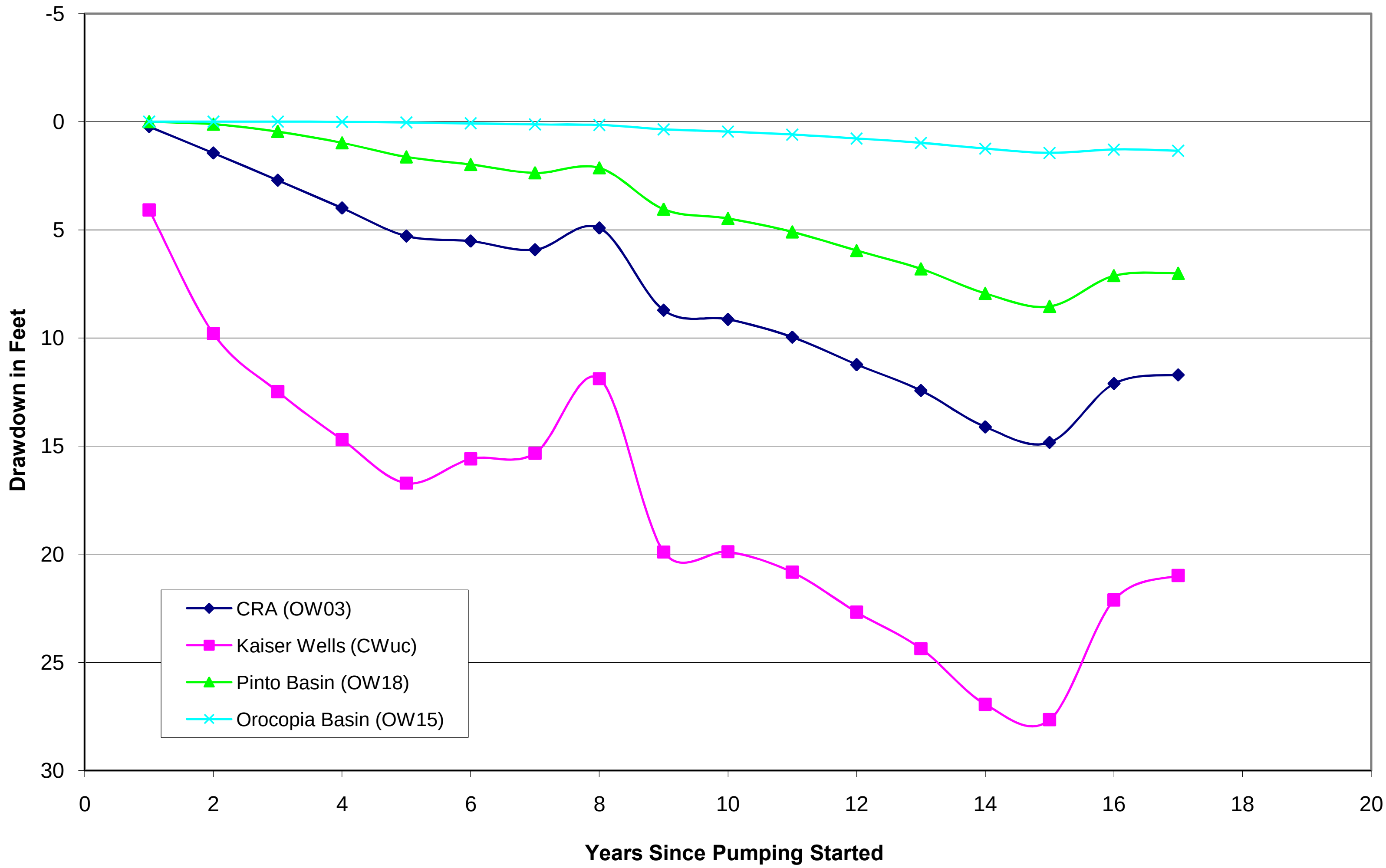


FIGURE 8
PINTO BASIN GROUNDWATER LEVELS

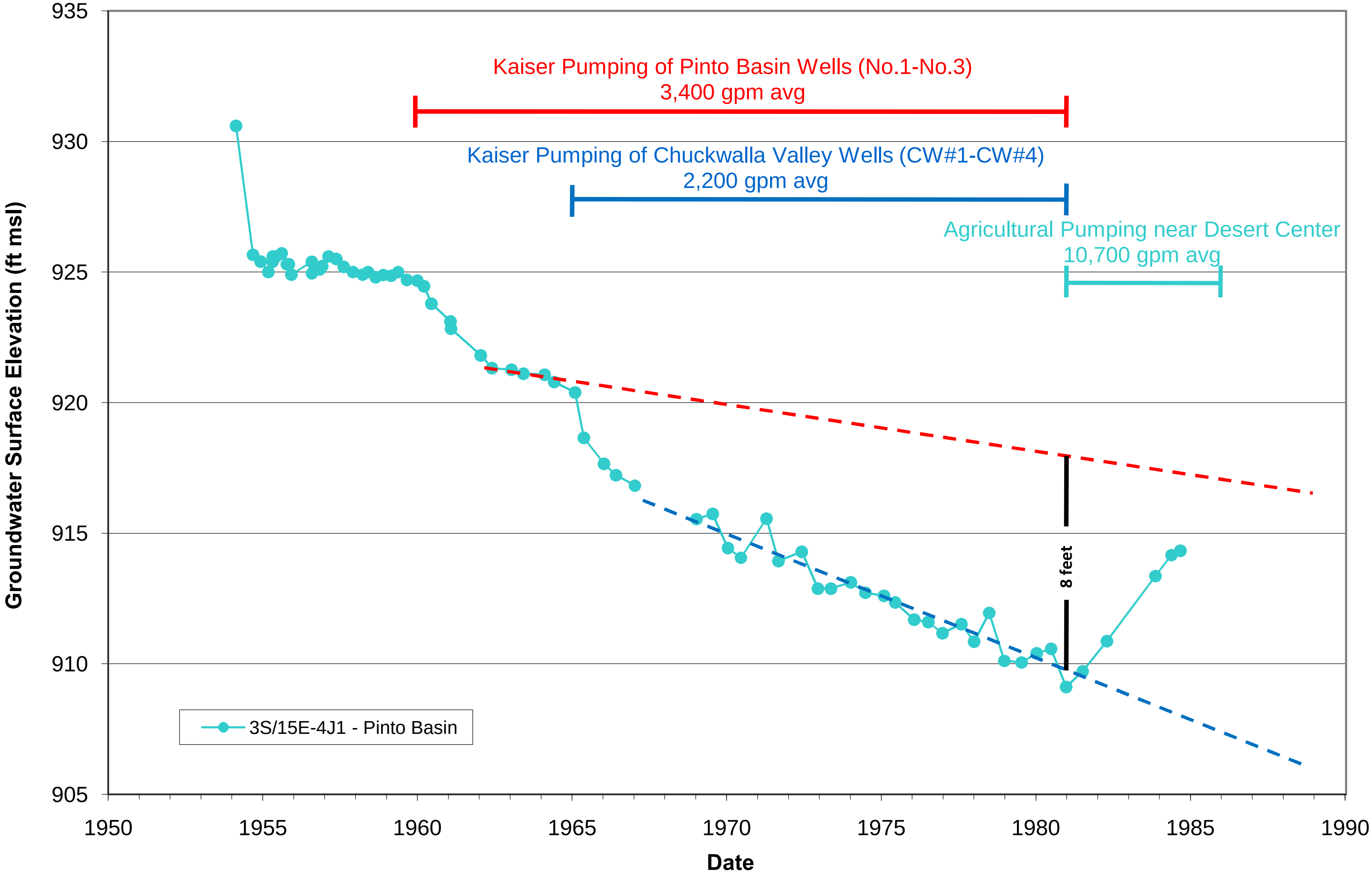
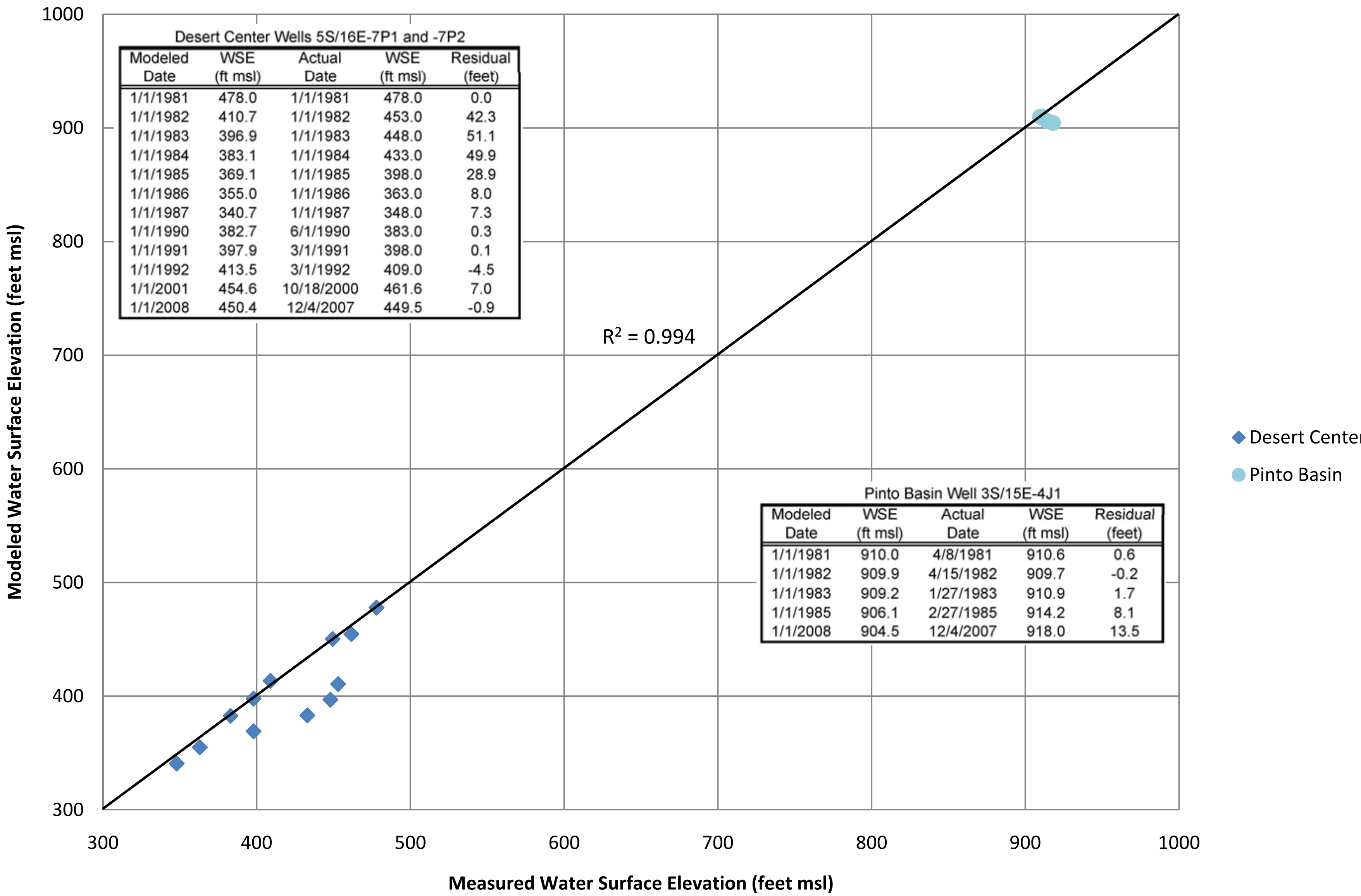


FIGURE 9

MODEL CALIBRATION

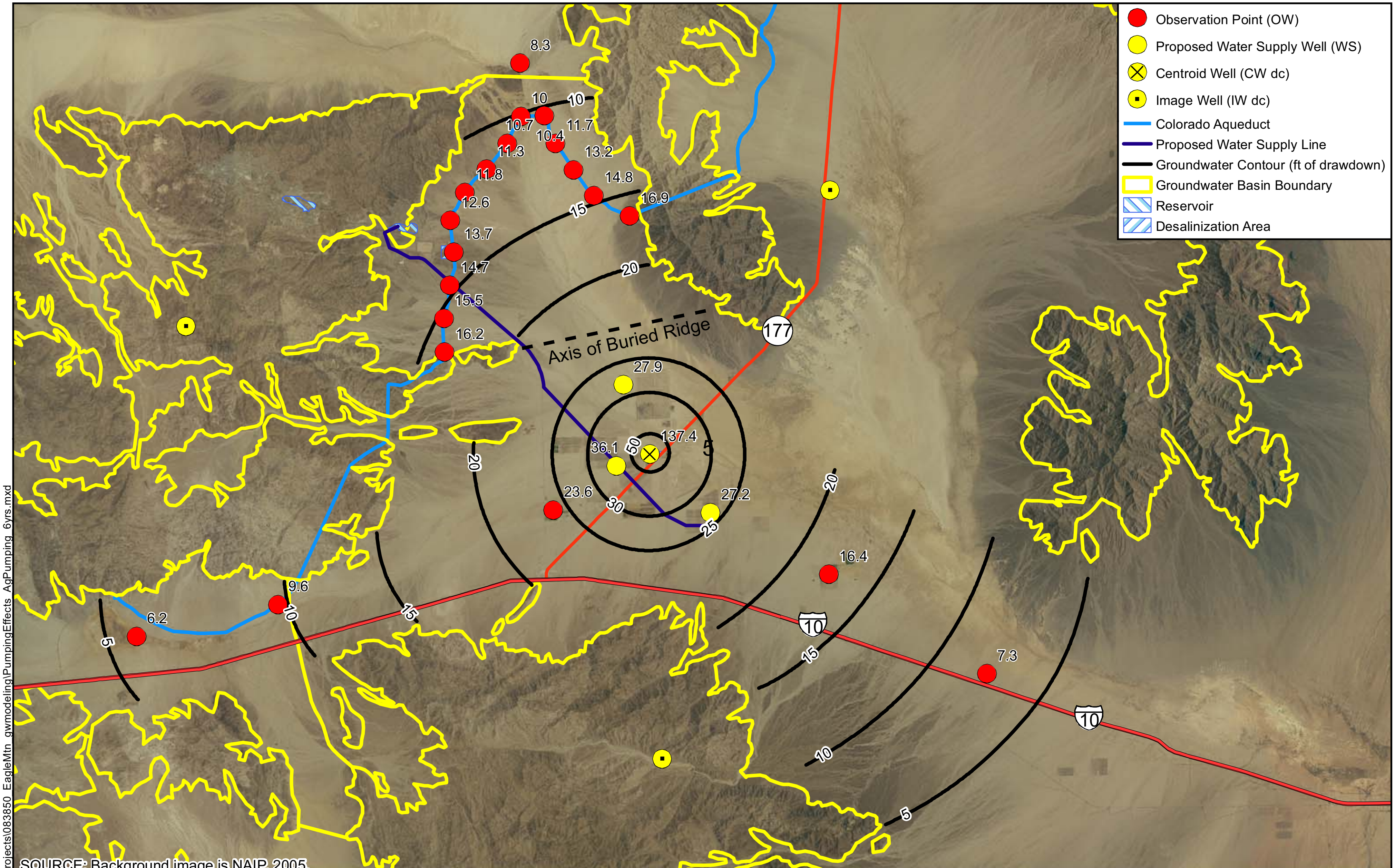


Desert Center Wells 5S/16E-7P1 and -7P2

Modeled Date	WSE (ft msl)	Actual Date	WSE (ft msl)	Residual (feet)
1/1/1981	478.0	1/1/1981	478.0	0.0
1/1/1982	410.7	1/1/1982	453.0	42.3
1/1/1983	396.9	1/1/1983	448.0	51.1
1/1/1984	383.1	1/1/1984	433.0	49.9
1/1/1985	369.1	1/1/1985	398.0	28.9
1/1/1986	355.0	1/1/1986	363.0	8.0
1/1/1987	340.7	1/1/1987	348.0	7.3
1/1/1990	382.7	6/1/1990	383.0	0.3
1/1/1991	397.9	3/1/1991	398.0	0.1
1/1/1992	413.5	3/1/1992	409.0	-4.5
1/1/2001	454.6	10/18/2000	461.6	7.0
1/1/2008	450.4	12/4/2007	449.5	-0.9

Pinto Basin Well 3S/15E-4J1

Modeled Date	WSE (ft msl)	Actual Date	WSE (ft msl)	Residual (feet)
1/1/1981	910.0	4/8/1981	910.6	0.6
1/1/1982	909.9	4/15/1982	909.7	-0.2
1/1/1983	909.2	1/27/1983	910.9	1.7
1/1/1985	906.1	2/27/1985	914.2	8.1
1/1/2008	904.5	12/4/2007	918.0	13.5



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Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

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DRAWDOWN AFTER 6 YEARS OF AGRICULTURAL PUMPING

MAY 2009

FIGURE 10

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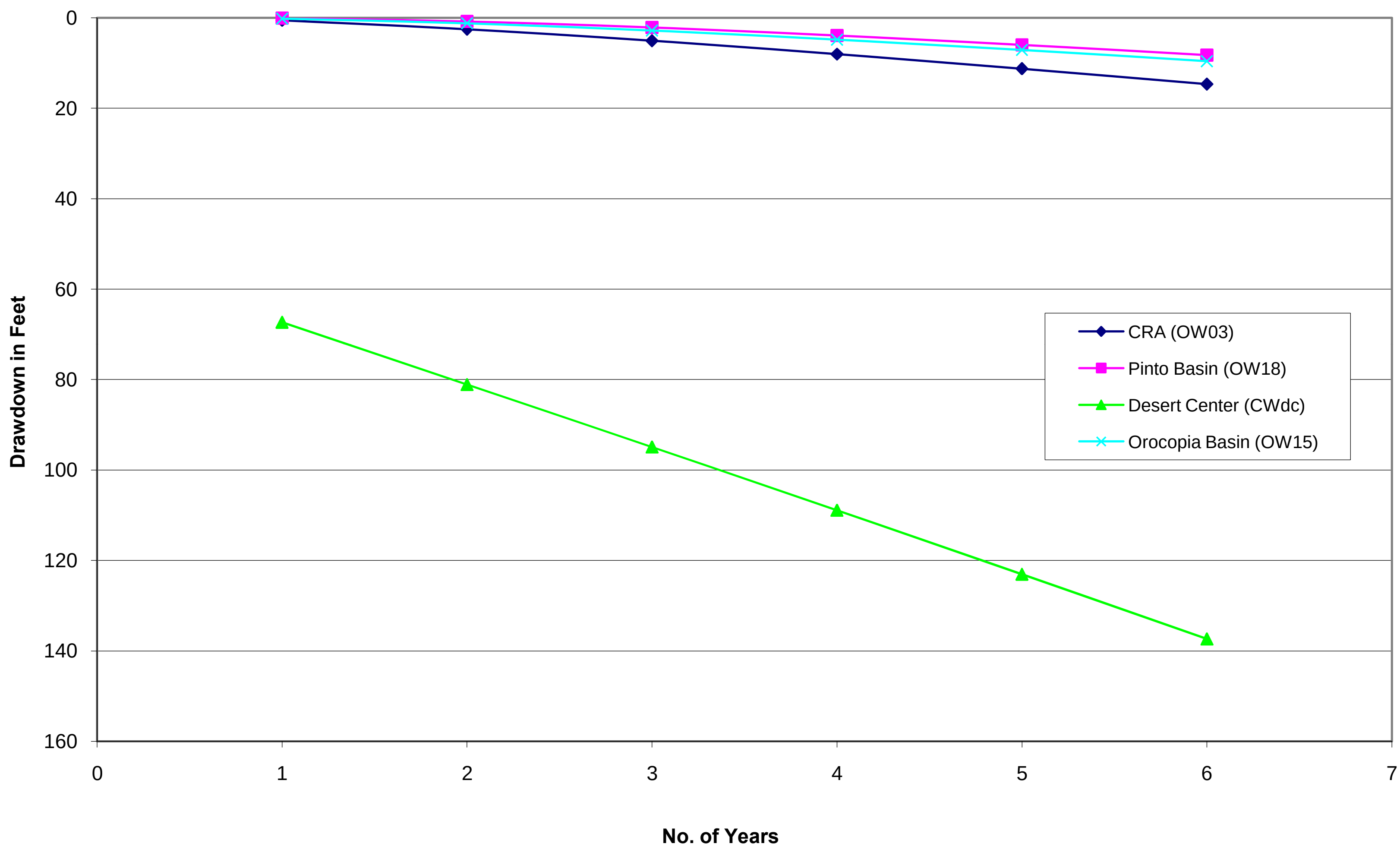
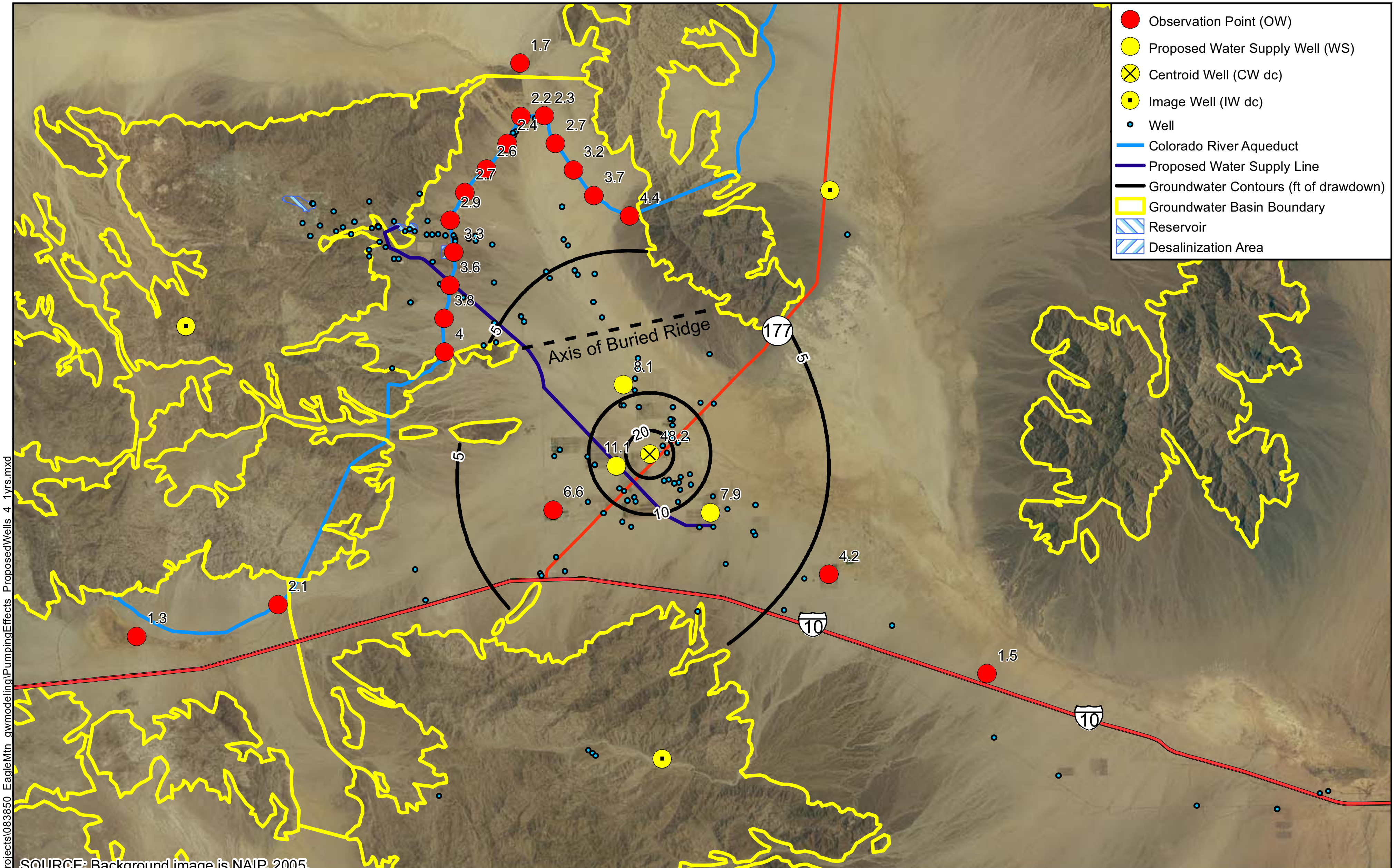
FIGURE 11
DRAWDOWN FROM 6 YEARS (1981 thru 1986) OF HISTORIC AGRICULTURAL PUMPING





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Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

DRAWDOWN AFTER INITIAL FILL OF RESERVOIRS (7 YEARS)

MAY 2009

FIGURE 12

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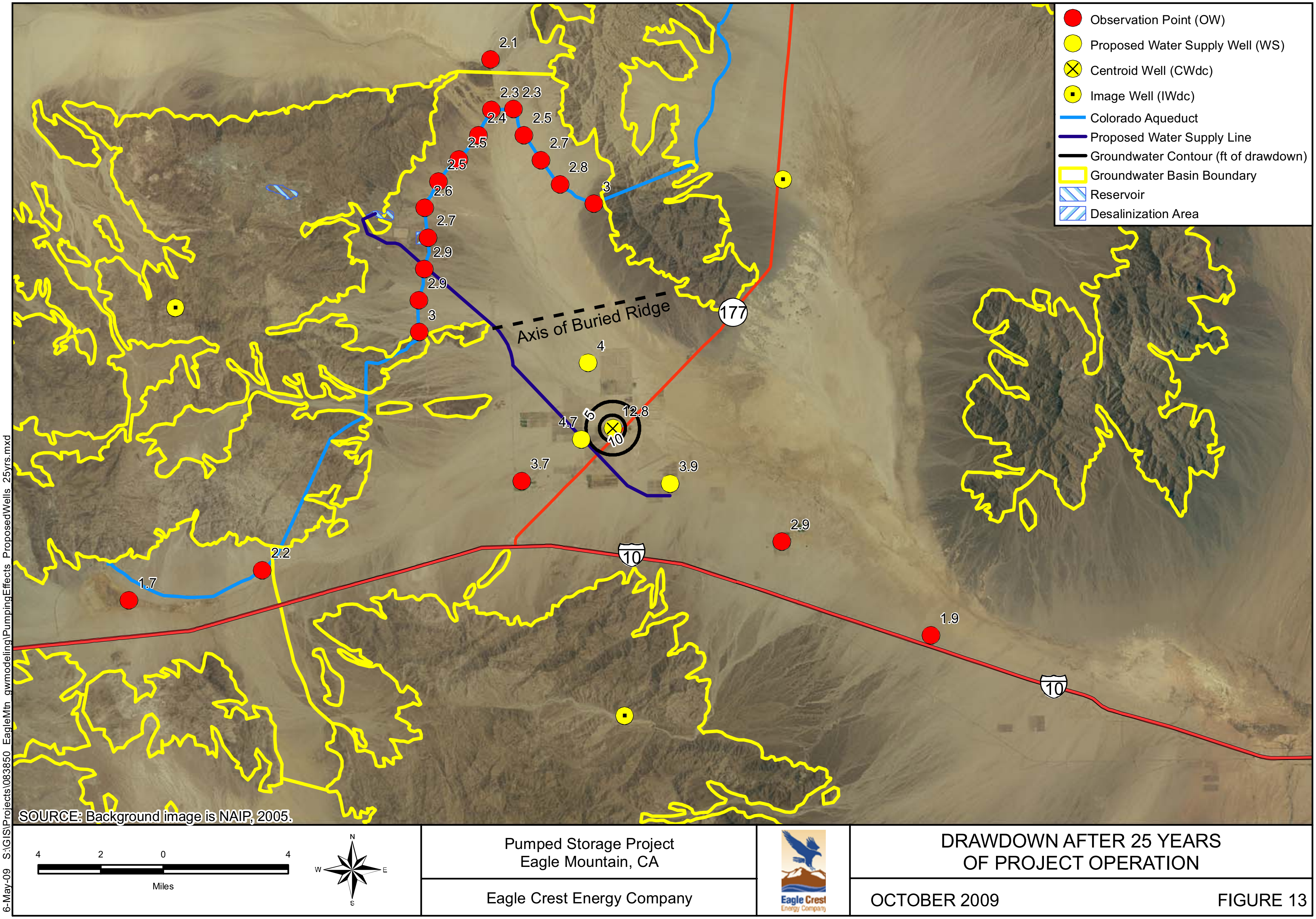

Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

DRAWDOWN AFTER 25 YEARS OF PROJECT OPERATION

OCTOBER 2009

FIGURE 13

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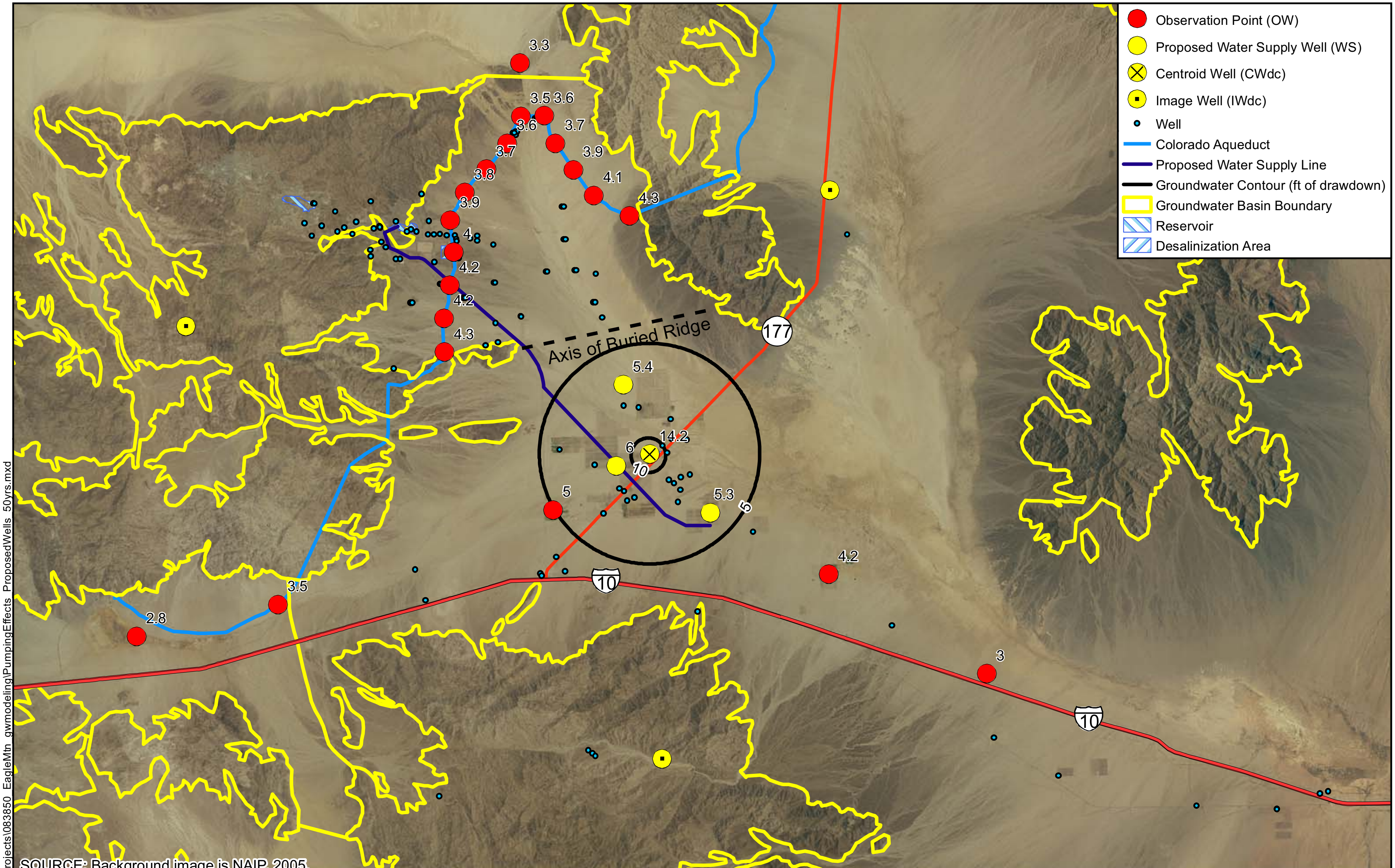

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Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

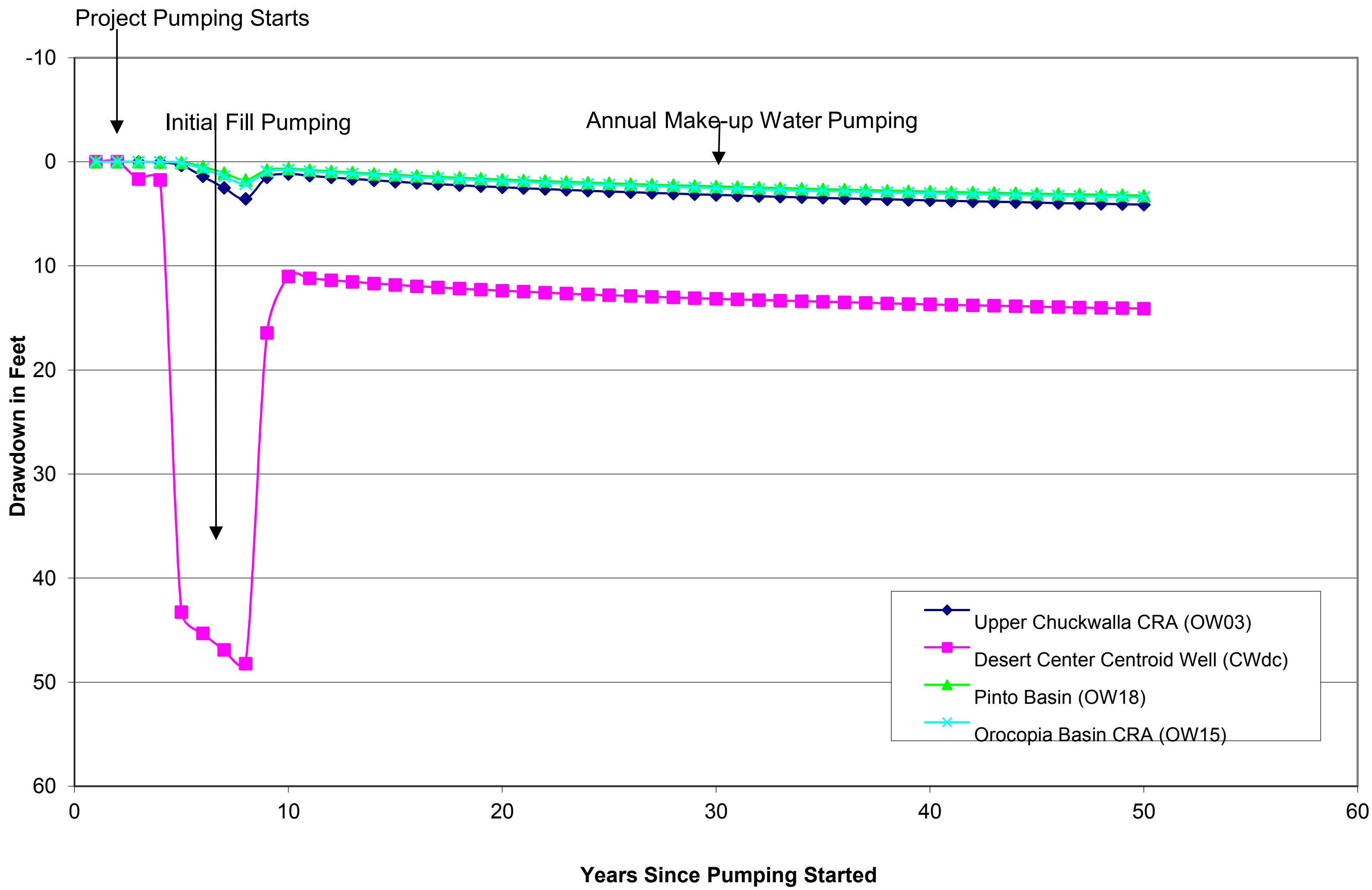
DRAWDOWN AFTER 50 YEARS OF PROJECT OPERATION

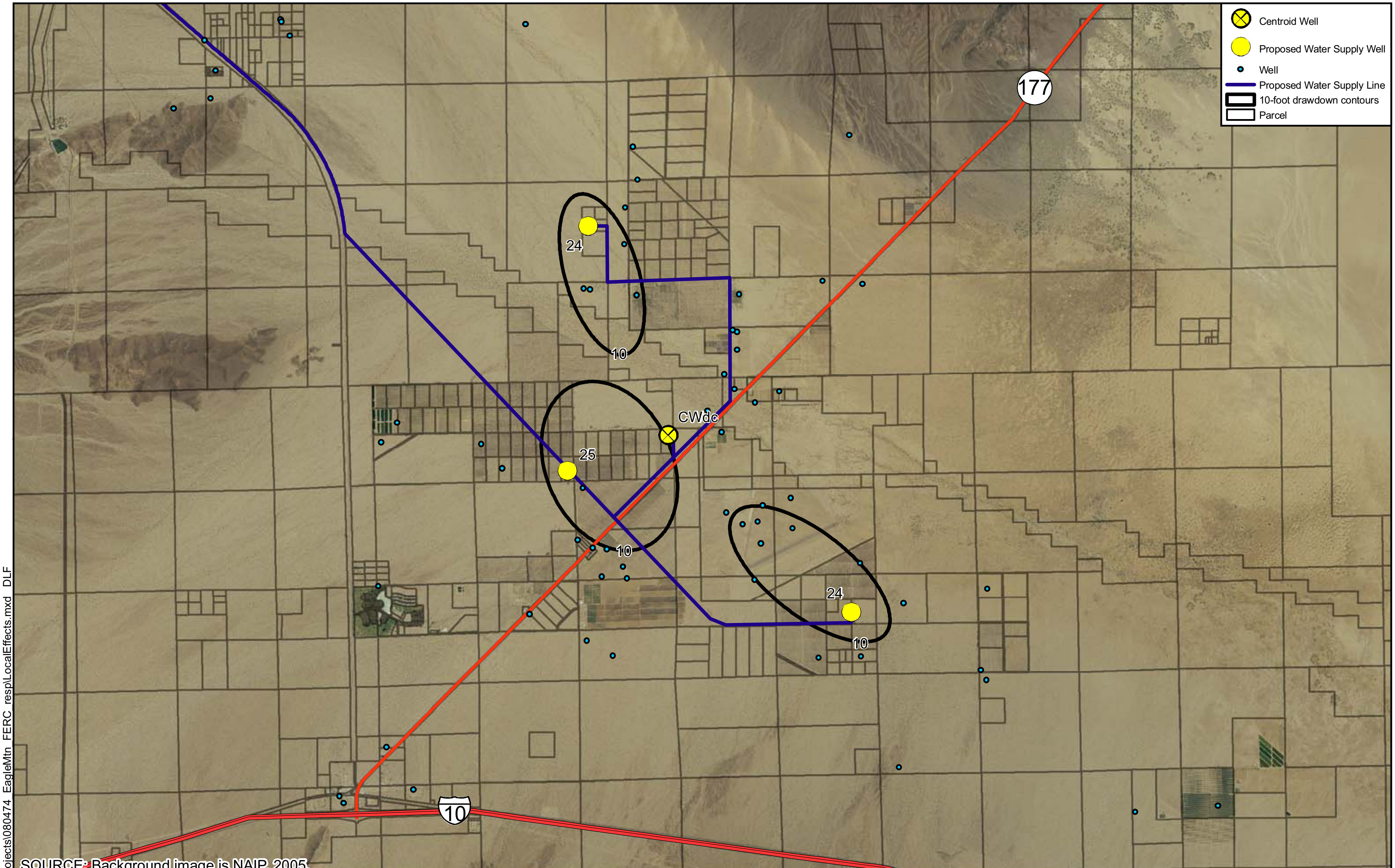
OCTOBER 2009

FIGURE 14

6-May-09 S:\GIS\Projects\083850 EagleMtn gwmodeling\PumpingEffects ProposedWells 50yrs.mxd

FIGURE 15
50-YEAR PROJECT PUMPING EFFECTS





7,000 3,500 0 7,000

Feet

N E S W

Pumped Storage Project
Eagle Mountain, CA

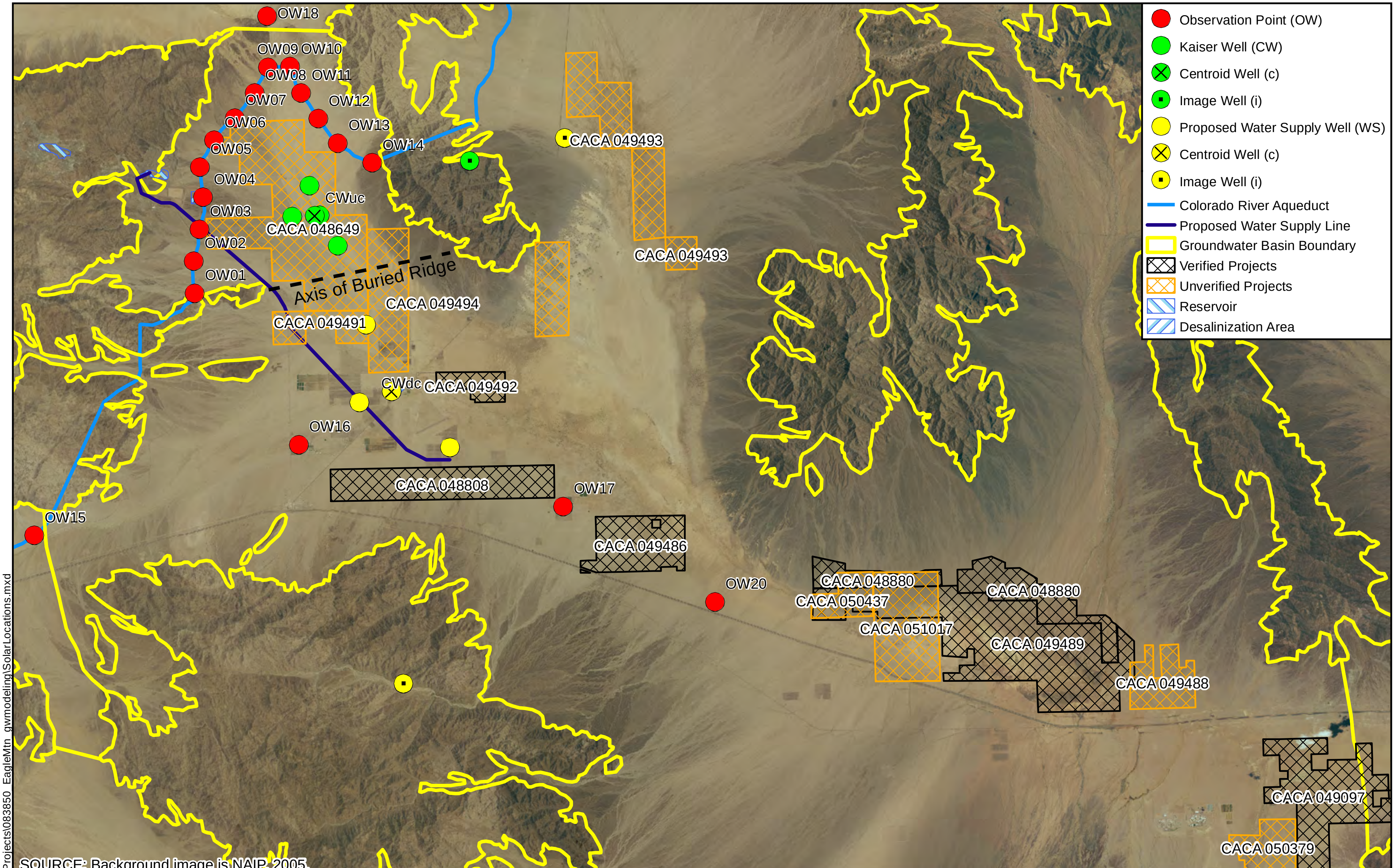
Eagle Crest Energy Company

ESTIMATED LOCAL PROJECT WATER SUPPLY WELL PUMPING EFFECTS AFTER INITIAL FILL

OCTOBER 2009

FIGURE 16

6-Oct-09 S:\GIS\Projects\080474 EagleMtn FERC resp\LocalEffects.mxd DLF



4 2 0 4

Miles

N W E S

Pumped Storage Project
Eagle Mountain, CA

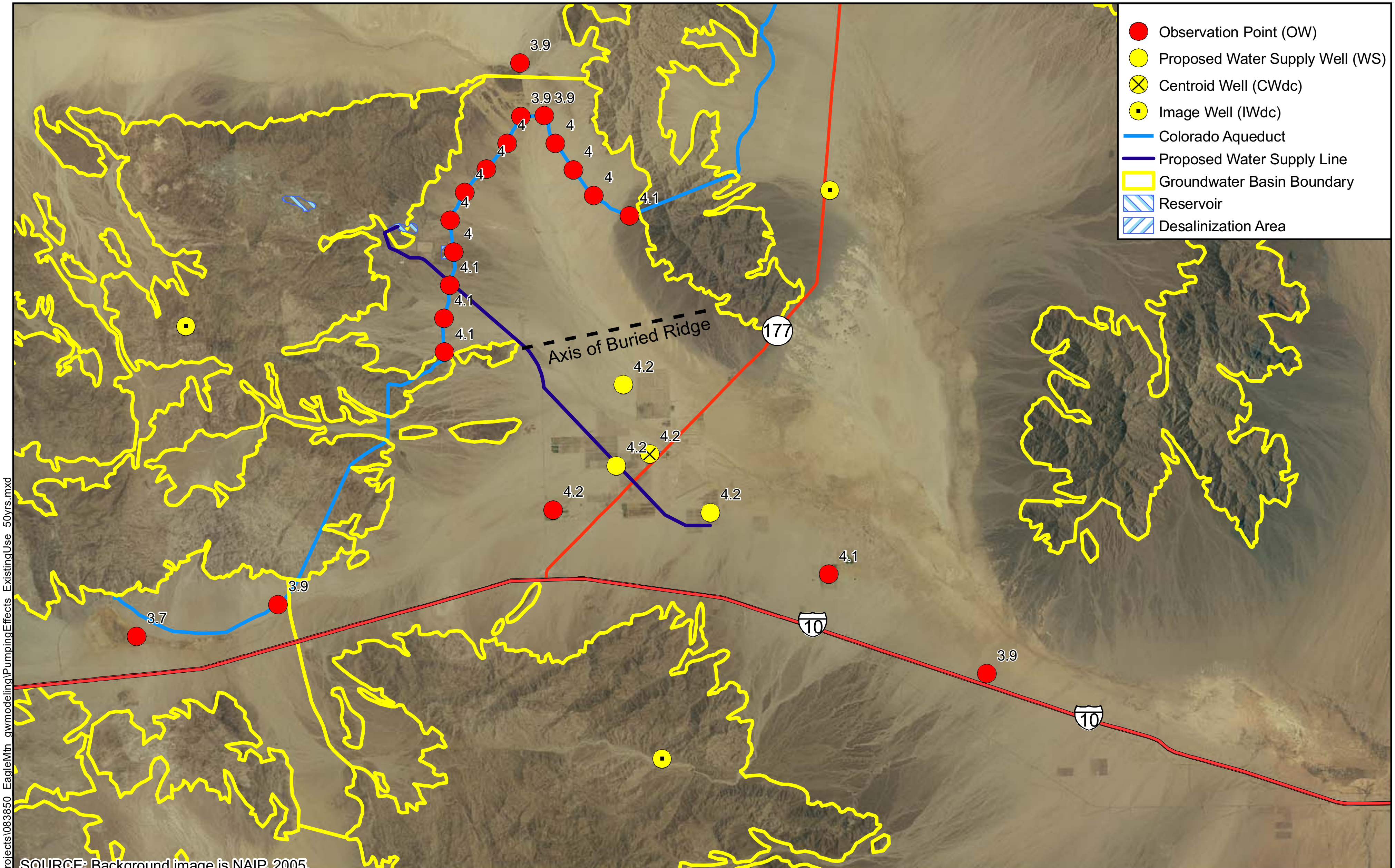
Eagle Crest Energy Company

PROPOSED SOLAR PROJECT LOCATIONS

OCTOBER 2009

FIGURE 17

25-Mar-09 S:\GIS\Projects\083850_EagleMtn_gwmodeling\SolarLocations.mxd



4 2 0 4

Miles

N W E S

Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

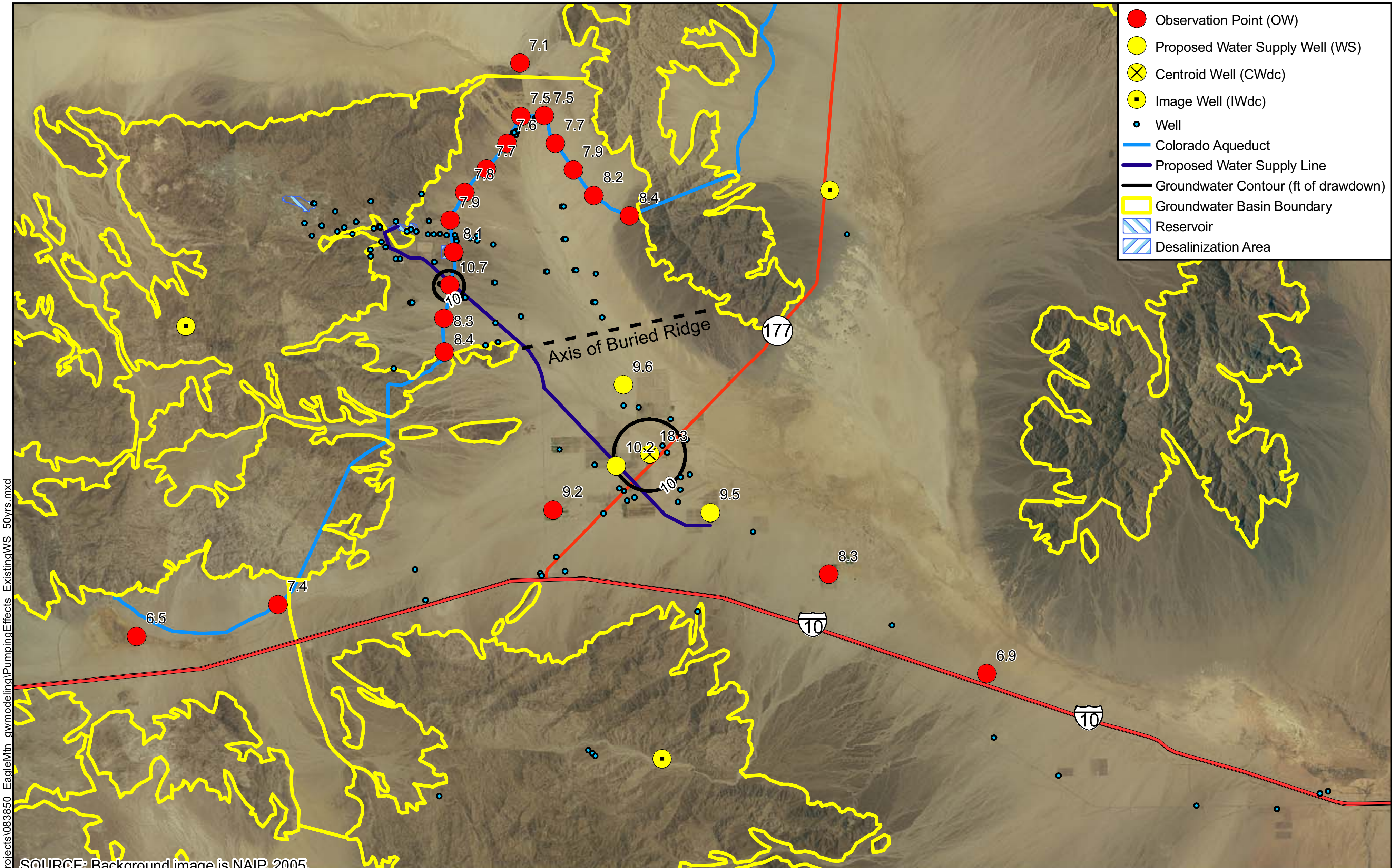
Eagle Crest Energy Company

DRAWDOWN AFTER 50 YEARS OF EXISTING PUMPING

OCTOBER 2009

FIGURE 18

6-May-09 S:\GIS\Projects\083850_EagleMtn_gwmodeling\PumpingEffects_ExistingUse_50yrs.mxd



6-May-09 S:\GIS\Projects\083850_EagleMtn_gwmodeling\PumpingEffects_ExistingWS_50yrs.mxd

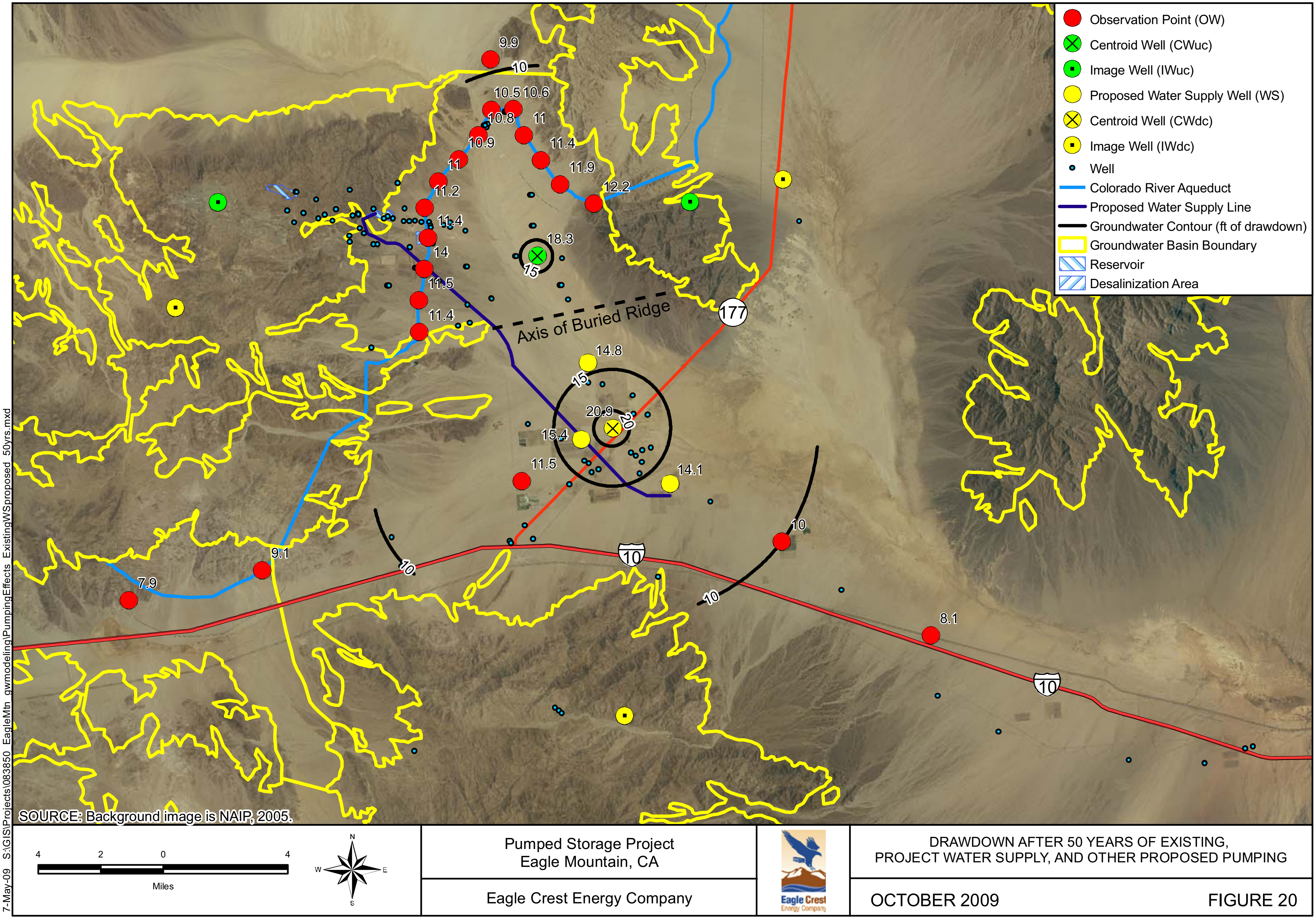
Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

DRAWDOWN AFTER 50 YEARS OF EXISTING AND PROJECT WATER SUPPLY PUMPING

OCTOBER 2009

FIGURE 19



Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

DRAWDOWN AFTER 50 YEARS OF EXISTING, PROJECT WATER SUPPLY, AND OTHER PROPOSED PUMPING

OCTOBER 2009

FIGURE 20

FIGURE 21
CUMULATIVE IMPACTS ASSESSMENT
MAXIMUM DRAWDOWN BENEATH CRA (OW03)

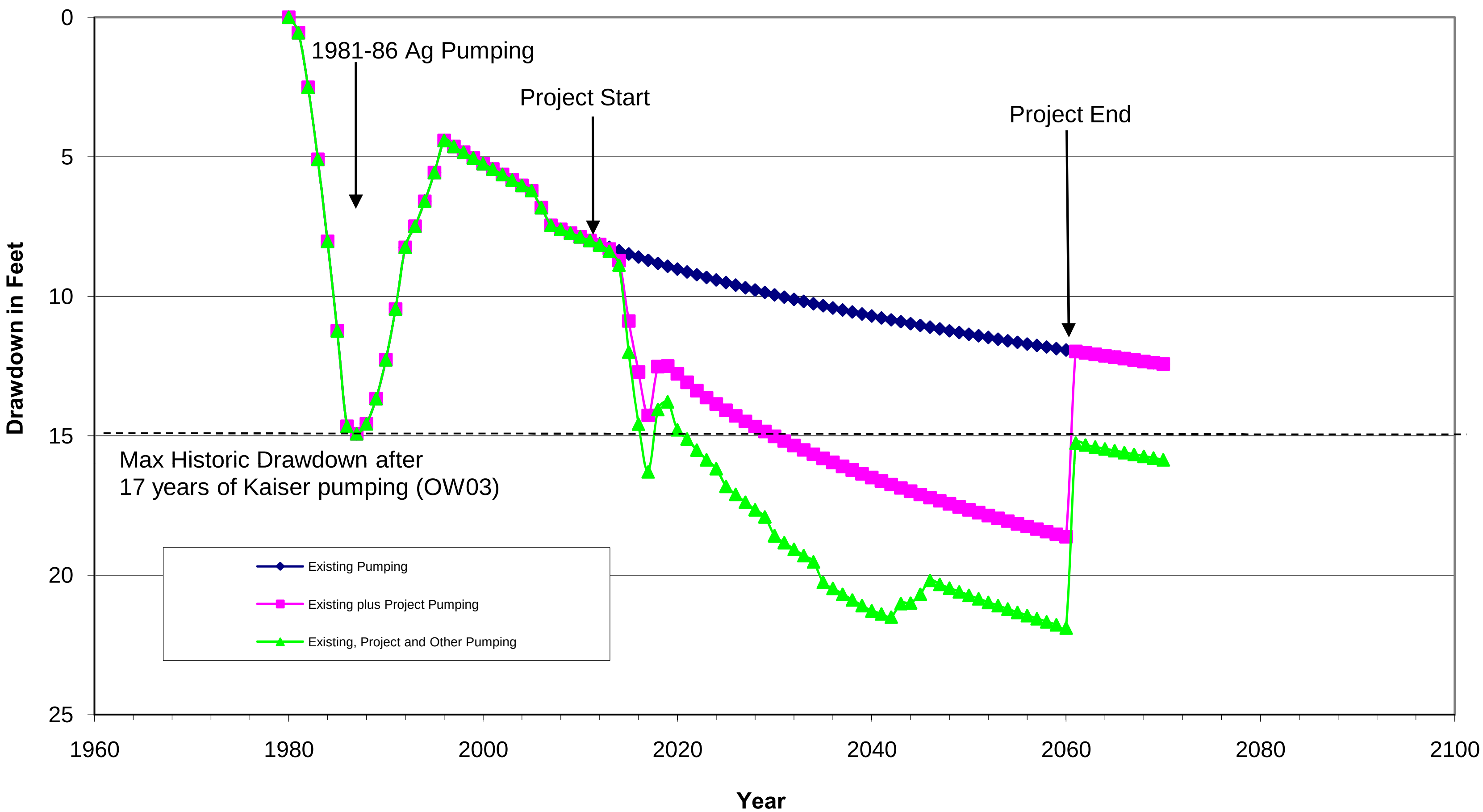


FIGURE 22
CUMULATIVE IMPACTS ASSESSMENT
MAXIMUM DRAWDOWN IN OROCOPIA VALLEY (0W15)

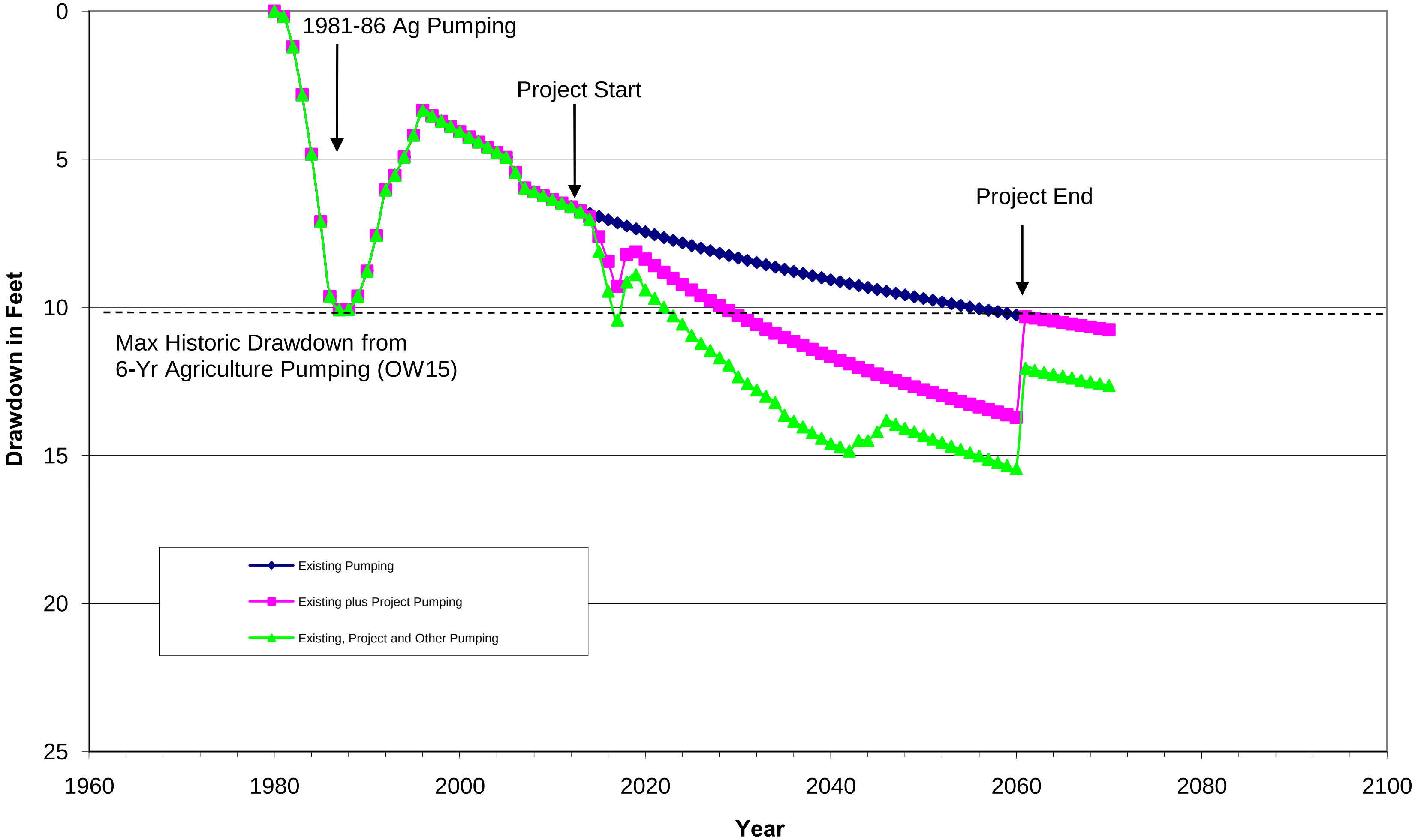


FIGURE 23
CUMULATIVE IMPACTS ASSESSMENT
MAXIMUM DRAWDOWN IN PINTO BASIN (OW18)

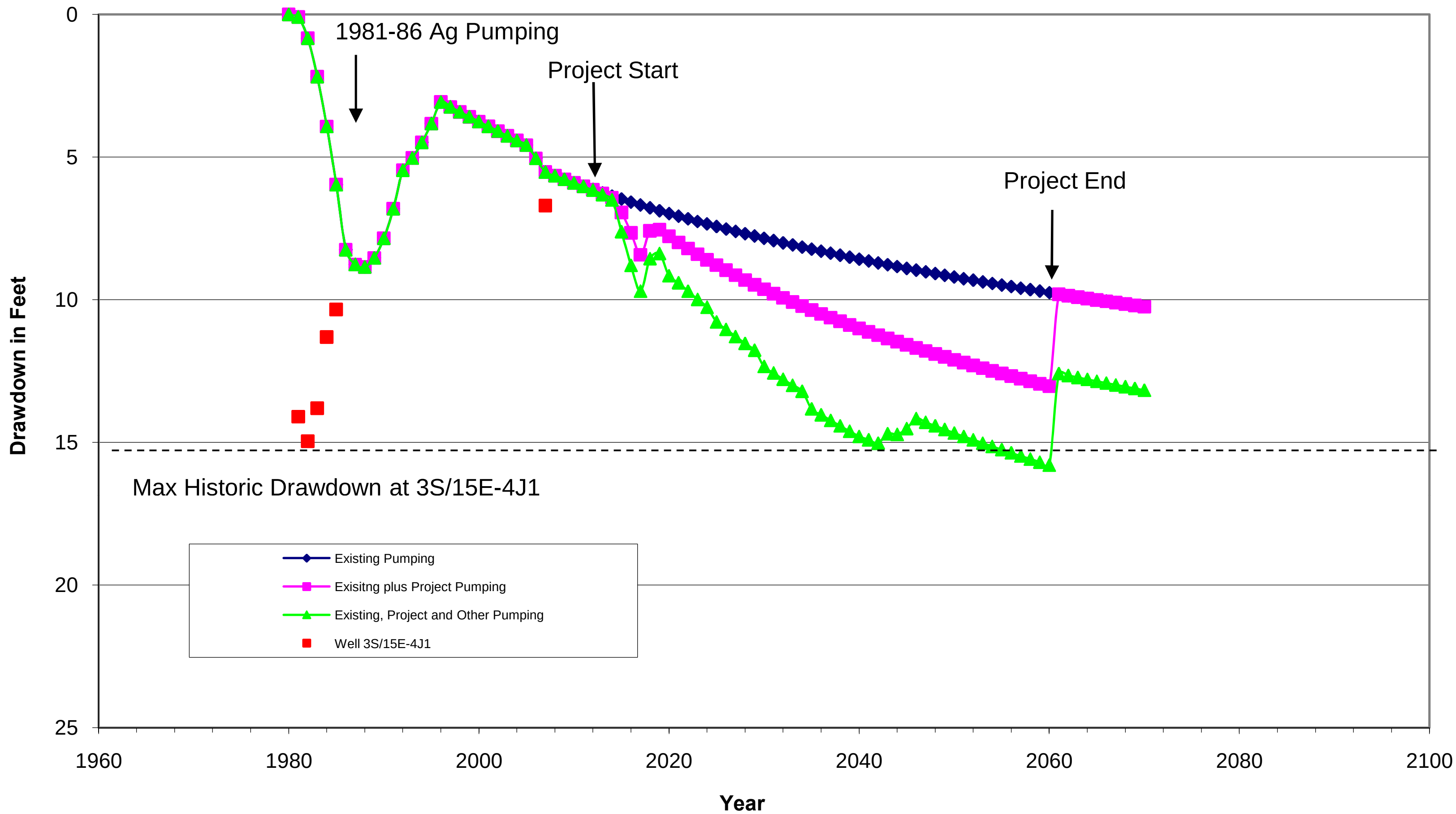
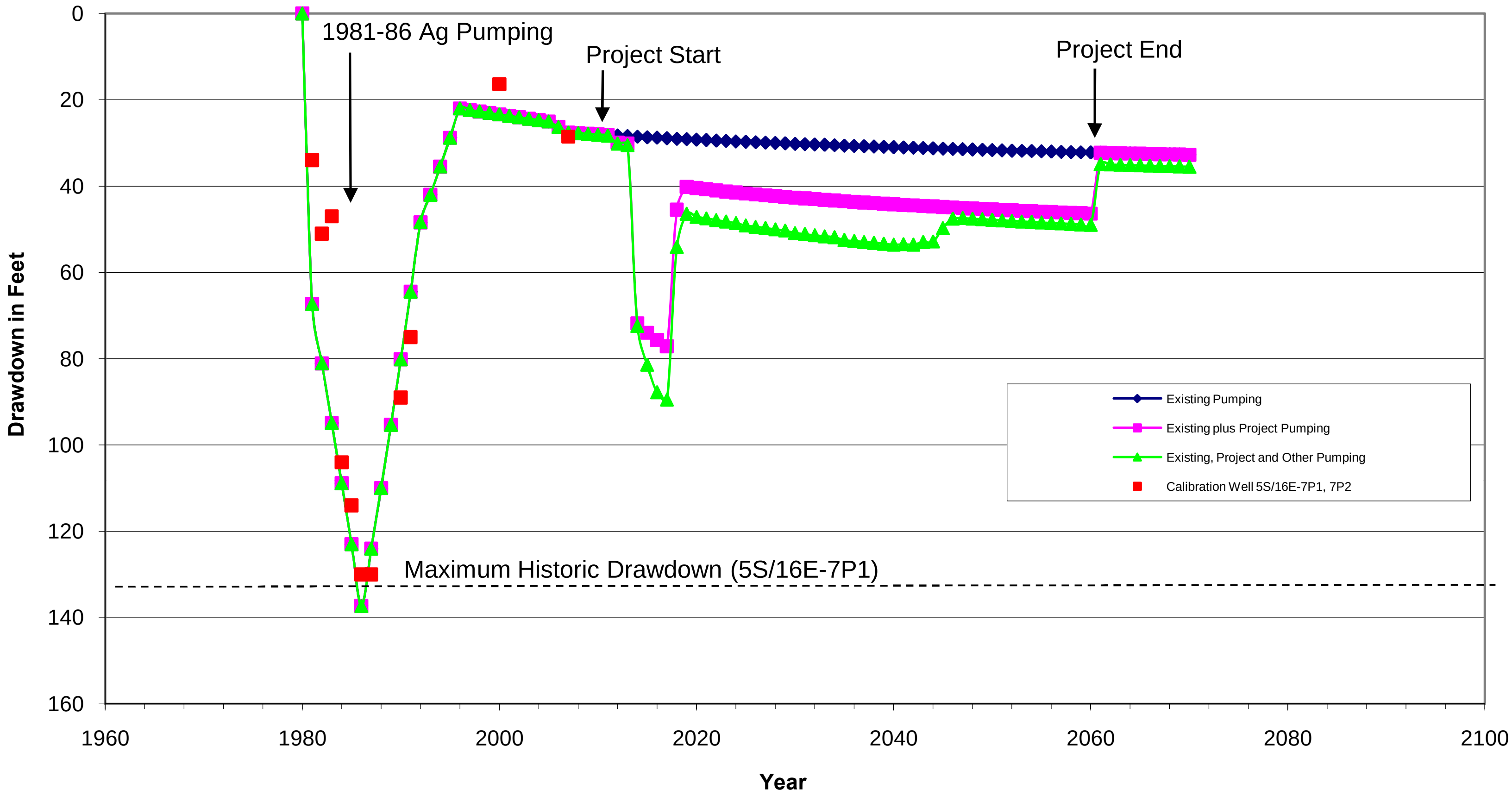
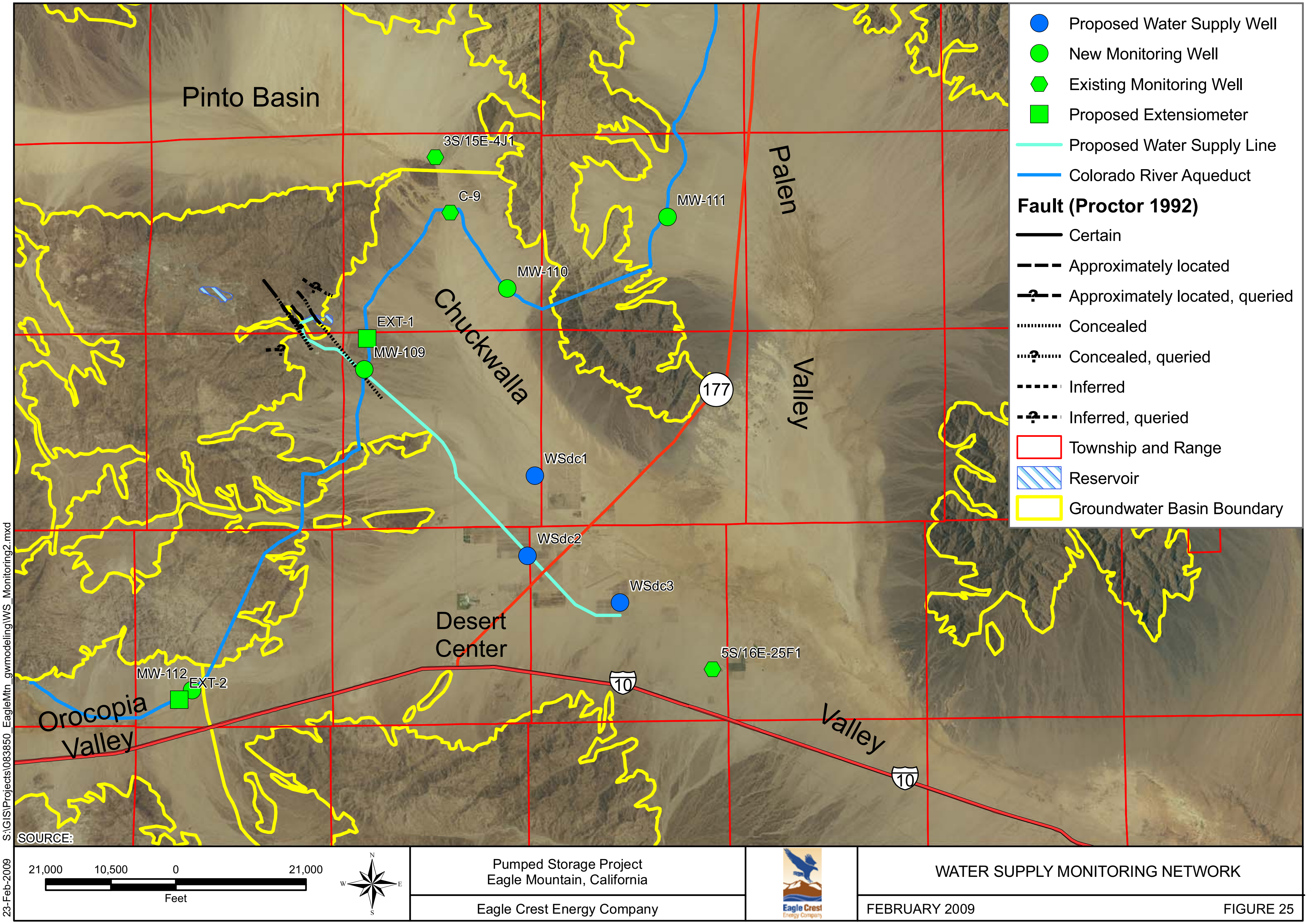


FIGURE 24
CUMULATIVE IMPACTS ASSESSMENT
MAXIMUM DRAWDOWN NEAR DESERT CENTER (CWdc)





Pinto Basin
Chuckwalla
Palen
Valley
Desert Center
Orocopia Valley
Valley
3S/15E-4J1
C-9
MW-111
MW-110
EXT-1
MW-109
177
WSdc1
WSdc2
WSdc3
5S/16E-25F1
MW-112
EXT-2
10
10
Proposed Water Supply Well
New Monitoring Well
Existing Monitoring Well
Proposed Extensiometer
Proposed Water Supply Line
Colorado River Aqueduct
Fault (Proctor 1992)
Certain
Approximately located
Approximately located, queried
Concealed
Concealed, queried
Inferred
Inferred, queried
Township and Range
Reservoir
Groundwater Basin Boundary
SOURCE:
21,000 10,500 0 21,000
Feet
N
E
S
W
Pumped Storage Project
Eagle Mountain, California
Eagle Crest Energy Company
Eagle Crest
WATER SUPPLY MONITORING NETWORK
FEBRUARY 2009
FIGURE 25
S:\GIS\Projects\083850_EagleMtn_gwmodeling\WS_Monitoring2.mxd
23-Feb-2009

Tables

Table 1
Fill Volume of Reservoirs[1]

	Acre-Feet (AF)
Upper Reservoir	
Total Reservoir Capacity	20,000
Inactive Storage[2]	2,300
Lower Reservoir	
Total Reservoir Capacity	21,900
Inactive Storage[2]	4,200
Minimum Operating Capacity	**6,500**
Full Operating Capacity[3]	**24,200**

[1] From ECE Draft License Application 2008.
[2] Included in Total Reservoir Capacity.
[3] Full Operating Capacity=Total Reservoir Capacity (Upper)+Inactive Storage (Lower).

Table 2
Amount of Reservoir Losses

	Acre-Feet/Year (AFY)
Seepage Rate[1]	
Upper Reservoir	738
Lower Reservoir	890
Total Seepage	1,628
Evaporation Rate[2]	
Upper Reservoir	908
Lower Reservoir	855
Total Evaporation	**1,763**
Yearly Losses	**3,391**

[1] From Miller and Westmore 2009. Assuming a 5 foot thick liner is installed.
[2] From ECE Draft License Application 2008. Assuming 7.5 feet/year evaporation rate.

Table 3
Pumping During Initial Fill

Pumping Rate (gpm)	Number of Wells	Pumping Duration (hours/day)[1]	Water Produced (AFY)
2,000	3	20	**8,066**

[1] Assuming 24 hours/day during Oct-May and 12 hours/day during Jun-Sept.

Table 4
Length of Time Needed for Initial Fill

Year	Water Pumped (AF)	Losses (AF)[1]	Volume in Reservoirs (AF)
2014	8,066	3,391	4,675
2015	8,066	1,763	10,977
2016	8,066	1,763	17,280
2017	8,066	1,763	23,583
2018	2,688	1,763	24,508
2019	1,763	1,763	24,508
Years for Fill to Minimum Operating Capacity			**1.3**
Years for Fill to Full Operating Capacity			**4.1**
Days for Fill to Full Operating Capacity			**1514**

[1] First year of pumping assumes filling reservoirs, evaporation, and seepage. In subsequent years, seeped water will be returned to reservoirs by seepage recovery wells.

Table 5
Pumping of Makeup Water

Pumping Rate (gpm)	Number of Wells	Pumping Duration (hours/day)	Water Produced[2] (AFY)
2,000	1	13.1	**1,763**
2,000	2	6.6	**1,763**

1 Reservoir seepage losses will be replaced/recovered by seepage recovery wells and returned to the reservoirs.

Table 6
Project Water Supply Pumping Rates During Project Life

Year	Comments	Cumulative Days	Water Pumped By Project Water Supply Wells (AF)	Cumulative Average Pumping (AFY)	Water Pumped (gpm)
2010	License Issued				
2011					
2012	Start of Construction	365	308	308	191
2013		730	308	308	191
2014	Start of Initial Fill	1,095	8,066	2,894	5,000
2015		1,460	8,066	4,187	5,000
2016		1,825	8,066	4,963	5,000
2017	End of Initial Fill	2,190	8,066	5,480	5,000
2018		2,555	2,688	5,081	1,666
2019		2,920	1,763	4,666	1,093
2020		3,285	1,763	4,344	1,093
2021		3,650	1,763	4,086	1,093
2022		4,015	1,763	3,874	1,093
2023		4,380	1,763	3,699	1,093
2024		4,745	1,763	3,550	1,093
2025		5,110	1,763	3,422	1,093
2026		5,475	1,763	3,311	1,093
2027		5,840	1,763	3,215	1,093
2028		6,205	1,763	3,129	1,093
2029		6,570	1,763	3,053	1,093
2030		6,935	1,763	2,985	1,093
2031		7,300	1,763	2,924	1,093
2032		7,665	1,763	2,869	1,093
2033		8,030	1,763	2,819	1,093
2034		8,395	1,763	2,773	1,093
2035		8,760	1,763	2,731	1,093
2036		9,125	1,763	2,692	1,093
2037		9,490	1,763	2,656	1,093
2038		9,855	1,763	2,623	1,093
2039		10,220	1,763	2,593	1,093
2040		10,585	1,763	2,564	1,093
2041		10,950	1,763	2,537	1,093
2042		11,315	1,763	2,512	1,093
2043		11,680	1,763	2,489	1,093
2044		12,045	1,763	2,467	1,093
2045		12,410	1,763	2,446	1,093
2046		12,775	1,763	2,427	1,093
2047		13,140	1,763	2,408	1,093
2048		13,505	1,763	2,391	1,093
2049		13,870	1,763	2,374	1,093
2050		14,235	1,763	2,359	1,093
2051		14,600	1,763	2,344	1,093
2052		14,965	1,763	2,329	1,093
2053		15,330	1,763	2,316	1,093
2054		15,695	1,763	2,303	1,093
2055		16,060	1,763	2,291	1,093
2056		16,425	1,763	2,279	1,093
2057		16,790	1,763	2,268	1,093
2058		17,155	1,763	2,257	1,093
2059		17,520	1,763	2,247	1,093
2060	License Ends	17,885	1,763	2,237	1,093
Average			2,237		1,387

Note: Assumes license is issued in 2010 and is for a 50 year period

Table 7
Summary of Alluvial Aquifer Characteristics in Chuckwalla Groundwater Basin

Source of Test Data	Well No./Name	Storativity from Aquifer Tests (unitless)	Assumed Storativity (unitless)	Flow Rate (gpm)	Drawdown (feet)	Saturated Aquifer Thickness (feet)	Distance from Well (feet)	Duration of Test (days)	Hydraulic Conductivity (ft/day)	Transmissivity (gpd/ft)
Well Log	CW-1		0.05	1,000	25	85	0.66	1.25	101	64,000
Well Log	CW-2		0.05	2,400	78	166	0.66	1.25	39	48,000
Well Log	CW-3		0.05	2,800	78	175	0.66	1.25	44	57,000
Well Log	CW-4		0.05	1,150	32	150	0.66	1.25	51	57,000
Greystone 1994	OW-2[1]	0.06			2.69	300	300	1.11	118	264,002
Greystone 1994	OW-2[1]	0.05			2.69	300	300	1.11	139	311,288
Average Value for Kaiser Wells (CW1-4)						144			**58**	**56,500**
Average Value for Project Water Supply Wells						300			**128**	**287,645**

Assumed Value

[1] Observation wells during pumping of Well 1 at a rate of 2300 gpm

[2] Observation well during pumping of Well 3 at a rate of 2350 gpm

Table 8
Pumping From Kaiser Wells (AFY)

	Pinto Basin				Chuckwalla Basin					Eagle Mountain
Year	No. 1	No. 2	No. 3	Total	CW#1	CW#2	CW#3	CW#4	**Total**	Total
1948	30		30	60						60
1949	80		80	160						160
1950	94		94	188						188
1951	110		110	220						220
1952	130		130	260						260
1953	160		160	320						320
1954	270		270	540						540
1955	330		330	660						660
1956	418		418	836						836
1957			647	647						647
1958			1,681	1,681						1,681
1959			1,712	1,712						1,712
1960	546	1,201	1,747	3,494						3,494
1961	604	1,329	1,933	3,866						3,866
1962	719	1,581	2,300	4,600						4,600
1963	1,441	2,511	3,952	7,904						7,904
1964	1,089	2,395	3,484	6,968						6,968
1965	930	2,045	2,975	5,950		1,117	1,337		**2,454**	8,404
1966	979	2,154	3,133	6,266		1,508	2,356		**3,864**	10,130
1967	1,045	2,299	3,344	6,688		1,586	2,365		**3,951**	10,639
1968	854	1,880	2,734	5,468		1,739	2,280		**4,019**	9,487
1969	910	2,003	2,513	5,426	225	2,050	1,822		**4,097**	9,523
1970	927	2,039	2,966	5,932	342	1,485	1,680		**3,507**	9,439
1971	811	1,784	2,595	5,190	203	1,510	1,498		**3,211**	8,401
1972	760	1,670	2,430	4,860	138	1,189	1,017		**2,344**	7,204
1973	799	1,758	2,557	5,114	837	1,977	910		**3,724**	8,838
1974	793	1,744	2,537	5,074	805	1,349	1,401		**3,555**	8,629
1975	786	1,727	2,513	5,026	314	1,623	1,637		**3,574**	8,600
1976	850	1,891	2,741	5,482	277	1,658	1,815		**3,750**	9,232
1977	927	2,063	2,990	5,980	170	1,384	1,343	999	**3,896**	9,876
1978	850	1,893	2,743	5,486		1,615	1,210	1,352	**4,177**	9,663
1979	808	1,886	2,694	5,388		1,201	1,519	1,446	**4,166**	9,554
1980	665	1,937	2,602	5,204		1,051	960	1,234	**3,245**	8,449
1981	790	2,193	2,983	5,966		874	1,022	1,109	**3,005**	8,971
1982	462	1,965	2,427	4,854		717	365	492	**1,574**	6,428
1983		1,613	1,613	3,226		46	1		**47**	3,273
1984		250	250	500		242	260	288	**790**	1,290
1985						333	151		**484**	484
Total				**137,196**					**63,434**	200,630
Pumping (1960-1981)[1]:				**5,515**						
Pumping (1965-1981)[2]:									**3,561**	

Source: Mann, 1986.

[1] 22-year average

[2] 17-year average

Table 9
Pumping From Kaiser Wells (gpm[1])

	Pinto Basin				Chuckwalla Basin					Eagle Mountain
Year	No. 1	No. 2	No. 3	Total	CW#1	CW#2	CW#3	CW#4	**Total**	Total
1948	19		19	37						37
1949	50		50	99						99
1950	58		58	117						117
1951	68		68	136						136
1952	81		81	161						161
1953	99		99	198						198
1954	167		167	335						335
1955	205		205	409						409
1956	259		259	518						518
1957			401	401						401
1958			1,042	1,042						1,042
1959			1,061	1,061						1,061
1960	338	745	1,083	2,166						2,166
1961	374	824	1,198	2,397						2,397
1962	446	980	1,426	2,852						2,852
1963	893	1,557	2,450	4,900						4,900
1964	675	1,485	2,160	4,320						4,320
1965	577	1,268	1,844	3,689		692	829		**1,521**	5,210
1966	607	1,335	1,942	3,884		935	1,461		**2,395**	6,280
1967	648	1,425	2,073	4,146		983	1,466		**2,449**	6,595
1968	529	1,165	1,695	3,390		1,078	1,413		**2,491**	5,881
1969	564	1,242	1,558	3,364	139	1,271	1,129		**2,540**	5,903
1970	575	1,264	1,839	3,677	212	921	1,041		**2,174**	5,851
1971	503	1,106	1,609	3,217	126	936	929		**1,991**	5,208
1972	471	1,035	1,506	3,013	86	737	630		**1,453**	4,466
1973	495	1,090	1,585	3,170	519	1,226	564		**2,309**	5,479
1974	492	1,081	1,573	3,145	499	836	869		**2,204**	5,349
1975	487	1,071	1,558	3,116	195	1,006	1,015		**2,216**	5,331
1976	527	1,172	1,699	3,398	172	1,028	1,125		**2,325**	5,723
1977	575	1,279	1,854	3,707	105	858	833	619	**2,415**	6,122
1978	527	1,174	1,700	3,401		1,001	750	838	**2,589**	5,990
1979	501	1,169	1,670	3,340		745	942	896	**2,583**	5,923
1980	412	1,201	1,613	3,226		652	595	765	**2,012**	5,238
1981	490	1,359	1,849	3,698		542	634	687	**1,863**	5,561
1982	286	1,218	1,505	3,009		444	226	305	**976**	3,985
1983		1,000	1,000	2,000		29	1		**29**	2,029
1984		155	155	310		150	161	179	**490**	800
1985						206	94		**300**	300
Total				**85,050**					**39,324**	124,374
Pumping (1960-1981)[2]:				**3,419**						
Pumping (1965-1981)[3]:									**2,208**	

[1] Assuming continuous pumping 24 hours a day, 365 days a year
[2] 22-year average
[3] 17-year average

Table 10

Chuckwalla Valley Agricultural Water Use Summary

Crop	Applied Water Duty / Acre (Feet/Acre)	Area 1986 (Acres)	Area 1992 (Acres)	Area 1996 (Acres)	Area 2005 (Acres)	Area 2007 (Acres)	Water Use 1986 (A.F.)	Water Use 1992 (A.F.)	Water Use 1996 (A.F.)	Water Use 2005 (A.F.)	Water Use 2007 (A.F.)
Desert Center Area											
Jojoba	2.2	4,005	1,351	120	120	120	8,811	2,972	264	264	264
Jojoba/Asparagus	4.6	457	0	0	0	0	2,102	0	0	0	0
Asparagus	8.3	1,157	200	110	0	0	9,603	1,660	914	0	0
Citrus	4.5	14	5	23	23	23	63	23	104	102	102
Dates	8.0	14	25	12		0	112	200	96	0	
Dates/Palms[1]	6.7				188	188				1,260	1,260
Vines	4.5	5	5	33	9	9	23	23	147	39	39
Pasture	6.4	10	0	0	0	0	64	0	0	0	0
Peaches/Apples	4.5	0	80	0	0	0	0	360	0	0	0
Melons/Peppers	3.5	0	100	0	0	0	0	350	0	0	0
Greenhouses[2]	8.3				0	5				0	42
Row Crops[2]	8.3				11	11				94	94
SUBTOTAL (Upper Chuckwalla)		5,662	1,766	298	351	355	20,778	5,587	1,525	1,758	1,800
Lower Chuckwalla Valley											
Citrus	4.5					207				0	931
Dates/Palms[1]	6.7			106	250	546			710	1,675	3,658
SUBTOTAL (Lower Chuckwalla)				106	250	753			710	1,675	4,589
TOTAL		**5,662**	**1,766**	**404**	**601**	**1,108**	**20,778**	**5,587**	**2,235**	**3,433**	**6,389**

Notes:

All water duties based on Mann, 1986 unless otherwise noted

[1] Water duty based on Kc of 0.95 (FAO, 1998), ETo of 6.0ft/yr (CIMIS 1999), and application efficiency of 0.85 (Jensen, 1980)

[2] Crop type unknown, so the largest possible water duty assumed

Table 11

Historic Pumping Near Desert Center

Year	Agricultural Pumping [1] (AF)	Aquaculture Pumping [2] (AF)	Sum of other Pumping [3] (AF)	Total Pumping[4] (AFY)	Total Pumping[4] (gpm[5])	Pumping Near OW-17 (AFY)	Pumping Near OW-17 (gpm[5])
1981	11,331	302	920	12,553	7,777		
1982	13,220	302	920	14,442	8,947		
1983	15,108	302	920	16,330	10,117		
1984	16,997	302	920	18,219	11,288		
1985	18,885	302	920	20,107	12,457		
1986	20,774	302	920	21,996	13,628		
1992	5,587	302	1,251	7,140	4,424		
1996	1,525	302	1,251	3,078	1,907	710	440
2005	1,758	215	1,251	3,224	1,997	1,675	1,038
2007	1,800	215	1,251	3,266	2,023	4,589	2,843

Notes:

[1] From Greystone 1994 and GEI 2008.

[2] Pumping required to account for evaporation from open water bodies associated with fish ponds or tanks. Based on aerial photos.

[3] Includes domestic, Lake Tamarisk, and So Cal Gas.

[4] Assumed to take place at CWdc

[5] Assuming continuous pumping 24 hours a day, 365 days a year

Table 12

Summary of Current, Project, and Proposed Water Use [1, 2]

Water User	Type of Use	Water Use (AFY)	Water Use (gpm)
Desert Center Area (CWdc)			
Lake Tamarisk	Current	1,092	677
Agriculture	Current	1,800	1,115
Aquaculture	Current	215	133
Desert Center Domestic	Current	51	32
Eagle Crest Energy Company [3]	Pumped Storage Project	2,237	1,386
Solar Energy Projects [4]	Proposed	922	571
	Current Subtotal	3,158	1,957
	Current + Project Subtotal	5,395	3,342
	Current + Project + Proposed Total	6,317	3,914
Upper Chuckwalla Valley Area (CWuc)			
Eagle Mountain Landfill [3]	Proposed	819	507
Eagle Mountain Townsite	Proposed	173	107
Solar Energy Projects [4]	Proposed	54	33
	Current Subtotal	0	0
	Current + Project Subtotal	0	0
	Current + Project + Proposed Total	1,046	648
East of Desert Center (OW17)			
Agriculture (Date and Citrus Grower)	Current	4,589	2,843
Solar Energy Projects [4]	Proposed	322	199
	Current Subtotal	4,589	2,843
	Current + Project Subtotal	4,589	2,843
	Current + Project + Proposed Total	4,911	3,043
Ford Dry Lake (OW20)			
Solar Energy Projects [4]	Proposed	2,445	1,515
	Current Subtotal	0	0
	Current + Project Subtotal	0	0
	Current + Project + Proposed Total	2,445	1,515
Total			
	Current Subtotal	**7,747**	**4,800**
	Current + Project Subtotal	**9,984**	**6,186**
	Current + Project + Proposed Total	**14,719**	**9,119**

Notes:

[1] See Appendix E, Water Use Distribution Data Transmittal for flow rates used in the drawdown estimates

[2] State Prison and solar facilities in Lower Chuckwalla Valley not included in the model due to large distance from project

State Prison average annual water use is 1,500 AFY while solar facilities average annual water use is 1,061 AFY

[3] Average over 50 year life of project

[4] Average over 30 year life of project

Table 13
Water Useage By Proposed Solar Plants (Assuming Dry Solar Thermal Cooling for Unverified Projects)

Project Serial Number[1]	Applicant[1]	Acres from Website [1]	Acres from Shapefile[1]	Type[1]	General Location	Construction Water Usage (AF)	Construction Water Usage (gpm/yr) [5]	Capacity[1] (MW)	Water Usage[2, 3,4] (AFY/(MW of plant capacity))	Water Usage (AFY)	Water Usage (gpm/yr)
CACA 048649	First Solar (assumed Phase 1)	7040	14772	Photovoltaic	Upper Chuckwalla Valley	60	12	350	0.07	26	16
	First Solar (assumed Phase 2)	7732		Photovoltaic	Upper Chuckwalla Valley	66	14	390	0.07	29	18
CACA 048808	Chuckwalla Solar LLC	4098	4099	Photovoltaic	Desert Center	**60**	**12**	**200**	**0.20**	**40**	25
CACA 048880	Genesis Solar/Florida Power & Light	4491	4492	Solar Thermal	Ford Dry Lake	**2440**	**504**	**250**	**6.58**	1644	1019
CACC 049097	Bullfrog Green Energy	6629		Photovoltaic	Lower Chuckwalla Valley	**85**	**26**	**500**	**0.02**	**12**	7
CACA 049486	Solar Millennium, LLC/Chevron	2753	3136	Solar Thermal	East of Desert Center	**1560**	**322**	**500**	**0.60**	300	186
CACA 049488	EnXco Development, Inc.	2070	2070	Solar Thermal	Ford Dry Lake	1222	252	300	0.60	180	112
CACA 049489	EnXco Development, Inc.	11603	16088	Photovoltaic	Ford Dry Lake	**20**	**6**	**200**	**0.03**	**5**	3
CACA 049491	EnXco Development, Inc.	1071	1052	Solar Thermal	Desert Center	1222	252	300	0.60	180	112
CACA 049492	EnXco Development, Inc.		1216	Photovoltaic	Desert Center	**20**	**6**	**100**	**0.05**	**5**	3
CACA 049493	Solel Inc.	8775	8770	Solar Thermal	Desert Center	2037	421	500	0.60	300	186
CACA 049494	Solel Inc.	7511	7399	Solar Thermal	Desert Center	2037	421	500	0.60	300	186
CACA 050379	Lightsource Renewables, LLC	7920		Solar Thermal	Lower Chuckwalla Valley	2240	463	550	0.60	330	204
CACA 050437				Solar Thermal	Ford Dry Lake	2037	421	500	0.60	300	186
CACA 051017				Solar Thermal	Ford Dry Lake	2037	421	500	0.60	300	186
					Total	17142	3553		Total	3951	2448
					Upper Chuckwalla Valley (CWuc) Subtotal	126	26			55	34
					Desert Center (CWdc) Subtotal	5375	1112			825	511
					East of Desert Center (OW17) Subtotal	1560	322			300	186
					Ford Dry Lake (OW20) Subtotal	7755	1604			2429	1505
					Lower Chuckwalla (unassigned) Subtotal	2325	489			342	212
					Total	17142	3553		Total	3951	2448

Notes:
[1] Source: Bureau of Land Management
[2] For Solar Thermal, water use based on other projects in area
[3] Assumes 3 year construction period unless bolded
Estimated values, no information currently available
Bolded value is verified

Table 14
Chuckwalla Valley Groundwater Basin Water Balance
Cumulative Effects On Groundwater Storage

Year	Eagle Mountain Pumped Storage Project Water Supply Wells[1]	Eagle Mountain Pumped Storage Project Construction Water Usage	Eagle Mountain Town Site[2]	Eagle Mountain Pumped Storage Project Seepage Recovery Wells[1]	Proposed Landfill Water Usage[2]	Proposed Solar Construction Water Usage[10]	Proposed Solar Water Usage[9]	Agricultural Pumping[3]	Aquaculture Pumping/Open Water Evap[4]	Desert Center Domestic[5]	So. Cal Gas[5]	Raceway	Lake Tamarisk[6]	Chuckwalla/ Ironwood State Prison[7]	Subsurface Outflow[8]	**Subtotal Outflow**	Inflow from Reservoir Seepage[1]	Lake Tamarisk Wastwater Return[8]	Infiltration at Chuckwalla/ Ironwood Prison Ponds	Average Recharge	**Subtotal Inflow**	**Inflow minus Outflow**	**Cumulative Change**	**Basinwide Change in Water Level (Feet)**
2008	0	0	0	0	0	0	0	6,400	599	50	1	0	1,090	2,100	400	10,640	0	36	795	12,700	13,531	2,891	2,891	0.19
2009	0	0	0	0	0	0	0	6,400	599	50	1	0	1,090	2,100	400	10,640	0	36	795	12,700	13,531	2,891	5,781	0.39
2010	0	0	0	0	0	10	0	6,400	599	50	1	11	1,090	2,100	400	10,661	0	36	795	12,700	13,531	2,870	8,651	0.58
2011	0	0	0	0	0	73	0	6,400	599	50	1	3	1,090	1,500	400	10,116	0	36	564	12,700	13,300	3,185	11,836	0.79
2012	0	308	0	0	0	92	5	6,400	599	50	1	3	1,090	1,500	400	10,449	0	36	564	12,700	13,300	2,852	14,687	0.98
2013	0	308	0	0	0	885	17	6,400	599	50	1	14	1,090	1,500	400	11,265	0	36	564	12,700	13,300	2,036	16,723	1.11
2014	7,758	308	0	1,628	0	1,783	62	6,400	599	50	1	3	1,090	1,500	400	21,582	1,628	36	564	12,700	14,928	-6,654	10,070	0.67
2015	8,066	0	0	1,628	0	2,849	88	6,400	599	50	1	3	1,090	1,500	400	22,675	1,628	36	564	12,700	14,928	-7,746	2,324	0.15
2016	8,066	0	0	1,628	0	3,439	1,761	6,400	599	50	1	14	1,090	1,500	400	24,949	1,628	36	564	12,700	14,928	-10,020	-7,697	-0.51
2017	8,066	0	0	1,628	0	3,870	2,241	6,400	599	50	1	3	1,090	1,500	400	25,848	1,628	36	564	12,700	14,928	-10,920	-18,617	-1.24
2018	2,688	0	0	1,628	0	2,783	2,721	6,400	599	50	1	3	1,090	1,500	400	19,864	1,628	36	564	12,700	14,928	-4,936	-23,552	-1.57
2019	1,767	0	0	1,628	0	1,358	3,351	6,400	599	50	1	3	1,090	1,500	400	18,147	1,628	36	564	12,700	14,928	-3,219	-26,771	-1.78
2020	1,763	0	173	1,628	245	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,804	1,628	36	564	12,700	14,928	-2,875	-29,647	-1.98
2021	1,763	0	173	1,628	185	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,744	1,628	36	564	12,700	14,928	-2,815	-32,462	-2.16
2022	1,763	0	173	1,628	185	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,744	1,628	36	564	12,700	14,928	-2,815	-35,277	-2.35
2023	1,763	0	173	1,628	185	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,744	1,628	36	564	12,700	14,928	-2,815	-38,092	-2.54
2024	1,763	0	173	1,628	185	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,744	1,628	36	564	12,700	14,928	-2,815	-40,908	-2.73
2025	1,763	0	173	1,628	365	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,924	1,628	36	564	12,700	14,928	-2,995	-43,903	-2.93
2026	1,763	0	173	1,628	365	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,924	1,628	36	564	12,700	14,928	-2,995	-46,898	-3.13
2027	1,763	0	173	1,628	365	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,924	1,628	36	564	12,700	14,928	-2,995	-49,893	-3.33
2028	1,763	0	173	1,628	365	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,924	1,628	36	564	12,700	14,928	-2,995	-52,888	-3.53
2029	1,763	0	173	1,628	365	0	3,951	6,400	599	50	1	3	1,090	1,500	400	17,924	1,628	36	564	12,700	14,928	-2,995	-55,884	-3.73
2030	1,763	0	173	1,628	581	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,140	1,628	36	564	12,700	14,928	-3,211	-59,095	-3.94
2031	1,763	0	173	1,628	581	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,140	1,628	36	564	12,700	14,928	-3,211	-62,306	-4.15
2032	1,763	0	173	1,628	581	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,140	1,628	36	564	12,700	14,928	-3,211	-65,517	-4.37
2033	1,763	0	173	1,628	581	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,140	1,628	36	564	12,700	14,928	-3,211	-68,729	-4.58
2034	1,763	0	173	1,628	581	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,140	1,628	36	564	12,700	14,928	-3,211	-71,940	-4.80
2035	1,763	0	173	1,628	823	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,382	1,628	36	564	12,700	14,928	-3,453	-75,393	-5.03
2036	1,763	0	173	1,628	823	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,382	1,628	36	564	12,700	14,928	-3,453	-78,846	-5.26
2037	1,763	0	173	1,628	823	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,382	1,628	36	564	12,700	14,928	-3,453	-82,299	-5.49
2038	1,763	0	173	1,628	823	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,382	1,628	36	564	12,700	14,928	-3,453	-85,753	-5.72
2039	1,763	0	173	1,628	823	0	3,951	6,400	599	50	1	3	1,090	1,500	400	18,382	1,628	36	564	12,700	14,928	-3,453	-89,206	-5.95
2040	1,763	0	173	1,628	823	0	3,946	6,400	599	50	1	3	1,090	1,500	400	18,377	1,628	36	564	12,700	14,928	-3,448	-92,654	-6.18
2041	1,763	0	173	1,628	823	0	3,894	6,400	599	50	1	3	1,090	1,500	400	18,325	1,628	36	564	12,700	14,928	-3,396	-96,050	-6.40
2042	1,763	0	173	1,628	823	0	3,863	6,400	599	50	1	3	1,090	1,500	400	18,294	1,628	36	564	12,700	14,928	-3,365	-99,415	-6.63
2043	1,763	0	173	1,628	823	0	2,190	6,400	599	50	1	3	1,090	1,500	400	16,620	1,628	36	564	12,700	14,928	-1,692	-101,107	-6.74
2044	1,763	0	173	1,628	823	0	1,710	6,400	599	50	1	3	1,090	1,500	400	16,140	1,628	36	564	12,700	14,928	-1,212	-102,319	-6.82
2045	1,763	0	173	1,628	1,070	0	1,230	6,400	599	50	1	3	1,090	1,500	400	15,907	1,628	36	564	12,700	14,928	-979	-103,298	-6.89
2046	1,763	0	173	1,628	1,070	0	600	6,400	599	50	1	3	1,090	1,500	400	15,277	1,628	36	564	12,700	14,928	-349	-103,647	-6.91
2047	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-103,396	-6.89
2048	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-103,145	-6.88
2049	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-102,894	-6.86
2050	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-102,643	-6.84
2051	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-102,392	-6.83
2052	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-102,140	-6.81
2053	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-101,889	-6.79
2054	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-101,638	-6.78
2055	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-101,387	-6.76
2056	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-101,136	-6.74
2057	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-100,885	-6.73
2058	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-100,634	-6.71
2059	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-100,383	-6.69
2060	1,763	0	173	1,628	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	14,677	1,628	36	564	12,700	14,928	251	-100,132	-6.68
2061	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-98,118	-6.54
2062	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-96,104	-6.41
2063	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-94,089	-6.27
2064	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-92,075	-6.14
2065	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-90,061	-6.00

Year	Eagle Mountain Pumped Storage Project Water Supply Wells[1]	Eagle Mountain Pumped Storage Project Construction Water Usage	Eagle Mountain Town Site[2]	Eagle Mountain Pumped Storage Project Seepage Recovery Wells[1]	Proposed Landfill Water Usage[2]	Proposed Solar Construction Water Usage[10]	Proposed Solar Water Usage[9]	Agricultural Pumping[3]	Aquaculture Pumping/Open Water Evap[4]	Desert Center Domestic[5]	So. Cal Gas[5]	Raceway	Lake Tamarisk[6]	Chuckwalla/ Ironwood State Prison[7]	Subsurface Outflow[8]	**Subtotal Outflow**	Inflow from Reservoir Seepage[1]	Lake Tamarisk Wastwater Return[8]	Infiltration at Chuckwalla/ Ironwood Prison Ponds	Average Recharge	**Subtotal Inflow**	**Inflow minus Outflow**	**Cumulative Change**	**Basinwide Change in Water Level (Feet)**
2066	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-88,047	-5.87
2067	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-86,033	-5.74
2068	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-84,019	-5.60
2069	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-82,005	-5.47
2070	0	0	173	0	1,070	0	0	6,400	599	50	1	3	1,090	1,500	400	11,286	0	36	564	12,700	13,300	2,014	-79,991	-5.33
2071	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-76,734	-5.12
2072	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-73,477	-4.90
2073	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-70,220	-4.68
2074	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-66,962	-4.46
2075	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-63,705	-4.25
2076	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-60,448	-4.03
2077	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-57,191	-3.81
2078	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-53,934	-3.60
2079	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-50,677	-3.38
2080	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-47,420	-3.16
2081	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-44,163	-2.94
2082	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-40,906	-2.73
2083	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-37,649	-2.51
2084	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-34,392	-2.29
2085	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-31,134	-2.08
2086	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-27,877	-1.86
2087	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-24,620	-1.64
2088	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-21,363	-1.42
2089	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-18,106	-1.21
2090	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-14,849	-0.99
2091	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-11,592	-0.77
2092	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-8,335	-0.56
2093	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-5,078	-0.34
2094	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	-1,821	-0.12
2095	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	1,437	0.10
2096	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	4,694	0.31
2097	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	7,951	0.53
2098	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	11,208	0.75
2099	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	14,465	0.96
2100	0	0	0	0	0	0	0	6,400	599	50	1	3	1,090	1,500	400	10,043	0	36	564	12,700	13,300	3,257	17,722	1.18

Notes:

1 EMEC 1994

2 CH2MHill 1996. Doesn't include prison population.

3 Value based on 2007 agricultural usage estimates (Table 3.3.3-2).

4 Pumping required to account for evaporation from open water bodies associated with fish ponds. Based on 2005 aerial photos and evaporation rate of 86 in/yr (USGS 1968).

5 Greystone 1994

6 Based on annual average water use pumping recordation data filed with the State water Resources Control Board for 2003 through 2009.

7 Personal communication with DPH

8 Based on 2000 census population of 200 people and assuming conservative value of 150 gal/person/day

9 For unverified projects, based on construction of two projects per year starting in 2013 and 30 year project life.

10 Based on average water use for all published construction water use projections for solar facilities, see Section 12.4, Attachment E

TABLE 15
Chuckwalla Valley Groundwater Basin Groundwater Balance Summary
Cummulative Effects on Groundwater Storage (AF)

Year	Subtotal Outflow	Subtotal Inflow	Inflow minus Outflow	Cumulative Change	Basinwide Change in Water Level
2008	10,640	13,531	2,891	2,891	0.19
2009	10,640	13,531	2,891	5,781	0.39
2010	10,661	13,531	2,870	8,651	0.58
2011	10,116	13,300	3,185	11,836	0.79
2012	10,449	13,300	2,852	14,687	0.98
2013	11,265	13,300	2,036	16,723	1.11
2014	21,582	14,928	-6,654	10,070	0.67
2015	22,675	14,928	-7,746	2,324	0.15
2016	24,949	14,928	-10,020	-7,697	-0.51
2017	25,848	14,928	-10,920	-18,617	-1.24
2018	19,864	14,928	-4,936	-23,552	-1.57
2019	18,147	14,928	-3,219	-26,771	-1.78
2020	17,804	14,928	-2,875	-29,647	-1.98
2021	17,744	14,928	-2,815	-32,462	-2.16
2022	17,744	14,928	-2,815	-35,277	-2.35
2023	17,744	14,928	-2,815	-38,092	-2.54
2024	17,744	14,928	-2,815	-40,908	-2.73
2025	17,924	14,928	-2,995	-43,903	-2.93
2026	17,924	14,928	-2,995	-46,898	-3.13
2027	17,924	14,928	-2,995	-49,893	-3.33
2028	17,924	14,928	-2,995	-52,888	-3.53
2029	17,924	14,928	-2,995	-55,884	-3.73
2030	18,140	14,928	-3,211	-59,095	-3.94
2031	18,140	14,928	-3,211	-62,306	-4.15
2032	18,140	14,928	-3,211	-65,517	-4.37
2033	18,140	14,928	-3,211	-68,729	-4.58
2034	18,140	14,928	-3,211	-71,940	-4.80
2035	18,382	14,928	-3,453	-75,393	-5.03
2036	18,382	14,928	-3,453	-78,846	-5.26
2037	18,382	14,928	-3,453	-82,299	-5.49
2038	18,382	14,928	-3,453	-85,753	-5.72
2039	18,382	14,928	-3,453	-89,206	-5.95
2040	18,377	14,928	-3,448	-92,654	-6.18
2041	18,325	14,928	-3,396	-96,050	-6.40
2042	18,294	14,928	-3,365	-99,415	-6.63
2043	16,620	14,928	-1,692	-101,107	-6.74
2044	16,140	14,928	-1,212	-102,319	-6.82
2045	15,907	14,928	-979	-103,298	-6.89
2046	15,277	14,928	-349	-103,647	-6.91
2047	14,677	14,928	251	-103,396	-6.89
2048	14,677	14,928	251	-103,145	-6.88
2049	14,677	14,928	251	-102,894	-6.86
2050	14,677	14,928	251	-102,643	-6.84
2051	14,677	14,928	251	-102,392	-6.83
2052	14,677	14,928	251	-102,140	-6.81
2053	14,677	14,928	251	-101,889	-6.79
2054	14,677	14,928	251	-101,638	-6.78
2055	14,677	14,928	251	-101,387	-6.76
2056	14,677	14,928	251	-101,136	-6.74
2057	14,677	14,928	251	-100,885	-6.73
2058	14,677	14,928	251	-100,634	-6.71
2059	14,677	14,928	251	-100,383	-6.69
2060	14,677	14,928	251	-100,132	-6.68
2061	11,286	13,300	2,014	-98,118	-6.54
2062	11,286	13,300	2,014	-96,104	-6.41
2063	11,286	13,300	2,014	-94,089	-6.27
2064	11,286	13,300	2,014	-92,075	-6.14
2065	11,286	13,300	2,014	-90,061	-6.00
2066	11,286	13,300	2,014	-88,047	-5.87
2067	11,286	13,300	2,014	-86,033	-5.74
2068	11,286	13,300	2,014	-84,019	-5.60
2069	11,286	13,300	2,014	-82,005	-5.47

Year	Subtotal Outflow	Subtotal Inflow	Inflow minus Outflow	Cumulative Change	Basinwide Change in Water Level
2070	11,286	13,300	2,014	-79,991	-5.33
2071	10,043	13,300	3,257	-76,734	-5.12
2072	10,043	13,300	3,257	-73,477	-4.90
2073	10,043	13,300	3,257	-70,220	-4.68
2074	10,043	13,300	3,257	-66,962	-4.46
2075	10,043	13,300	3,257	-63,705	-4.25
2076	10,043	13,300	3,257	-60,448	-4.03
2077	10,043	13,300	3,257	-57,191	-3.81
2078	10,043	13,300	3,257	-53,934	-3.60
2079	10,043	13,300	3,257	-50,677	-3.38
2080	10,043	13,300	3,257	-47,420	-3.16
2081	10,043	13,300	3,257	-44,163	-2.94
2082	10,043	13,300	3,257	-40,906	-2.73
2083	10,043	13,300	3,257	-37,649	-2.51
2084	10,043	13,300	3,257	-34,392	-2.29
2085	10,043	13,300	3,257	-31,134	-2.08
2086	10,043	13,300	3,257	-27,877	-1.86
2087	10,043	13,300	3,257	-24,620	-1.64
2088	10,043	13,300	3,257	-21,363	-1.42
2089	10,043	13,300	3,257	-18,106	-1.21
2090	10,043	13,300	3,257	-14,849	-0.99
2091	10,043	13,300	3,257	-11,592	-0.77
2092	10,043	13,300	3,257	-8,335	-0.56
2093	10,043	13,300	3,257	-5,078	-0.34
2094	10,043	13,300	3,257	-1,821	-0.12
2095	10,043	13,300	3,257	1,437	0.10
2096	10,043	13,300	3,257	4,694	0.31
2097	10,043	13,300	3,257	7,951	0.53
2098	10,043	13,300	3,257	11,208	0.75
2099	10,043	13,300	3,257	14,465	0.96
2100	10,043	13,300	3,257	17,722	1.18

Table 16
Mitigation Monitoring Network and Maximum Allowable Changes

Existing Monitoring Wells	New Monitoring Wells Well	Maximum Allowable Drawdown (feet)	Minimum Allowable Elevation (feet)
3S/15E-4J1 (OW18)		10	906
C-9		11	
	MW-109 (near OW03)	14	
	MW-110 (near OW13)	12	
	MW-112 (near OW15)	9	
	MW-111 (CRA in Palen Valley) [2]	Unknown	
5S/6E-25F1 (OW17) [2]		13	

Existing Water Supply Well	New Water Supply Well	Maximum Allowable Drawdown (feet)	Maximum Allowable Elevation (feet)
	WS-1	51	382
	WS-2	51	382
	WS-3	51	382

Existing Extensiometers	New Extensiometers	Maximum Subsidence (feet)	Maximum Allowable Elevation (feet)
	E-1	0.125	
	E-2	0.125	

Notes:

[1] Maximum allowable drawdown may be revised upon completion of project aquifer testing

[2] Boring shall be drilled to bedrock or first water. If saturated alluvium is encounter construct a monitoring well.

[3] Drawdown could be greater depending upon the confinement of the aquifers in the eastern portion of the valley and pumping by solar facilities

Attachment A

Eagle Crest
Energy Company

Eagle Mountain
Pumped Storage
Project

Memo

To: Matthew Hacker, Metropolitan Water District of Southern California

From: Richard Shatz, GEI Consultants, Inc. (prepared for Eagle Crest Energy Company)

CC: Arthur Lowe, President and CEO of Eagle Crest Energy Company; Jeff Harvey, Harvey Consulting Group, LLC; Ginger Gillin, GEI Consultants, Inc.

Date: January 6, 2009

Re: Alluvial Hydraulic Properties, Chuckwalla Groundwater Basin

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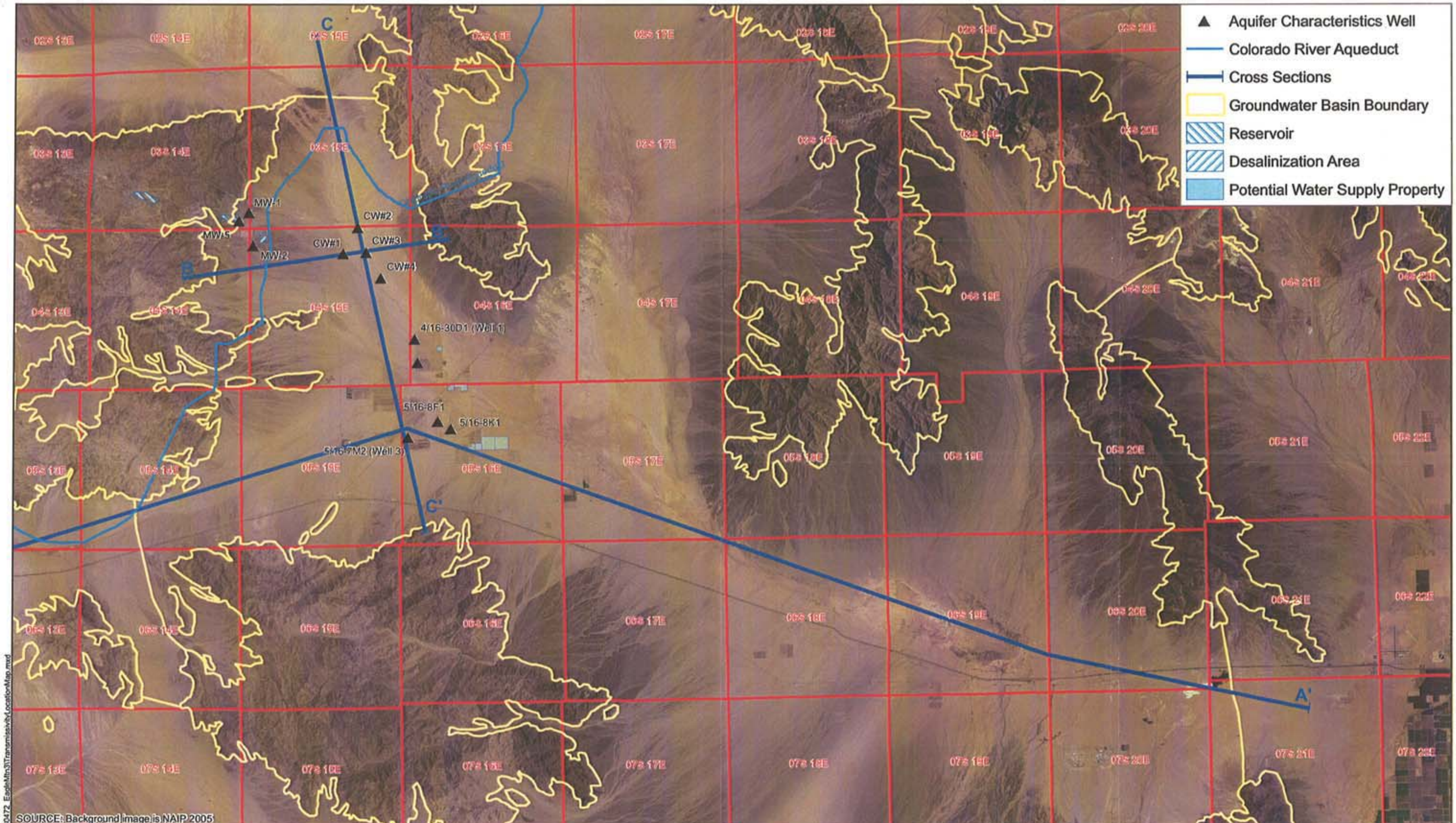
GEI Consultants, Inc., Bookman-Edmonston Division (GEI/B-E), prepared this data transmittal to present hydraulic characteristics of the alluvium in the Chuckwalla groundwater basin. This transmittal contains a map showing the locations of the wells where the hydraulic characteristics were estimated, cross sections showing the subsurface lithologies, and a summary table of the hydraulic characteristics. Where available, the original test data for each well are included along with the well log. Some of the hydraulic characteristics were estimated by GEI/B-E using a polynomial expression of the Theis equation and limited test data from the well log or from published literature. These calculation sheets are also included. In some cases detailed aquifer testing was performed but the analysis did not produce reasonable results. In these cases, the hydraulic characteristics were further evaluated using a range of storativities while varying the transmissivities to obtain the measured drawdown. We recognize that using the Theis polynomial calculator does not account for factors such as leakance or barriers to flow, but when data are lacking, it may provide an estimate of the aquifer characteristics.

I look forward to meeting with you to discuss and select reasonable hydraulic characteristics for use in projections of potential effects of the water supply pumping and design of the seepage recovery well system. If you have any questions regarding the contents of this data transmittal, please call me at 916-631-4566.



Eagle Mountain Pumped Storage
Eagle Mountain, California

Eagle Crest Energy Company

LOCATION OF WELLS WITH
AQUIFER CHARACTERISTICS DATA

JANUARY 2009

FIGURE

6-Jan-08 S:\GIS\Projects\080472_EagleMtn3\Transmissivity\LocationMap.mxd

Summary of Alluvial Aquifer Characteristics in Chuckwalla Groundwater Basin

Source of Test Data	Well No./Name	Estimated Storativity (unitless)	Estimated Specific Yield (unitless)	Assumed Storativity (unitless)	Flow Rate (gpm)	Drawdown (feet)	Saturated Aquifer Thickness (feet)	Distance from Well (feet)	Duration of Test (days)	Hydraulic Conductivity (ft/day)	Transmissivity (gpd/ft)	Recommended Value to Use
Well Log	CW-1			0.1	1,000	25	85	0.66	1.25	94	60,000	x
Well Log	CW-1			0.01	1,000	25	85	0.66	1.25	113	72,000	
Well Log	CW-1			0.001	1,000	25	85	0.66	1.25	131	83,000	
Well Log	CW-1			0.0001	1,000	25	85	0.66	1.25	148	94,000	
Well Log	CW-2			0.1	2,400	78	166	0.66	1.25	36	45,000	x
Well Log	CW-2			0.01	2,400	78	166	0.66	1.25	43	54,000	
Well Log	CW-2			0.001	2,400	78	166	0.66	1.25	51	63,000	
Well Log	CW-2			0.0001	2,400	78	166	0.66	1.25	57	71,000	
Well Log	CW-3			0.1	2,800	78	175	0.66	1.25	41	54,000	x
Well Log	CW-3			0.01	2,800	78	175	0.66	1.25	49	64,000	
Well Log	CW-3			0.001	2,800	78	175	0.66	1.25	57	74,000	
Well Log	CW-3			0.0001	2,800	78	175	0.66	1.25	64	84,000	
Well Log	CW-4			0.1	1,150	32	150	0.66	1.25	48	54,000	x
Well Log	CW-4			0.01	1,150	32	150	0.66	1.25	57	64,000	
Well Log	CW-4			0.001	1,150	32	150	0.66	1.25	66	74,000	
Well Log	CW-4			0.0001	1,150	32	150	0.66	1.25	75	84,000	
Gsi/Water, 1992	MW-1						51			7.1	2,700	
Gsi/Water, 1992	MW-2				33	37	65			0.02	10	
	MW-2						65			0.37	180	
Gsi/Water, 1992	MW-3				3.3	33					200	
Gsi/Water, 1992	MW-4				3.5	47	40			0.02	6	
	MW-4						40			0.50	150	
Gsi/Water, 1992	MW-5				20	25	30			2.0	450	
	MW-5						30			2.2	500	
	MW-5						30			7.1	1,600	
Gsi/Water, 1992	MW-6				5	12	65			0.1	50	
							65			1.4	680	
							65			1.8	870	
Gsi/Water, 1992	School Well				75	11	265			0.5	1,000	
							265			5.1	10,105	
Greystone 1994	Well 1				2,300	70.47	300	1.25	1.11	14	31,757	
Greystone 1994	Well 1				2,300	70.47	300	1.25	1.11	22	48,352	
Greystone 1994	Well 1				2,300	70.47	300	1.25	1.11	6	12,613	
Greystone 1994	Well 1				2,300	70.47	300	1.25	1.11	43	97,124	
Greystone 1994	OW-1	0.32	0.5		-	3.51	300	100	1.11	101	225,657	
Greystone 1994	OW-1	0.32			-	3.51	300	100	1.11	105	235,975	
Greystone 1994	OW-1	0.27			-	3.51	300	100	1.11	116	261,202	
Greystone 1994	OW-1				-	3.51	300	100	1.11	137	307,625	
Greystone 1994	OW-2	0.06	0.5		-	2.69	300	300	1.11	111	248,825	
Greystone 1994	OW-2	0.06			-	2.69	300	300	1.11	118	264,002	x
Greystone 1994	OW-2	0.05			-	2.69	300	300	1.11	139	311,288	x
Greystone 1994	OW-2				-	2.69	300	300	1.11	163	365,359	
	OW-1			0.1	-	3.51	300	100	1.11	160	360,000	
	OW-1			0.01	-	3.51	300	100	1.11	254	570,000	
	OW-1			0.001	-	3.51	300	100	1.11	339	760,000	
	OW-1			0.0001	-	3.51	300	100	1.11	423	950,000	
	OW-2			0.1	-	2.69	300	300	1.11	94	210,000	
	OW-2			0.01	-	2.69	300	300	1.11	227	510,000	
	OW-2			0.001	-	2.69	300	300	1.11	348	780,000	
	OW-2			0.0001	-	2.69	300	300	1.11	446	1,000,000	
Greystone 1994	Well 3				2,350	46.91	300	1.25	1.99	37	82,396	
Greystone 1994	Well 3				2,350	46.91	300	1.25	1.99	44	98,555	
Greystone 1994	Well 3				2,350	46.91	300	1.25	1.99	8	18,441	
Greystone 1994	Well 3				2,350	46.91	300	1.25	1.99	42	94,619	
Greystone 1994	OW-1	0.74	0.31		-	4.33	300	100	1.94	45	102,067	
Greystone 1994	OW-1	1.03			-	4.33	300	100	1.94	54	121,607	
Greystone 1994	OW-1	0.77			-	4.33	300	100	1.94	63	141,749	
Greystone 1994	OW-1				-	4.33	300	100	1.94	67	150,291	
Greystone 1994	OW-2	0.58	0.58		-	1.13	300	300	1.99	34	76,401	
Greystone 1994	OW-2	0.71			-	1.13	300	300	1.99	44	97,972	
Greystone 1994	OW-2	0.57			-	1.13	300	300	1.99	128	287,139	
Greystone 1994	OW-2				-	1.13	300	300	1.99	143	319,797	
	OW-1			0.1	-	4.33	454	100	1.94	97	330,000	x
	OW-1			0.01	-	4.33	454	100	1.94	147	500,000	
	OW-1			0.001	-	4.33	454	100	1.94	194	660,000	
	OW-1			0.0001	-	4.33	454	100	1.94	239	810,000	
	OW-2			0.1	-	1.13	454	300	1.99	294	1,000,000	
	OW-2			0.01	-	1.13	454	300	1.99	501	1,700,000	
	OW-2			0.001	-	1.13	454	300	1.99	677	2,300,000	
	OW-2			0.0001	-	1.13	454	300	1.99	854	2,900,000	
Well Log	Well 3			0.1	3,082	83	454	0.66	1.25	16	56,000	
Well Log	Well 3			0.01	3,082	83	454	0.66	1.25	19	66,000	
Well Log	Well 3			0.001	3,082	83	454	0.66	1.25	23	77,000	
Well Log	Well 3			0.0001	3,082	83	454	0.66	1.25	26	87,000	
Well Log	5/16-8F1			0.1	125	62	20	0.58	1.25	16	2,400	
Well Log	5/16-8F1			0.01	125	62	20	0.58	1.25	20	2,900	
Well Log	5/16-8F1			0.001	125	62	20	0.58	1.25	23	3,500	
Well Log	5/16-8F1			0.0001	125	62	20	0.58	1.25	27	4,100	
Well Log	5/16-8K1			0.1	180	20	18	0.58	1.25	105	14,000	
Well Log	5/16-8K1			0.01	180	20	18	0.58	1.25	124	17,000	
Well Log	5/16-8K1			0.001	180	20	18	0.58	1.25	142	19,000	
Well Log	5/16-8K1			0.0001	180	20	18	0.58	1.25	161	22,000	

Assumed Value

* Well 2 pumping test not performed. Greystone 1994
* Charpied Well - Informal pumping test performed 5/15/08. Results not valid because water level was higher after 2 days pumping.

DRAFT

Memo

Eagle Mountain Pumped Storage Project

To: Stephen Lowe, Eagle Crest Energy Company

From: Ryan Alward, Richard Shatz (CEG 1514), GEI Consultants, Inc.

CC: Steve Lowe, President and CEO of Eagle Crest Energy Company; Jeff Harvey, Harvey Consulting Group, LLC; Ginger Gillin, GEI Consultants, Inc.

Date: April 17, 2009

Re: Supplemental Alluvial Hydraulic Properties, Chuckwalla Groundwater Basin

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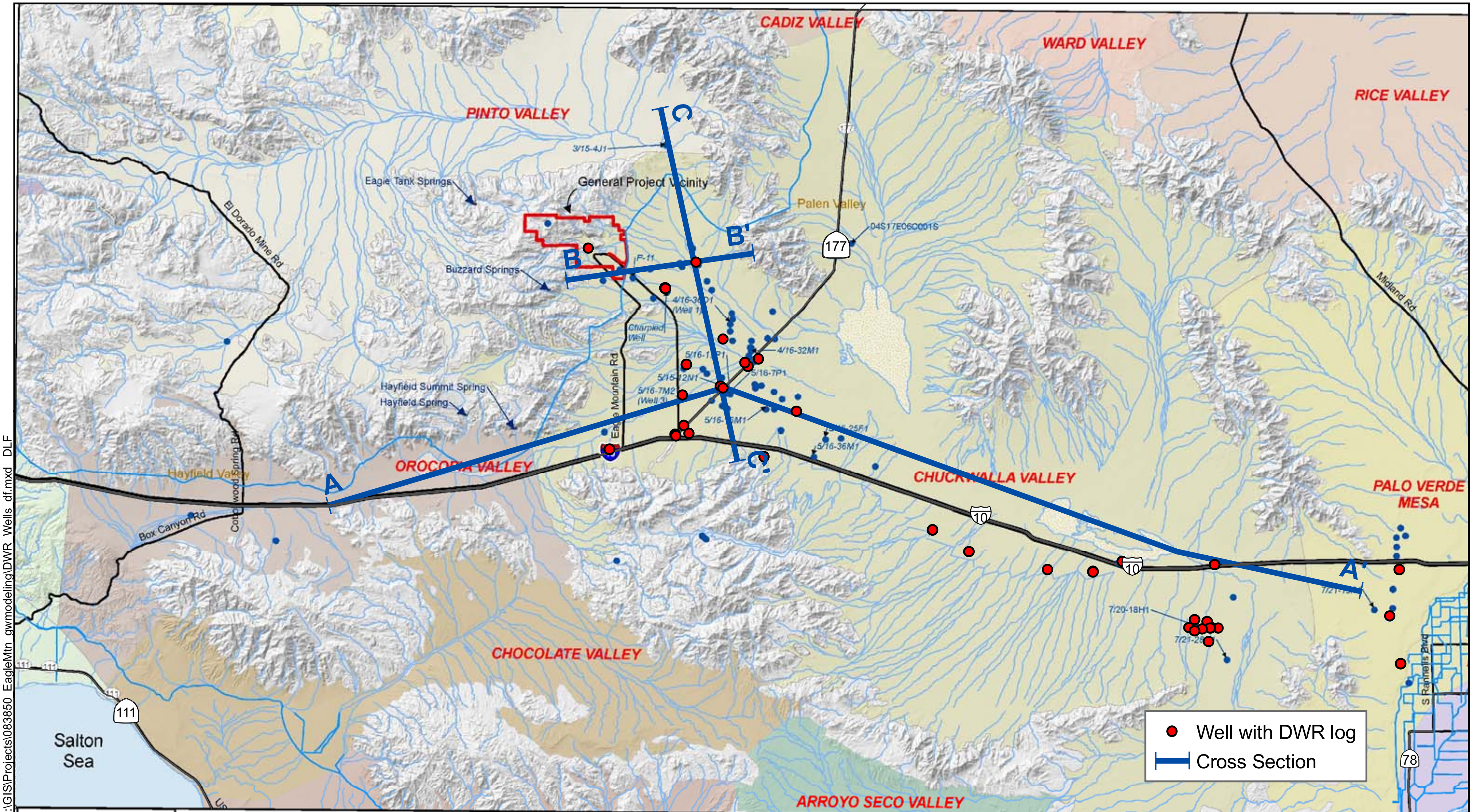
GEI Consultants, Inc. prepared this memo to supplement the hydraulic characteristics data transmittal for the Chuckwalla groundwater basin released on January 6, 2009.

A recent search by the Department of Water Resources, as requested by SWRCB, yielded 134 well logs. Of the 134 well logs GEI already had data for 32 wells, in the upper Chuckwalla groundwater basin. Of the remaining 102 logs, 43 logs had sufficient information to accurately locate the wells. Of the 59 wells not locatable most were logs for monitoring wells. Figure 1 shows the locations of the locatable wells along with previously located wells. Table 1 and Table 2 list the locatable and unlocatable wells.

The locatable wells were added to the geologic cross-sections if the new wells were near the cross-section profiles. Figure 2 shows the geologic map of the area. Figures 3 – 5 are the revised geologic sections.

Twelve locatable well logs contained sufficient production test data to estimate the aquifer hydraulic characteristics using a polynomial expression of the Theis equation. Of the 59 wells not locatable, five wells had sufficient production test data to estimate the aquifer hydraulic characteristics. These wells can only be positioned, at best, within one mile of the actual well location. Figure 6 shows the locations of the wells and the approximate location of the wells that could not be located accurately. Table 3 summarizes the aquifer hydraulic characteristics.



40,000 20,000 0 40,000

Feet

N E S W

Pumped Storage Project
Eagle Mountain, California

Eagle Crest Energy Company

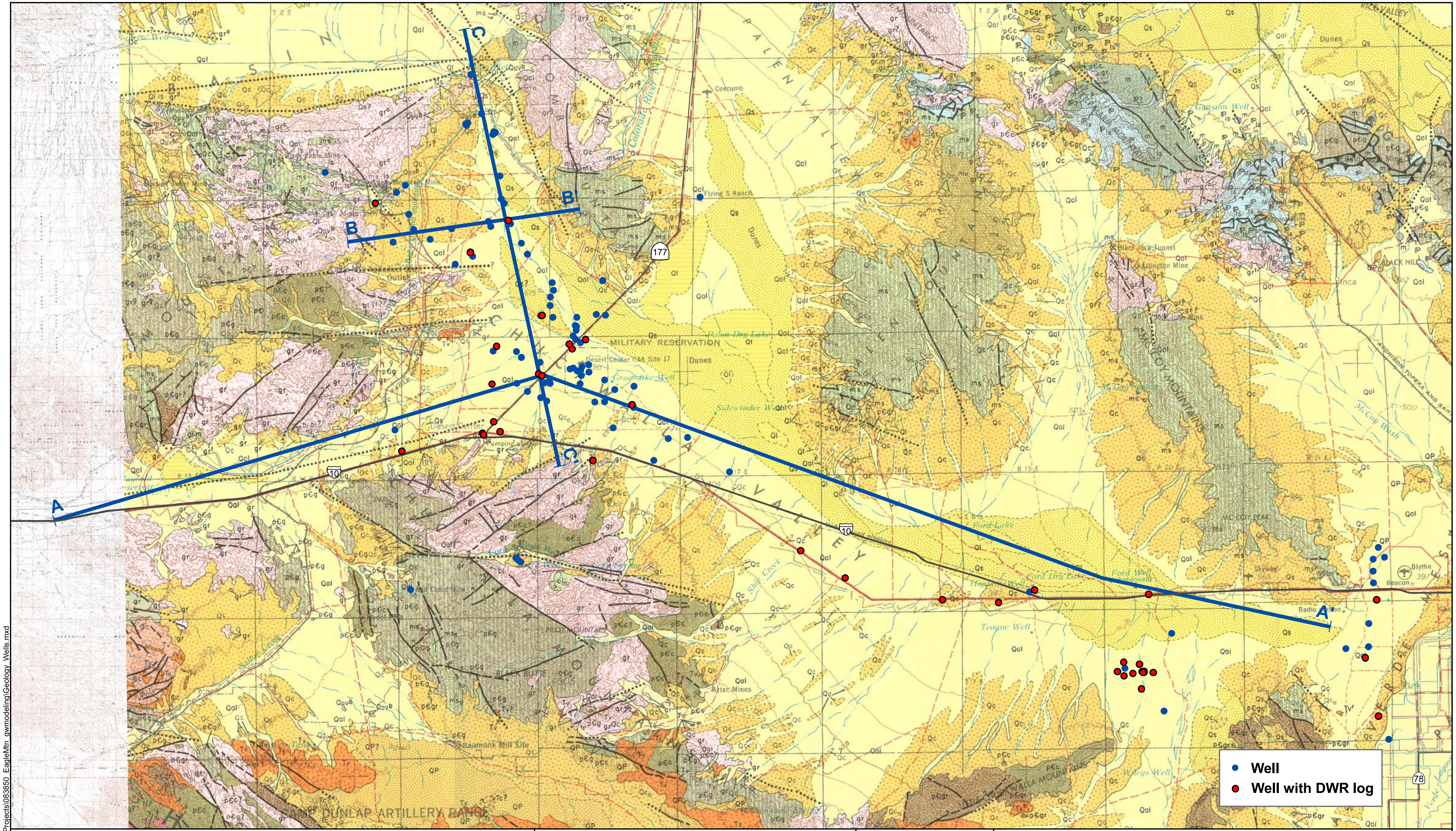
LOCATIONS OF WELLS WITH LOGS FROM DWR

APRIL 2009

FIGURE 1

S:\GIS\Projects\083850_EagleMtn_gwmodeling\DWR_Wells_df.mxd DLF

17-Apr-2009



21-Apr-2009 S:\GIS\Projects\083850_EagleMtn_gwmodeling\Geology_Wells.mxd

40,000 20,000 0 40,000
Feet

N
W E
S

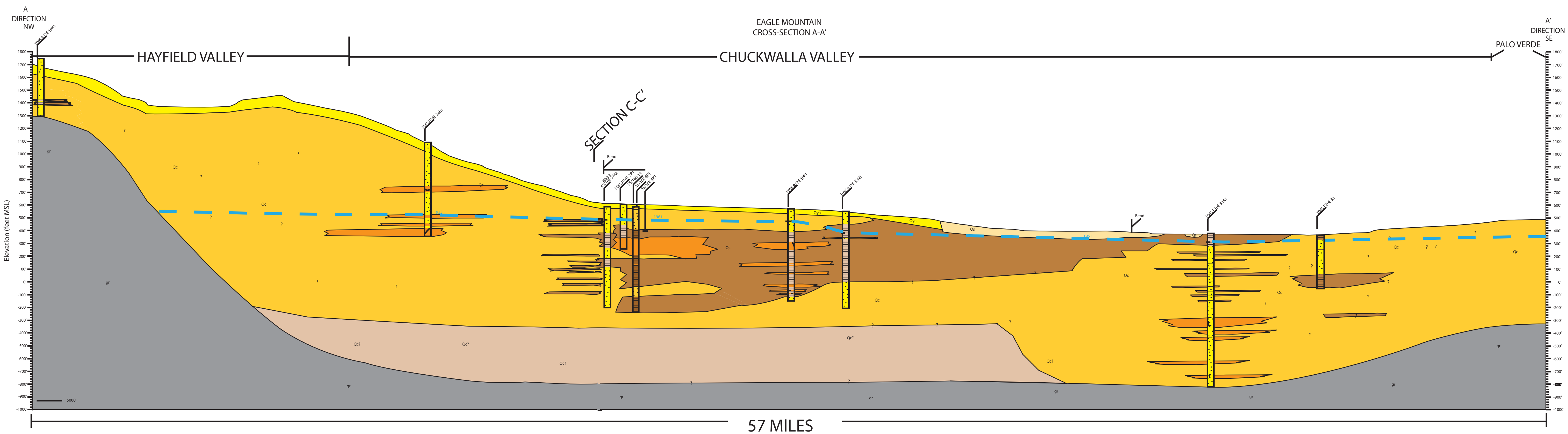
Pumped Storage Project
Eagle Mountain, California

Eagle Crest Energy Company

GEOLOGIC MAP

APRIL 2009

FIGURE 2



LEGEND

GRAVELS	
SANDS	
SILT OR CLAY	
VOLCANICS	
BASEMENT	

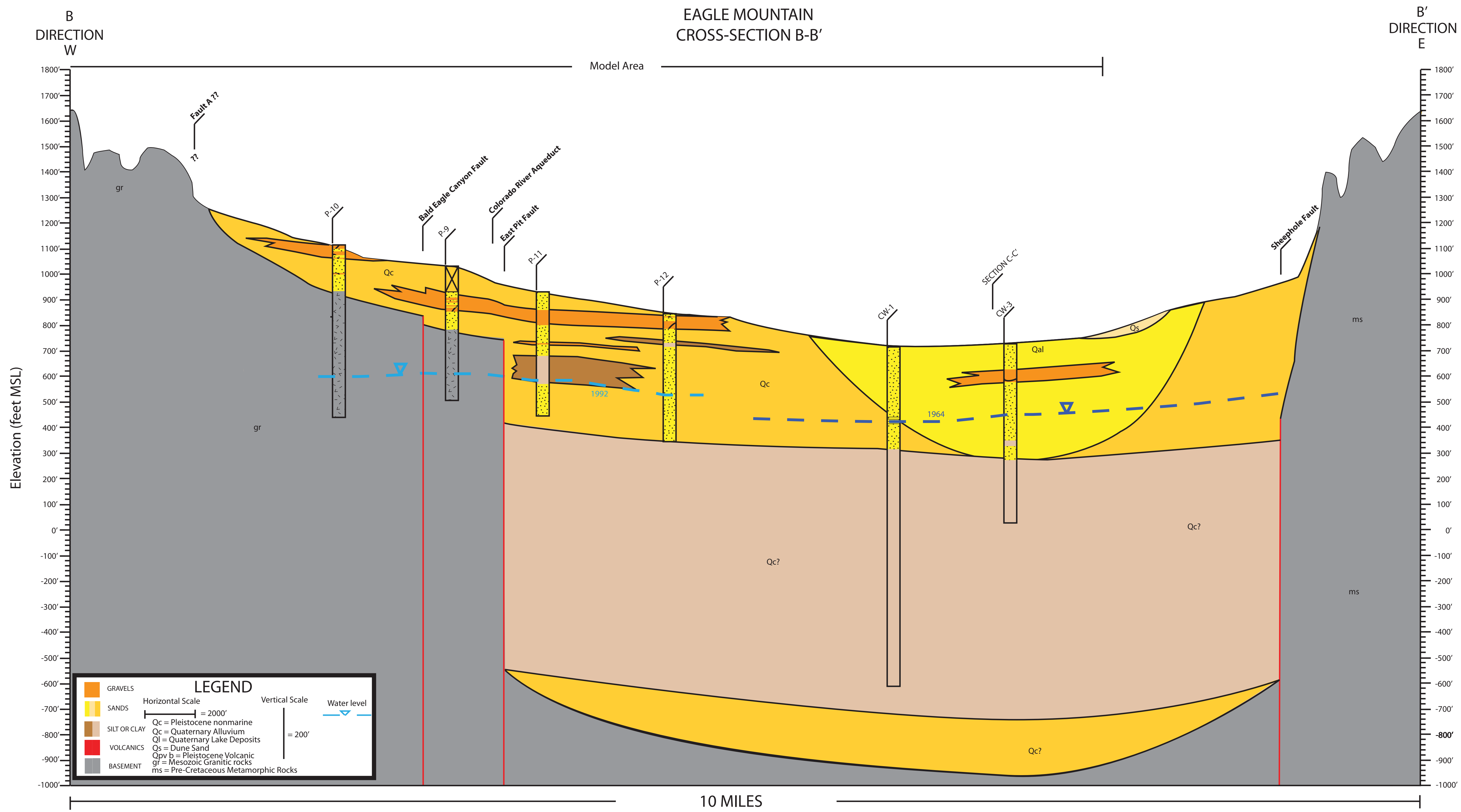
Qc = Pleistocene nonmarine
Qc = Quaternary Alluvium
Ql = Quaternary Lake Deposits
Qs = Dune Sand
Qpv b = Pleistocene Volcanic
gr = Mesozoic Granitic rocks
ms = Pre-Cretaceous Metamorphic Rocks

Water level

Vertical Scale
= 200'

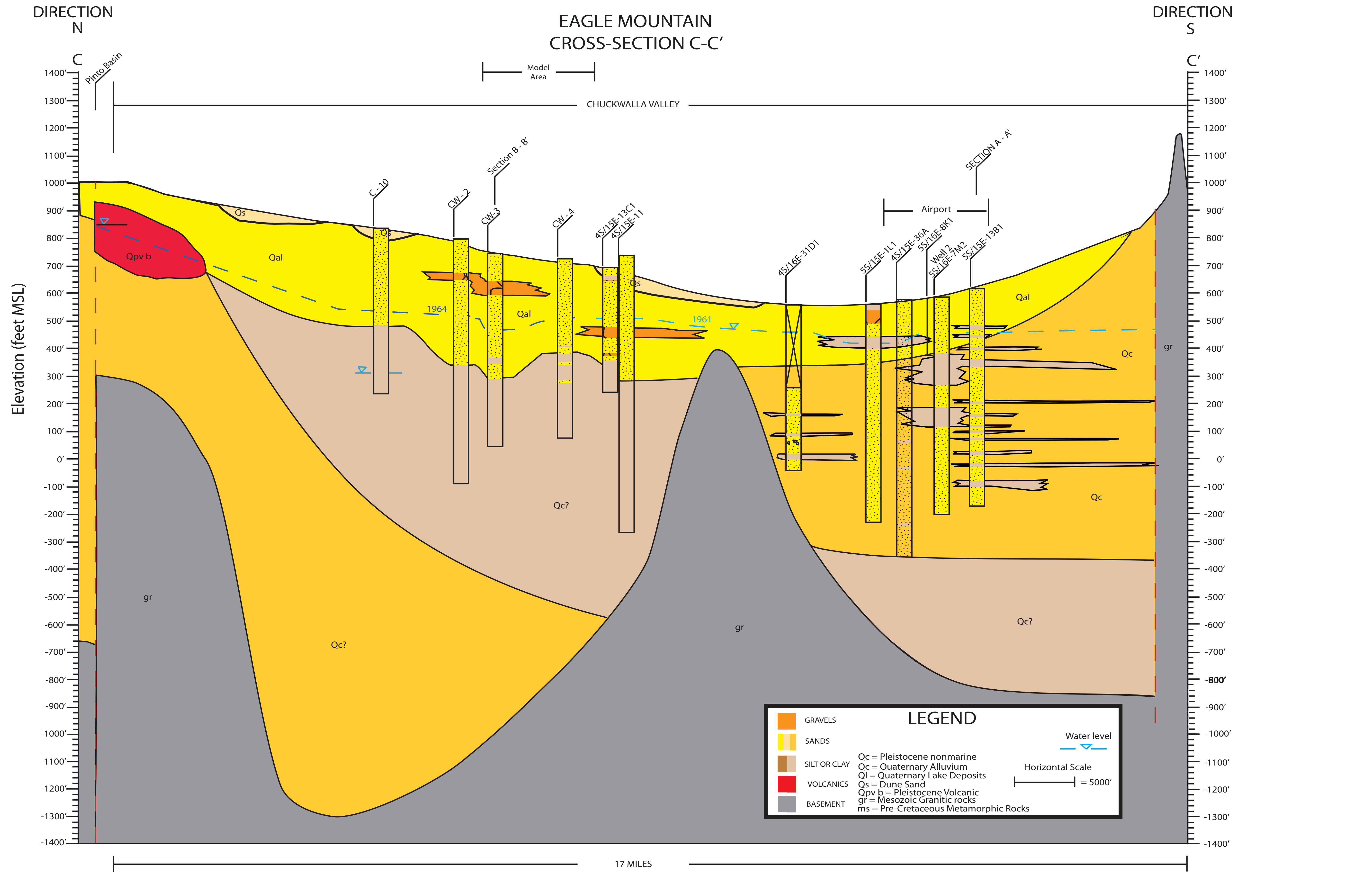
Horizontal Scale
= 5000'

EAGLE MOUNTAIN PUMPED STORAGE EAGLE MOUNTAIN, CALIFORNIA	CROSS-SECTION A - A'
EAGLE CREST ENERGY COMPANY	APRIL 2009 FIGURE 3

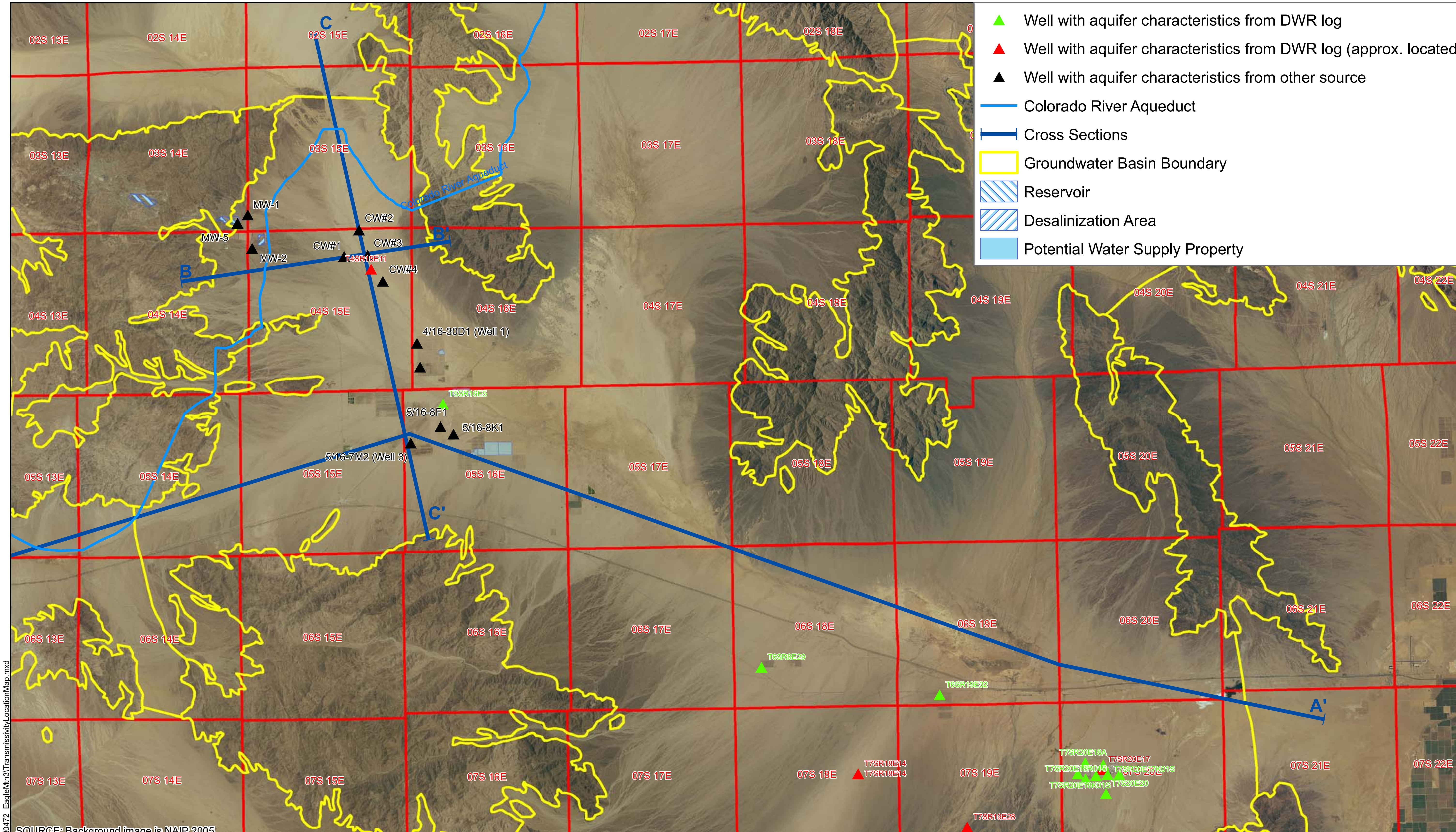


EAGLE MOUNTAIN PUMPED STORAGE EAGLE MOUNTAIN, CA	Eagle Crest Energy Company	CROSS-SECTION B-B'	
EAGLE CREST ENERGY COMPANY		APRIL 2009	FIGURE 4

EAGLE MOUNTAIN
CROSS-SECTION C-C'



EAGLE MOUNTAIN PUMPED STORAGE EAGLE MOUNTAIN, CALIFORNIA	Eagle Crest Energy Company	CROSS-SECTION C - C'
EAGLE CREST ENERGY COMPANY		APRIL 2009 FIGURE 5



5 2.5 0 5

Miles

N W E S

Eagle Mountain Pumped Storage
Eagle Mountain, California

Eagle Crest Energy Company

Eagle Crest Energy Company

LOCATION OF WELLS WITH
AQUIFER CHARACTERISTICS DATA

APRIL 2009

FIGURE 6

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Table 1
All wells Located - Geologic and Hydraulic Characteristics

State Well Number	WCR Number	Well Type	Well Depth feet bgs	Log Depth feet bgs	Sanitary Seal feet bgs	Screen Interval feet bgs	Gravel Interval feet bgs	Pumping Rate gpm	Pumping Duration Days	SWL feet bgs	PWL feet bgs	DD feet	Comments
T4S15E16	456914	MW	350	350	0-20	250-350	20-350	25	2	280	x	x	Charpied MW-2
T4S15E16	456913	MW	350	350	0-20	250-350	20-350	25	2	280	x	x	Charpied MW-1
T4S15E16	456915	MW	350	350	0-20	250-350	20-350	25	2	280	x	x	Charpied MW-3
T4S15E36	102259	ag	900	943	0-150	216-360 560-600 672-900	150-900	x	x	105	x	x	not exactly located but on same property as well.
T4SR14E2	487705	mw	663	675	0-21	615-663	515-673	16	1	580	x	x	At old mining town
T4SR15E11	103839	pw	500	650	0-30	170-410 494-500	30-500	1150	32	212	X	x	public supply well for Kaiser Steel 1977
T5S15E27	799986	domestic	618	625	0-50	438-618	x	150	x	415	x	x	
T5SR15E14D	x	ag	1023	1031	0-100	778-997	x	x	x	x	x	x	
T5SR15E2	455508	ag	800	800	0-20	580-800	20-800	1200	8 hrs	200	240	40	
T5SR15E23	1081762	domestic	610	620	0-63	335-595	63-610	50	x	380	x	x	
T5SR15E23	218827	ad dom	550	555	0-180	360-540	180-550	45	x	400	x	x	
T5SR15E26C	x	domestic	603	603	0-150	443-603	x	x	x	352	x	x	no state well llog number. it is at S+D Trailer Park
T5SR15E27B3	x	domestic	600	600	x	x	x	x	x	375	x	x	40 hp turbine pump and bowls set at 470 feet
T5SR15E30	1084991	anode well	500	500	x	260-500	166-500	x	x	x	x	x	cathodic protection well doesn't produce water
T5SR16E14	230620	domestic	751	810	0-20	272-432 432-632 702-741	20-751	500	x	80	x	x	
T5SR16E33	171102	industrial	378	398	0-200	x	x	x	x	x	x	x	
T5SR16E4	1081757	ag	390	400	0-25	150-390	25-390	200	2	70	x	x	
T5SR16E5	069757	ag	600	600	0-20	340-600	20-600	900	12	58	150	x	
T5SR16E5	728885	domestic	250	250	0-20	130-250	20-250	10	2	81	x	5	
T5SR16E7E1S	103821/6801	domestic	420	420	0-218	320-420	0-420	x	x	141	x	x	
T5SR16E7M3S	40025	domestic	390	398	0-175	288-390	175-390	x	x	140	x	x	
T6SR17E24	218095	ag domestic	682	752	0-20	332-552 592-672	0-682	x	x	335	x	x	
T6SR18E29	217367	ag	957	970	0-20	560-940	0-957	600	33	180	300	x	Well at Jojoba field well#2 in east side of same field. Don't have log for that well.
T6SR18E36	230632	ag domestic	940	970	0-20	290 330-490 530-650 770-810 870	20-940	600	x	140	x	x	
T6SR19E32	230640	ag domestic	732	790	0-20	307-327 365-722	x	1500	x	200	x	x	
T6SR19E32	353739	ag domestic	982	1025	0-25	890-940	25-1000	450	72	125	300	x	TDS is 2400 ppm Newer well on property
T6SR19E34	01839	other	400	400	none	0-274	0-274	x	x	x	x	x	So Cal Gas Co well All Clay and Shale some fine sand
T6SR20E33	01842	other	400	400	none	0-278	0-278	x	x	x	x	x	So Cal Gas Co well
T7SR20E16M01S	157672	pw	1200	1220	0-230	690-1190	230-1200	1200	85 minute	202	283	x	State Prison Well
T7SR20E17G01S	15917	pw	1200	1215	0-240	690-1190	230-1200	1200	24	203	278	x	State Prison Well
T7SR20E17K01S	15912	pw	1200	1200	0-235	690-1190	235-1200	1600	24	205	236	x	State prison well
T7SR20E17L01S	485765	pw	1200	1230	0-140	140-590	590-1200	1600	24	213	x	60	state prison well
T7SR20E18A	27724	ag	1083	1139	0-853	853-1083	853-1083	1000	24	178	x	90	Temp of water is 112 degree F. Well may have been abandoned
T7SR20E18K01S	485768	pw	1200	1230	0-140	690-1200	140-1200	1000	48	193	x	97	state prison well
T7SR20E18R01S	485766/485767	pw	1160	1230	0-140	140-590	140-1160	1500		130	202	90	state prison well
T7SR21E1	231353	ag	345	351	none	155-335	0-345	1000	x	145	x	x	none
T7SR21E14J	37717	ag	900	1367	0-600	700-900	0-900	800	15.5	130	x	x	Water temp was 115 deg. F.
T7SR21E36	218844	ag	344	705	0-20	134-334	20-344	1500		138	x	x	may have another well on same property
T7SR20E20	157634	ag	1100	1100	0-400	738-1100	400-1000	2130	0.333333333	197	305	108	
T7SR20E17	485758	MW	53	53	0-40	40-53	40-53	x	x	48	x	x	Monitoring Well at the Prison
T5S15E23	218827	ag dom	550	555	0-180	360-540	180-550	45		400			
T7SR20E17	485760	MW	53	53	0-40	40-53	40-53	x	x	48	x	x	Monitoring Well at the Prison
T7SR20E17	485759	MW	53	53	0-40	40-53	40-53	x	x	48	x	x	Monitoring Well at the Prison

Table 2
All Unlocated Wells - Geologic and Hydraulic Characteristics

State Well Number	WCR Number	Well Type	Reason for Not Locatable: Not enough info	Outside of Groundwater Basin - within watershed	Locatable within one mile	wrong location	Outside of Chuckwalla Watershed	Location on Log Questionable	Assumed Storativity (unitless)	Flow Rate (gpm)	Drawdown (feet)	Saturated Aquifer Thickness (feet)	Distance from Well (feet)	Duration of Test (days)	Construction Date	General Area	Well Depth feet bgs	Log Depth feet bgs
T4SR14E11	487748	MW	x		x										8/19/1992	Eagle Mountain	675	675
T4SR14E2	487726	MW	x		x										8/20/1992	Eagle Mountain	0	625
T4SR14E2	487707	MW	x		x										9/10/1992	Eagle Mountain	625	625
T4SR14E2	487724	MW	x		x										8/20/1992	Eagle Mountain	0	625
T4SR14E2	487706	MW	x		x										8/20/1992	Eagle Mountain	0	625
T4SR14E4	395181	MW	x		x			x							11/11/1997	Eagle Mountain	943	980
T4SR14E4	395170	MW	x		x										1/23/1993	Eagle Mountain	730	730
T4SR14E4	395173	MW	x		x										34075	Eagle Mountain	1000	1000
T4SR14E4	395175	MW	x		x										4/16/1993	Eagle Mountain	953	953
T4SR14E4	395180	MW	x		x										11/11/1993	Eagle Mountain	968	1000
T4SR14E4	395182	MW	x		x										34288	Eagle Mountain	945	960
T4SR14E4	395183	MW	x		x										11/15/1993	Eagle Mountain	968	1000
T4SR14E4	395184	MW	x		x										12/27/1993	Eagle Mountain	1020	1050
T4SR15E7	487749	MW	x		x										8/18/1992	Eagle Mountain	520	525
T4SR15E8	487746	MW	x		x										8/19/1992	Eagle Mountain	500	500
T4SR15E8	487747	MW	x		x										8/19/1992	Eagle Mountain	470	475
T4SR16E30	456921	MW	x		x										34626	Desert Center	200	200
T4SR16E30	456927	MW	x		x										9/12/1994	Desert Center	200	200
T4SR17E6C1		PW	x		x										11703	Upper Chuckwalla	494	501
T4SR17E6C2	37433	MW	x		x										2/21/1969	Upper Chuckwalla		1303
T5SR14E24R1		Test Hole			x	x		x							1/19/1933	Upper Chuckwalla	732	
T5SR15E13	230659	domestic	x		x					1000+					4/16/1982	Desert Center	697	730
T5SR15E20C	37432		x		x			s							2/12/1969	Desert Center	575	575
T5SR15E22		Open Hole, Later Cased	x		x										9/2/1953	Desert Center		
T5SR15E23N	53466		x		x											Chuckwalla		
T5SR15E30	1098010				x											Desert Center		
T5SR15E8	157633	ag	x		x				0.001	500	30	240		0.333333333	2/5/1986	Desert Center	800	867
T5SR16E16	43825	ag	x		x			x							5/18/1982	Desert Center	800	800
T5SR16E30	171101	industrial	x		x										3/2/1985	Desert Center	375	375
T5SR16E30	456920	MW	x		x	x		x							10/19/1994	Desert Center		
T5SR16E30	456922	MW	x		x	x		x							34626	Desert Center		
T5SR16E30	456924	MW	x		x	x		x							10/19/1994	Desert Center		
T5SR16E33	496742	Cathodic	x		x										9/27/1994	Desert Center		
T5SR16E5&8	073695	ag	x		x	x		x	0.01	760	102	220		0.5	4/10/1980	Desert Center	460	465
T5SR17E30	447172	ag	x		x			x							36157	Desert Center		
T5SR22E26	16998	ag	x		x		x								6/9/1953	Out of Area		
T6SR14E7F1	103834	Test Hole	x		x										12/28/1976	Chuckwalla	672	672
T6SR17E	069764	ag	x												12/2/1980	Chuckwalla	710	710
T6SR19E33X1			x		x										1911			
T6SR20E31	281824	other			x		x								2/23/1989			
T6SR20E33	278937	anode			x		x								4/29/1989			
T7SR18E14	03645	ag	x		x		x		0.0001	400	240	100		0.5	2/8/1983	South of Chuckwalla	960	985
T7SR18E14	03647	ag	x		x		x		0.0001	400	260	300		0.5	2/8/1983	South of Chuckwalla	1000	1000
T7SR18E14	03648	ag	x		x		x								30355	South of Chuckwalla	unknown	
T7SR19E28	217391	ag	x		x			x							3/15/1982	South Chuckwalla	830	830
T7SR19E28	266157	Test Well	x		x			x							6/6/1989	South Chuckwalla	0	825
T7SR19E28	336234	ag	x		x			x	0.001	2000	3	400		0.083333333	11/30/1989	South Chuckwalla	1100	1145
T7SR20E17	218900	ag	x		x			x	0.001	800	62	300		1	7/28/1981	South Chuckwalla	1050	1070
T7SR20E17	485769	MW	x		x			x							11/11/1992	South Chuckwalla		
T7SR20E17	477987	MW	x		x			x							11/11/1992	South Chuckwalla		
T7SR20E17	485770	MW	x		x			x							33919	South Chuckwalla		
T7SR21E12D	90467	ag			x		x								23988	Pinto		
T7SR21E12N1	x				x		x								3/25/1905	Pinto		
T5SR16E	05442	Cathodic	x					x										
School House Well			x		x											Chuckwalla		
T4SR15E11	395287	PW	x		x			x	0.01						9/20/1993	Desert Center	580	1000
T5SR15E27H1	x	abandoned	x		x			x							2/27/1951	Desert Center		
T5SR16E7M4S	x	domestic	x		x	x		x							1980	Desert Center		
T7SR21E	218845	ad dom	x				x								5/18/1981	Pinto		

Table 3
Supplement of Alluvial Aquifer Characteristics in Chuckwalla Groundwater Basin

Source of Test Data	Well No./Name	Well Total Depth (feet)	Assumed Storativity (unitless)	Flow Rate (gpm)	Drawdown (feet)	Saturated Aquifer Thickness (feet)	Distance from Well (feet)	Duration of Test (days)	Hydraulic Conductivity (ft/day)	Transmissivity (gpd/ft)	Recommended Value to Use
LOCATED											
T5SR15E2	455508	800	0.01	1200	40	220	1	0.3333333	22	36,000	
T5SR16E5	069757	600	0.001	900	92	260	1	0.5	8	16,500	
T6SR18E29	217367	957	0.0001	600	120	380	1	1.4	3.5	10,000	
T6SR19E32	353739	982	0.0001	450	175	50	1	3	12	4,500	
T7SR20E16M01S	157672	1200	0.0001	1200	81	510	1	0.1	7	27,000	
T7SR20E17G01S	15917	1200	0.0001	1200	75	510	1	1	9	34,000	
T7SR20E17K01S	15912	1200	0.001	1600	31	510	1	1	27	102,000	
T7SR20E17L01S	485765	1200	0.0001	1600	60	510	1	1	15	57,000	
T7SR20E18A	27724	1083	0.001	1000	90	230	1	1	12	20,000	
T7SR20E18K01S	485768	1200	0.0001	1000	97	510	1	2	5	20,000	
T7SR20E18R01S	485766/485767	1160	0.0001	1500	90	450	1	5.4	12	39,000	
T7SR20E20	157634	1100	0.001	2130	108	362	1	0.3	11	28,500	
UNLOCATED											
T4SR15E11	395287	580	0.01-0.001	1400	112	240	1	3	12 to 13	20,750-24,000	
T7SR18E14	3645	960	0.0001	400	240	100	1	0.5	4	2,900	
T7SR18E14	3647	1000	0.0001	400	260	300	1	0.5	1	2,700	
T7SR19E28	336234	1100	0.01	2000	3	400	1	0.08	434	1,300,000	I don't think this is valid
T7SR20E17	218900	1050	0.001	800	62	300	1	1	1	8,200	

Assumed Value

Attachment B

Kaiser Well Pumping 17-Years

Transmissivity (T)	696	m^2/d	T: 7,487	ft^2/d	K: 49.9	ft/d
Storage Coefficient (S)	5.00E-02	unitless	56,000	gal/d/ft	373.33	$gal/d/ft^2$
Time (t)	6205	Days				

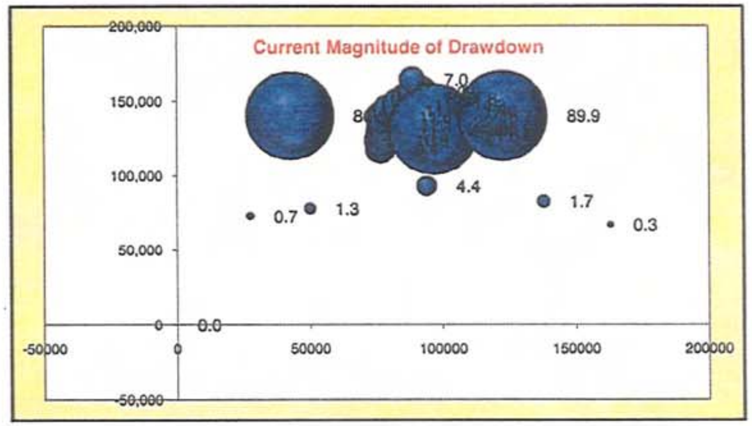
b: 150 b (ft)

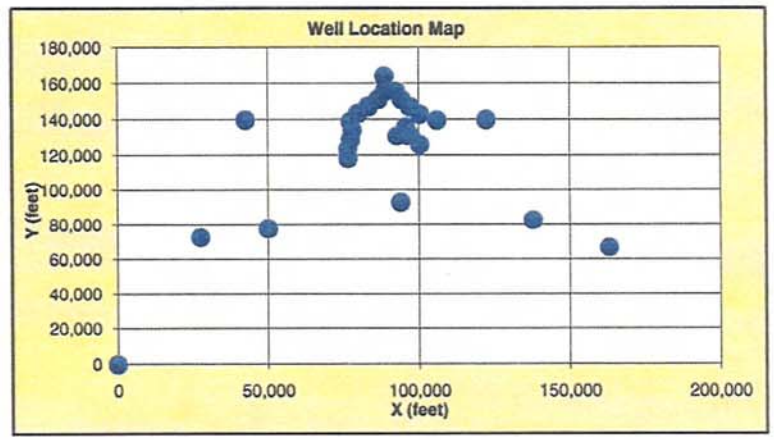
Max contribution from adjacent well: 50% %

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		9.4	-
OW02	76582	123564		10.6	-
OW03	77513	128854		11.7	-
OW04	78123	134152		12.1	-
OW05	77586	139175		11.6	-
OW06	79932	143615		11.4	-
OW07	83363	147349		11.2	-
OW08	86660	151487		10.6	-
OW09	88842	155752		9.5	-
OW10	92566	155866		9.9	-
OW11	94364	151469		11.8	-
OW12	97228	147233		14.3	-
OW13	100489	143155		17.0	-
OW14	106161	139900		18.7	-
OW15	50085	77990		1.3	-
WSuc1	92912	130967		24.4	-
WSuc2	95770	136110		22.8	-
WSuc3	97472	131206		36.5	-
WSuc4	100476	126092		21.0	-
CWuc	96645	131107	variable	90.8	
OW17	137873	82786		1.7	-
OW16	93990	93057		4.4	-
IWuc1	122403	140173	variable	89.9	
IWuc2	42646	140148	variable	86.5	
OW18	88706	164240		7.0	-
OW19	27591	72923		0.7	-
OW20	163091	66971		0.3	-
1	0	0		0.0	-
2	0	0		0.0	-
3	0	0		0.0	-
Maximum				90.8	

Total Amount of Water - - acre-ft/yr 0 gpm 0.00 MGD





Well Production Changes with Time (all units are gpm)

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days																		
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205	6570
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSuc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSuc4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWuc	1521	2395	2449	2491	2540	2174	1991	1453	2309	2204	2216	2325	2415	2589	2583	2012	1863	0
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	1521	2395	2449	2491	2540	2174	1991	1453	2309	2204	2216	2325	2415	2589	2583	2012	1863	0
IWuc2	1521	2395	2449	2491	2540	2174	1991	1453	2309	2204	2216	2325	2415	2589	2583	2012	1863	0
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5750	5750	5750	3133	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

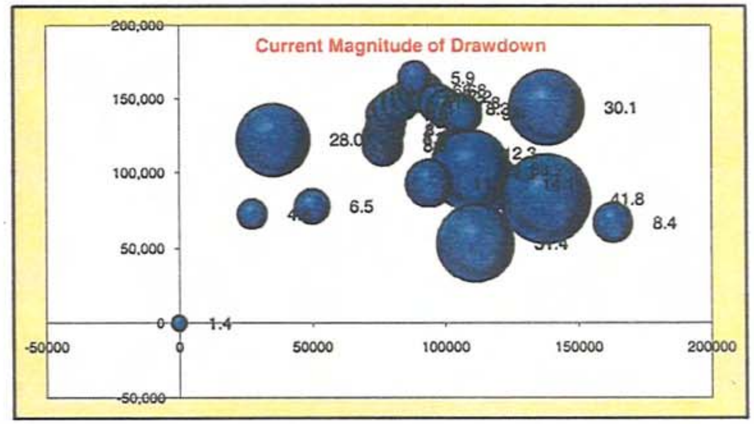
Proposed Pumping: Aq 27 years-K=100

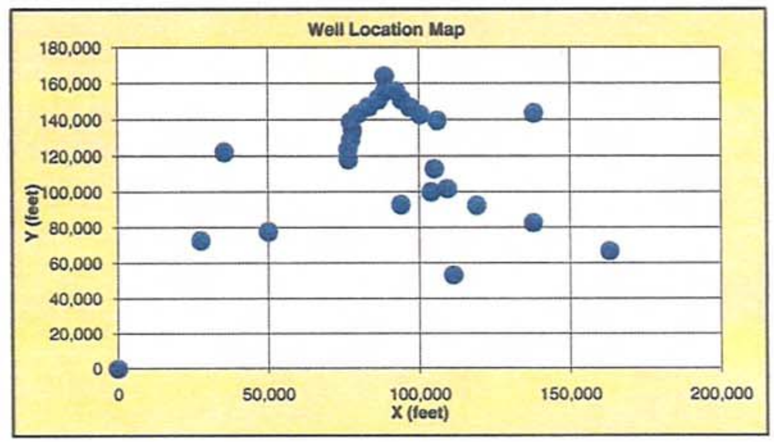
Transmissivity (T)	2,795	m^2/d	30,080	ft^2/d	K: 100.3 ft/d	b: 300 b (ft)	Max contribution from adjacent well: 10% %
Storage Coefficient (S)	5.00E-02	unitless	225,000	gal/d/ft	750.00 $gal/d/ft^2$		
Time (t)	9855	Days					

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		8.8	-
OW02	76582	123564		8.5	-
OW03	77513	128854		8.2	-
OW04	78123	134152		7.9	-
OW05	77586	139175		7.5	-
OW06	79932	143615		7.3	-
OW07	83363	147349		7.1	-
OW08	86660	151487		6.9	-
OW09	88842	155752		6.6	-
OW10	92566	155866		6.8	-
OW11	94364	151469		7.2	-
OW12	97228	147233		7.8	-
OW13	100489	143155		8.3	-
OW14	106161	139900		9.0	-
OW15	50085	77990		6.5	-
WSdc1	105147	113006		12.3	-
WSdc2	104059	100068		14.3	-
WSdc3	119052	92612		14.1	-
CWdc	109389	101945	10,700	33.2	
OW17	137873	82786		41.8	
OW16	93990	93057		11.5	-
IWdc1	138151	144025	10,700	30.1	
IWdc2	35469	122291	10,700	28.0	
IWdc3	111364	53406	10,700	31.4	
OW18	88706	164240		5.9	-
OW19	27591	72923		4.8	-
OW20	163091	66971		8.4	-
1	0	0		1.4	-
2	0	0		1.4	-
3	0	0		1.4	-
Maximum				41.8	

Total Amount of Water 69,028 acre-ft/yr 42,800 gpm 61.63 MGD





Well Production Changes with Time (all units are gpm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Days																	
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
OW17	0	0	0	0	0	0	0	0	0	0	0	0	110	220	330	440	506.4444
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
IWdc2	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
IWdc3	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5750	5750	5750	3133	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917

18	19	20	21	22	23	24	25	26	27
1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
6570	6935	7300	7665	8030	8395	8760	9125	9490	9855
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
572.8889	639.3333	705.7778	772.2222	838.6667	905.1111	971.5556	1038	1940.5	2843
0	0	0	0	0	0	0	0	0	0
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023

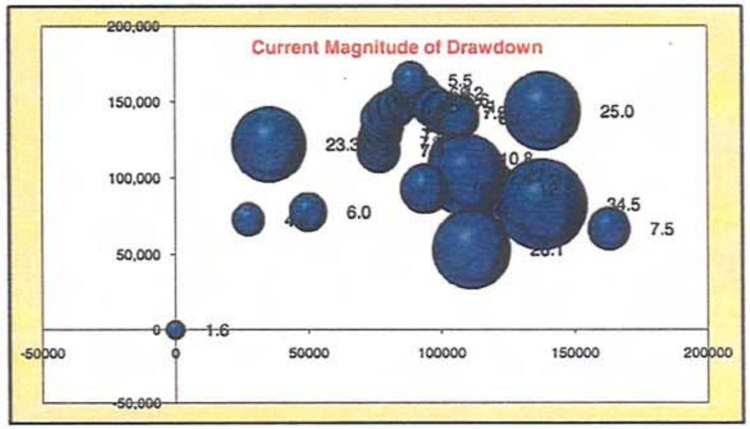
Proposed Pumping: Aq 27 years-K=125

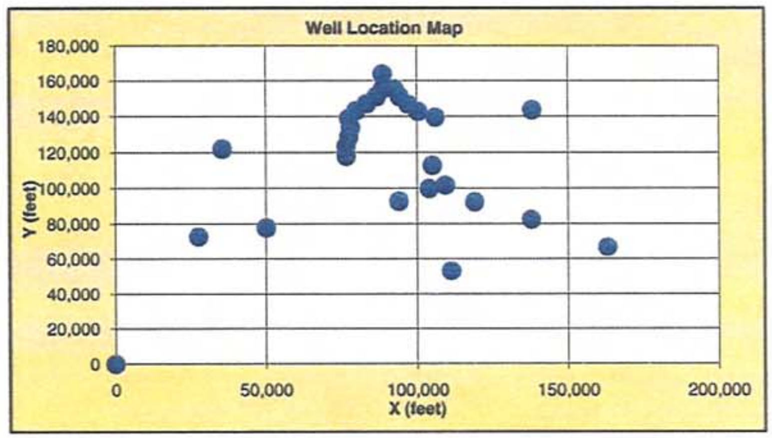
			T		K		b		Max contribution from adjacent well	
Transmissivity (T)	3,478	m^2/d	37,433	ft^2/d	124.8	ft/d	300	b (ft)	10%	%
Storage Coefficient (S)	5.00E-02	unitless	280,000	gal/d/ft	933.33	$gal/d/ft^2$				
Time (t)	9855	Days								

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		7.9	-
OW02	76582	123564		7.7	-
OW03	77513	128854		7.5	-
OW04	78123	134152		7.2	-
OW05	77586	139175		6.9	-
OW06	79932	143615		6.7	-
OW07	83363	147349		6.5	-
OW08	86660	151487		6.3	-
OW09	88842	155752		6.1	-
OW10	92566	155866		6.2	-
OW11	94364	151469		6.6	-
OW12	97228	147233		7.1	-
OW13	100489	143155		7.5	-
OW14	106161	139900		8.1	-
OW15	50085	77990		6.0	-
WSdc1	105147	113006		10.8	-
WSdc2	104059	100068		12.4	-
WSdc3	119052	92612		12.3	-
CWdc	109389	101945	10,700	27.6	
OW17	137873	82786		34.5	
OW16	93990	93057		10.1	-
IWdc1	138151	144025	10,700	25.0	
IWdc2	35469	122291	10,700	23.3	
IWdc3	111364	53406	10,700	26.1	
OW18	88706	164240		5.5	-
OW19	27591	72923		4.5	-
OW20	163091	66971		7.5	-
1	0	0		1.6	-
2	0	0		1.6	-
3	0	0		1.6	-
Maximum				34.5	

Total Amount of Water 69,028 acre-ft/yr 42,800 gpm 61.63 MGD





Well Production Changes with Time (all units are gpm)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Days																	
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
OW17	0	0	0	0	0	0	0	0	0	0	0	0	110	220	330	440	506.4444
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
IWdc2	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
IWdc3	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5750	5750	5750	3133	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917

18	19	20	21	22	23	24	25	26	27
1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
6570	6935	7300	7665	8030	8395	8760	9125	9490	9855
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
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0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
572.8889	639.3333	705.7778	772.2222	838.6667	905.1111	971.5556	1038	1940.5	2843
0	0	0	0	0	0	0	0	0	0
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
1927	1937	1947	1957	1967	1977	1987	1997	2010	2023
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

1927 1937 1947 1957 1967 1977 1987 1997 2010 2023

Proposed Pumping: Aq 6 years

Transmissivity (T)	3,478	m^2/d	T: 37,433	ft^2/d	K: 124.8 ft/d
Storage Coefficient (S)	5.00E-02	unitless	280,000	gal/d/ft	933.33 $gal/d/ft^2$
Time (t)	2190	Days			

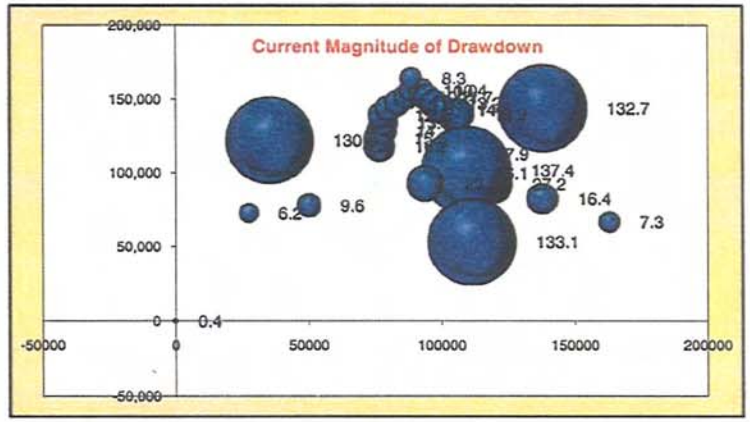
b: 300 b (ft)

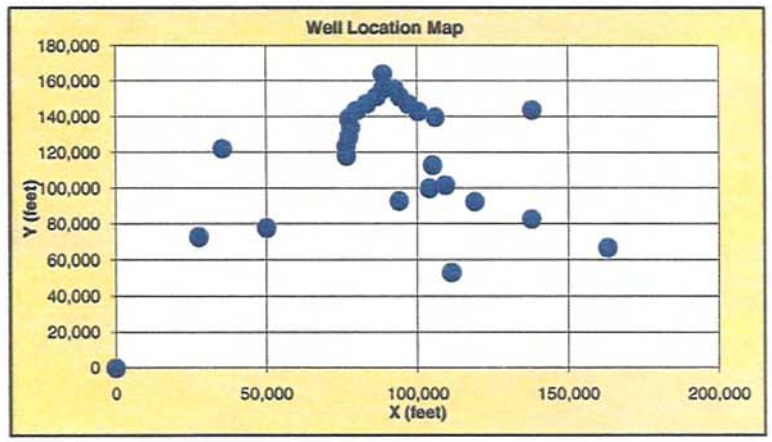
Max contribution from adjacent well: 10% %

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		16.2	-
OW02	76582	123564		15.5	-
OW03	77513	128854		14.7	-
OW04	78123	134152		13.7	-
OW05	77586	139175		12.6	-
OW06	79932	143615		11.8	-
OW07	83363	147349		11.3	-
OW08	86660	151487		10.7	-
OW09	88842	155752		10.0	-
OW10	92566	155866		10.4	-
OW11	94364	151469		11.7	-
OW12	97228	147233		13.2	-
OW13	100489	143155		14.8	-
OW14	106161	139900		16.9	-
OW15	50085	77990		9.6	-
WSdc1	105147	113006		27.9	-
WSdc2	104059	100068		36.1	-
WSdc3	119052	92612		27.2	-
CWdc	109389	101945	10,700	137.4	
OW17	137873	82786		16.4	-
OW16	93990	93057		23.6	-
IWdc1	138151	144025	10,700	132.7	
IWdc2	35469	122291	10,700	130.0	
IWdc3	111364	53406	10,700	133.1	
OW18	88706	164240		8.3	-
OW19	27591	72923		6.2	-
OW20	163091	66971		7.3	-
1	0	0		0.4	-
2	0	0		0.4	-
3	0	0		0.4	-
Maximum				137.4	

Total Amount of Water 69,028 acre-ft/yr 42,800 gpm 61.63 MGD





Well Production Changes with Time (all units are gpm)

Well Name	Days 365	730	1095	1460	1825	2190	2555
OW01	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0
CWdc	7782	8953	10123	11294	12465	13636	0
OW17	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0
IWdc1	7782	8953	10123	11294	12465	13636	0
IWdc2	7782	8953	10123	11294	12465	13636	0
IWdc3	7782	8953	10123	11294	12465	13636	0
OW18	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
Total	5750	5750	5750	3133	1093	1093	1093

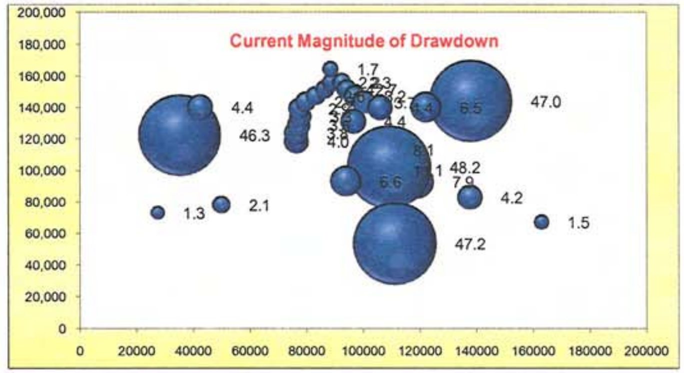
Proposed Project Pumping: 7 years

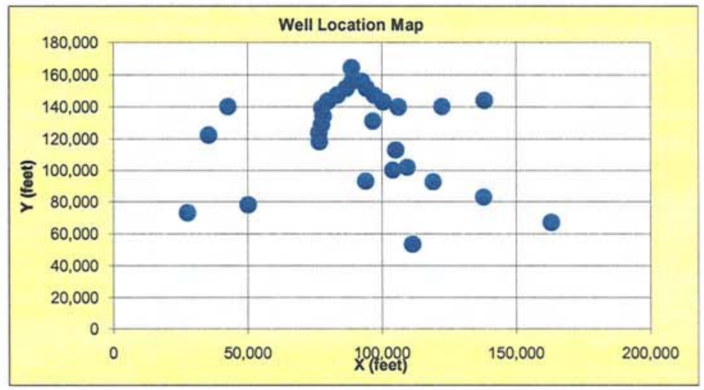
Transmissivity (T)	3,478	m^2/d	T: 37,433	ft^2/d	K: 124.8	ft/d	b: 300	b (ft)	Max contribution from adjacent well: 50% %
Storage Coefficient (S)	5.00E-02	unitless	280,000	gal/d/ft	933.33	$gal/d/ft^2$			
Time (t)	1460	Days							

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		4.0	-
OW02	76582	123564		3.8	-
OW03	77513	128854		3.6	-
OW04	78123	134152		3.3	-
OW05	77586	139175		2.9	-
OW06	79932	143615		2.7	-
OW07	83363	147349		2.6	-
OW08	86660	151487		2.4	-
OW09	88842	155752		2.2	-
OW10	92566	155866		2.3	-
OW11	94364	151469		2.7	-
OW12	97228	147233		3.2	-
OW13	100489	143155		3.7	-
OW14	106161	139900		4.4	-
OW15	50085	77990		2.1	-
WSdc1	105147	113006		8.1	-
WSdc2	104059	100068		11.1	-
WSdc3	119052	92612		7.9	-
CWdc	109389	101945	variable	48.2	
OW17	137873	82786		4.2	-
OW16	93990	93057		6.6	-
IWdc1	138151	144025	variable	47.0	
IWdc2	35469	122291	variable	46.3	
IWdc3	111364	53406	variable	47.2	
OW18	88706	164240		1.7	-
OW19	27591	72923		1.3	-
OW20	163091	66971		1.5	-
Cwuc	96645	131107		4.4	-
IWuc1	122403	140173		6.5	-
IWuc2	42646	140148		4.4	-
Maximum				48.2	

Total Amount of Water - acre-ft/yr 0 gpm 0.00 MGD





Well Production Changes with Time (all units are gpm)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days																		
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205	6570
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	0	0	191	191	5000	5000	5000	5000	0	0	0	0	0	0	0	0	0	0
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	0	0	191	191	5000	5000	5000	5000	0	0	0	0	0	0	0	0	0	0
IWdc2	0	0	191	191	5000	5000	5000	5000	0	0	0	0	0	0	0	0	0	0
IWdc3	0	0	191	191	5000	5000	5000	5000	0	0	0	0	0	0	0	0	0	0
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cwuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5750	5750	5750	3133	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

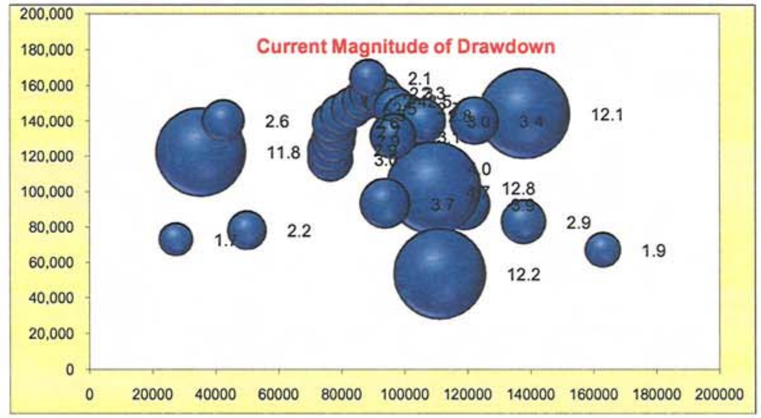
Proposed Project Pumping: 25 years

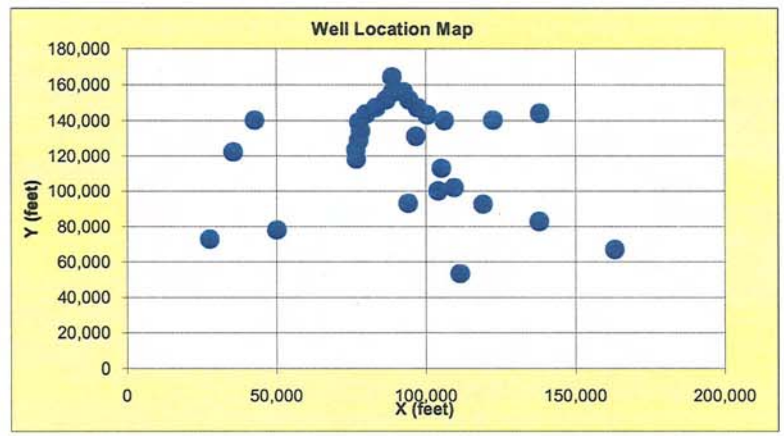
			T		K		b		Max contribution from adjacent well	
Transmissivity (T)	3,478	m^2/d	37,433	ft^2/d	124.8	ft/d	300	b (ft)	50%	%
Storage Coefficient (S)	5.00E-02	unitless	280,000	gal/d/ft	933.33	$gal/d/ft^2$				
Time (t)	7665	Days								

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		3.0	-
OW02	76582	123564		2.9	-
OW03	77513	128854		2.9	-
OW04	78123	134152		2.7	-
OW05	77586	139175		2.6	-
OW06	79932	143615		2.5	-
OW07	83363	147349		2.5	-
OW08	86660	151487		2.4	-
OW09	88842	155752		2.3	-
OW10	92566	155866		2.3	-
OW11	94364	151469		2.5	-
OW12	97228	147233		2.7	-
OW13	100489	143155		2.8	-
OW14	106161	139900		3.0	-
OW15	50085	77990		2.2	-
WSdc1	105147	113006		4.0	-
WSdc2	104059	100068		4.7	-
WSdc3	119052	92612		3.9	-
CWdc	109389	101945	variable	12.8	
OW17	137873	82786		2.9	-
OW16	93990	93057		3.7	-
IWdc1	138151	144025	variable	12.1	
IWdc2	35469	122291	variable	11.8	
IWdc3	111364	53406	variable	12.2	
OW18	88706	164240		2.1	-
OW19	27591	72923		1.7	-
OW20	163091	66971		1.9	-
Cwuc	96645	131107		3.1	-
IWuc1	122403	140173		3.4	-
IWuc2	42646	140148		2.6	-
Maximum				12.8	

Total Amount of Water - acre-ft/yr 0 gpm 0.00 MGD





Well Production Changes with Time (all units are gpm)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days																		
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205	6570
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc2	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc3	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cwuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5750	5750	5750	3133	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

Well Producti	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Years	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
							Days											
Well Name	6935	7300	7665	8030	8395	8760	9125	9490	9855	10220	10585	10950	11315	11680	12045	12410	12775	13140
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	1093	1093	1093	1093	1093	1093	1093	0	0	0	0	0	0	0	0	0	0	0
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	1093	1093	1093	1093	1093	1093	1093	0	0	0	0	0	0	0	0	0	0	0
IWdc2	1093	1093	1093	1093	1093	1093	1093	0	0	0	0	0	0	0	0	0	0	0
IWdc3	1093	1093	1093	1093	1093	1093	1093	0	0	0	0	0	0	0	0	0	0	0
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cwuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

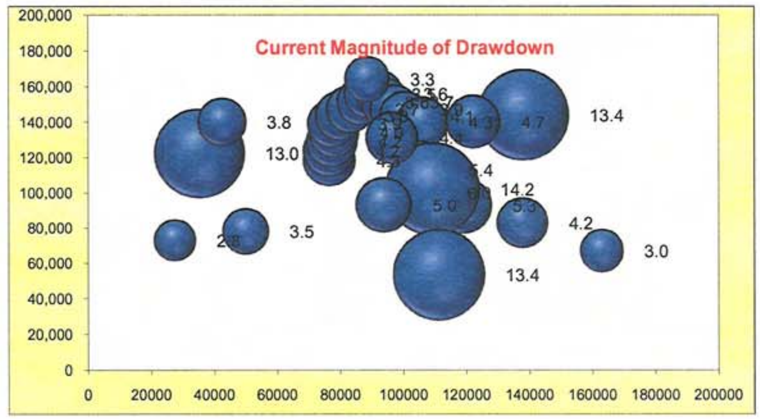
Proposed Project Pumping: 50 years

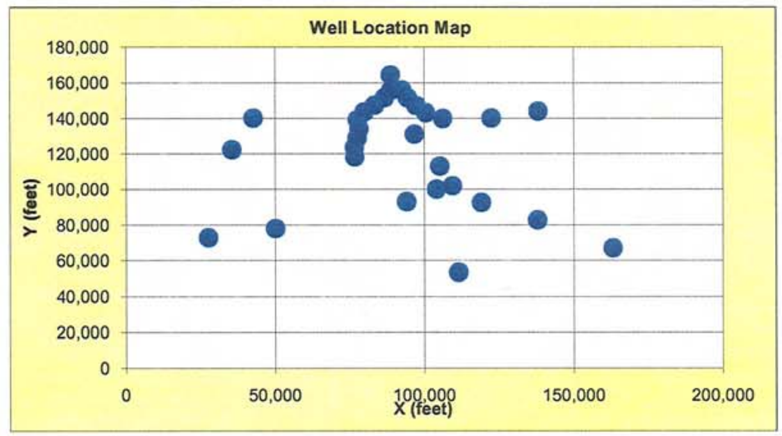
			T		K		b		Max contribution from adjacent well	
Transmissivity (T)	3,478	m^2/d	37,433	ft^2/d	124.8	ft/d	300	b (ft)	50%	%
Storage Coefficient (S)	5.00E-02	unitless	280,000	gal/d/ft	933.33	$gal/d/ft^2$				
Time (t)	18615	Days								

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		4.3	-
OW02	76582	123564		4.2	-
OW03	77513	128854		4.2	-
OW04	78123	134152		4.0	-
OW05	77586	139175		3.9	-
OW06	79932	143615		3.8	-
OW07	83363	147349		3.7	-
OW08	86660	151487		3.6	-
OW09	88842	155752		3.5	-
OW10	92566	155866		3.6	-
OW11	94364	151469		3.7	-
OW12	97228	147233		3.9	-
OW13	100489	143155		4.1	-
OW14	106161	139900		4.3	-
OW15	50085	77990		3.5	-
WSdc1	105147	113006		5.4	-
WSdc2	104059	100068		6.0	-
WSdc3	119052	92612		5.3	-
CWdc	109389	101945	variable	14.2	
OW17	137873	82786		4.2	-
OW16	93990	93057		5.0	-
IWdc1	138151	144025	variable	13.4	
IWdc2	35469	122291	variable	13.0	
IWdc3	111364	53406	variable	13.4	
OW18	88706	164240		3.3	-
OW19	27591	72923		2.8	-
OW20	163091	66971		3.0	-
Cwuc	96645	131107		4.4	-
IWuc1	122403	140173		4.7	-
IWuc2	42646	140148		3.8	-
Maximum				14.2	

Total Amount of Water	-	acre-ft/yr	0 gpm	0.00 MGD





Well Production Changes with Time (all units are gpm)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days																		
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205	6570
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc2	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc3	0	0	191	191	5000	5000	5000	5000	1666	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cwuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5750	5750	5750	3133	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

Well Producti

	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Years	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
								Days										
Well Name	6935	7300	7665	8030	8395	8760	9125	9490	9855	10220	10585	10950	11315	11680	12045	12410	12775	13140
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc2	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc3	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cwuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
Well Producti															
Years	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Well Name	13505	13870	14235	14600	14965	15330	15695	16060	16425	16790	17155	17520	17885	18250	18615
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc2	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
IWdc3	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cwuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093	1093

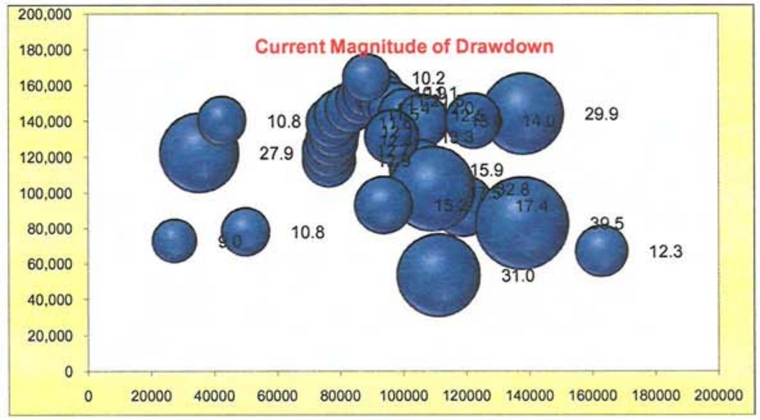
Proposed Pumping: 89-Yrs Existing Ag. and Dom.

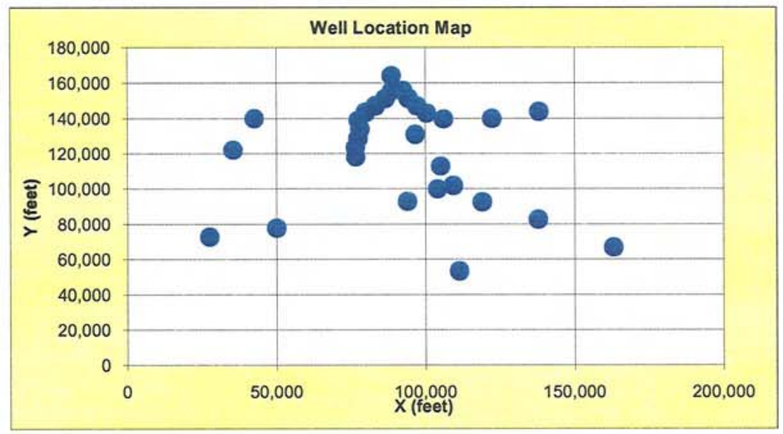
			T		K		b		Max contribution from adjacent well	
Transmissivity (T)	3,478	m^2/d	37,433	ft^2/d	124.8	ft/d	300	b (ft)	10%	%
Storage Coefficient (S)	5.00E-02	unitless	280,000	gal/d/ft	933.33	$gal/d/ft^2$				
Time (t)	32850	Days								

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		12.9	-
OW02	76582	123564		12.7	-
OW03	77513	128854		12.4	-
OW04	78123	134152		12.1	-
OW05	77586	139175		11.8	-
OW06	79932	143615		11.5	-
OW07	83363	147349		11.4	-
OW08	86660	151487		11.2	-
OW09	88842	155752		10.9	-
OW10	92566	155866		11.1	-
OW11	94364	151469		11.5	-
OW12	97228	147233		12.0	-
OW13	100489	143155		12.5	-
OW14	106161	139900		13.0	-
OW15	50085	77990		10.8	-
WSdc1	105147	113006		15.9	-
WSdc2	104059	100068		17.5	-
WSdc3	119052	92612		17.4	-
CWdc	109389	101945	variable	32.8	
OW17	137873	82786	variable	39.5	
OW16	93990	93057		15.2	-
IWdc1	138151	144025	variable	29.9	
IWdc2	35469	122291	variable	27.9	
IWdc3	111364	53406	variable	31.0	
OW18	88706	164240		10.2	-
OW19	27591	72923		9.0	-
OW20	163091	66971		12.3	-
CWuc	96645	131107		13.3	-
IWuc1	122403	140173		14.0	-
IWuc2	42646	140148		10.8	-
Maximum				39.5	

Total Amount of Water	-	acre-ft/yr	0 gpm	0.00 MGD





Well Production Changes with Time (all units are gpm)

No. of Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	Days																	
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205	6570
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917	1927
OW17	0	0	0	0	0	0	0	0	0	0	0	0	110	220	330	440	506.4444	572.8889
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917	1927
IWdc2	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917	1927
IWdc3	7777	8947	10117	11288	12457	13628	12094	10560	9026	7492	5958	4424	3794.75	3165.5	2536.25	1907	1917	1927
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	31108	35788	40468	45152	49828	54512	48376	42240	36104	29968	23832	17696	15289	12882	10475	8068	8174	8281

Well Producti

No. of Years	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Days											Project Start						
Well Name	6935	7300	7665	8030	8395	8760	9125	9490	9855	10220	10585	10950	11315	11680	12045	12410	12775	13140
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	1937	1947	1957	1967	1977	1987	1997	2010	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW17	639.3333	705.7778	772.2222	838.6667	905.1111	971.5556	1038	1940.5	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	1937	1947	1957	1967	1977	1987	1997	2010	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc2	1937	1947	1957	1967	1977	1987	1997	2010	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc3	1937	1947	1957	1967	1977	1987	1997	2010	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	8387	8494	8600	8707	8813	8920	9026	9981	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935

Well Producti

No. of Years	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
	Days																	
Well Name	13505	13870	14235	14600	14965	15330	15695	16060	16425	16790	17155	17520	17885	18250	18615	18980	19345	19710
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW17	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc2	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc3	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935

Well Producti

No. of Years	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Year	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
	Days																	
Well Name	20075	20440	20805	21170	21535	21900	22265	22630	22995	23360	23725	24090	24455	24820	25185	25550	25915	26280
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW17	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc2	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc3	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935

Well Producti

No. of Years	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Year	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070
	Days							Project End										
Well Name	26645	27010	27375	27740	28105	28470	28835	29200	29565	29930	30295	30660	31025	31390	31755	32120	32485	32850
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW17	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843	2843
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc2	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
IWdc3	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWuc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWuc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935	10935

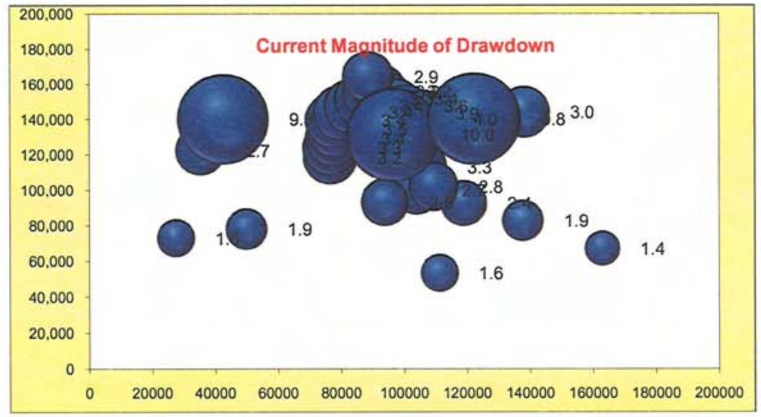
Proposed Pumping: 30-Yrs Solar and 50-Yrs Landfill

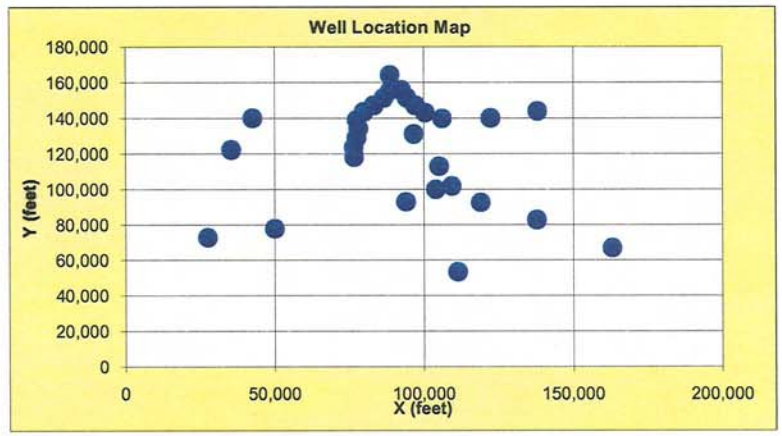
			T		K		b		Max contribution from adjacent well	
Transmissivity (T)	3,478	m^2/d	37,433	ft^2/d	124.8	ft/d	300	b (ft)	10%	%
Storage Coefficient (S)	5.00E-02	unitless	280,000	gal/d/ft	933.33	$gal/d/ft^2$				
Time (t)	22265	Days								

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		3.2	-
OW02	76582	123564		3.3	-
OW03	77513	128854		3.4	-
OW04	78123	134152		3.5	-
OW05	77586	139175		3.4	-
OW06	79932	143615		3.4	-
OW07	83363	147349		3.4	-
OW08	86660	151487		3.3	-
OW09	88842	155752		3.2	-
OW10	92566	155866		3.2	-
OW11	94364	151469		3.4	-
OW12	97228	147233		3.6	-
OW13	100489	143155		3.9	-
OW14	106161	139900		4.0	-
OW15	50085	77990		1.9	-
WSdc1	105147	113006		3.3	-
WSdc2	104059	100068		2.7	-
WSdc3	119052	92612		2.4	-
CWdc	109389	101945	175	2.8	
OW17	137873	82786	225	1.9	
OW16	93990	93057		2.5	-
IWdc1	138151	144025	175	3.0	
IWdc2	35469	122291	175	2.7	
IWdc3	111364	53406	175	1.6	
OW18	88706	164240		2.9	-
OW19	27591	72923		1.6	-
OW20	163091	66971		1.4	-
CWuc	96645	131107	515	10.0	
IWuc1	122403	140173	515	9.8	
IWuc2	42646	140148	515	9.3	
Maximum				10.0	

Total Amount of Water: 3,984 acre-ft/yr; 2,470 gpm; 3.56 MGD





Well Production Changes with Time (all units are gpm)

No. of Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
	Days																			
Well Name	365	730	1095	1460	1825	2190	2555	2920	3285	3650	4015	4380	4745	5110	5475	5840	6205	6570	6935	7300
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	7	14	20	27	30	703	1130	1123	748	513	513	513	513	513	513	513	513	513	513	513
OW17	0	0	0	0	322	322	322	186	186	186	186	186	186	186	186	186	186	186	186	186
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	7	14	20	27	30	703	1130	1123	748	513	513	513	513	513	513	513	513	513	513	513
IWdc2	7	14	20	27	30	703	1130	1123	748	513	513	513	513	513	513	513	513	513	513	513
IWdc3	7	14	20	27	30	703	1130	1123	748	513	513	513	513	513	513	513	513	513	513	513
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	6	6	3	507	759	759	1274	1974	1974	1974	1505	1505	1505	1505	1505	1505	1505	1505	1505	1505
CWuc	0	0	12	26	26	30	34	34	34	34	293	256	256	256	256	368	368	368	368	368
IWuc1	0	0	12	26	26	30	34	34	34	34	293	256	256	256	256	368	368	368	368	368
IWuc2	0	0	12	26	26	30	34	34	34	34	293	256	256	256	256	368	368	368	368	368
Total	33	63	122	694	1278	3982	6219	6756	5254	4315	4622	4511	4511	4511	4511	4845	4845	4845	4845	4845

Existing Well Pumping						
Project Pumping	5000	5000	5000	5000	1476	1093
Solar	175	175	175	175	175	175

Well Producti

No. of Years	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
								Days												
Well Name	7665	8030	8395	8760	9125	9490	9855	10220	10585	10950	11315	11680	12045	12410	12775	13140	13505	13870	14235	14600
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	513	513	513	513	513	513	513	513	513	513	513	488	485	485	485	188	2	2	2	2
OW17	186	186	186	186	186	186	186	186	186	186	186	186	186	186	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	513	513	513	513	513	513	513	513	513	513	513	488	485	485	485	188	2	2	2	2
IWdc2	513	513	513	513	513	513	513	513	513	513	513	488	485	485	485	188	2	2	2	2
IWdc3	513	513	513	513	513	513	513	513	513	513	513	488	485	485	485	188	2	2	2	2
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	1505	1505	1505	1505	1505	1505	1505	1505	1505	1505	1502	1502	1502	483	372	372	372	0	0	0
CWuc	501	501	501	501	501	651	651	651	651	651	651	651	635	617	617	770	770	770	770	770
IWuc1	501	501	501	501	501	651	651	651	651	651	651	651	635	617	617	770	770	770	770	770
IWuc2	501	501	501	501	501	651	651	651	651	651	651	651	635	617	617	770	770	770	770	770
Total	5247	5247	5247	5247	5247	5697	5697	5697	5697	5697	5694	5595	5533	4461	4163	3433	2689	2318	2318	2318

Well Producti

No. of Years	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Year	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063
Well Name	14965	15330	15695	16060	16425	16790	17155	17520	17885	18250	18615	18980	19345	19710
OW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWdc	2	2	2	2	2	2	2	2	2	2	2	2	2	2
OW17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IWdc1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
IWdc2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
IWdc3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
OW18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWuc	770	770	770	770	770	770	770	770	770	770	770	770	770	770
IWuc1	770	770	770	770	770	770	770	770	770	770	770	770	770	770
IWuc2	770	770	770	770	770	770	770	770	770	770	770	770	770	770
Total	2318	2318	2318	2318	2318	2318	2318	2318	2318	2318	2318	2318	2318	2318

Well Producti

No. of Years	55	56	57	58	59	60	61
Year	2064	2065	2066	2067	2068	2069	2070
			Days				
Well Name	20075	20440	20805	21170	21535	21900	22265
OW01	0	0	0	0	0	0	0
OW02	0	0	0	0	0	0	0
OW03	0	0	0	0	0	0	0
OW04	0	0	0	0	0	0	0
OW05	0	0	0	0	0	0	0
OW06	0	0	0	0	0	0	0
OW07	0	0	0	0	0	0	0
OW08	0	0	0	0	0	0	0
OW09	0	0	0	0	0	0	0
OW10	0	0	0	0	0	0	0
OW11	0	0	0	0	0	0	0
OW12	0	0	0	0	0	0	0
OW13	0	0	0	0	0	0	0
OW14	0	0	0	0	0	0	0
OW15	0	0	0	0	0	0	0
WSdc1	0	0	0	0	0	0	0
WSdc2	0	0	0	0	0	0	0
WSdc3	0	0	0	0	0	0	0
CWdc	2	2	2	2	2	2	2
OW17	0	0	0	0	0	0	0
OW16	0	0	0	0	0	0	0
IWdc1	2	2	2	2	2	2	2
IWdc2	2	2	2	2	2	2	2
IWdc3	2	2	2	2	2	2	2
OW18	0	0	0	0	0	0	0
OW19	0	0	0	0	0	0	0
OW20	0	0	0	0	0	0	0
CWuc	770	770	770	770	770	770	770
IWuc1	770	770	770	770	770	770	770
IWuc2	770	770	770	770	770	770	770
Total	2318	2318	2318	2318	2318	2318	2318

Attachment C

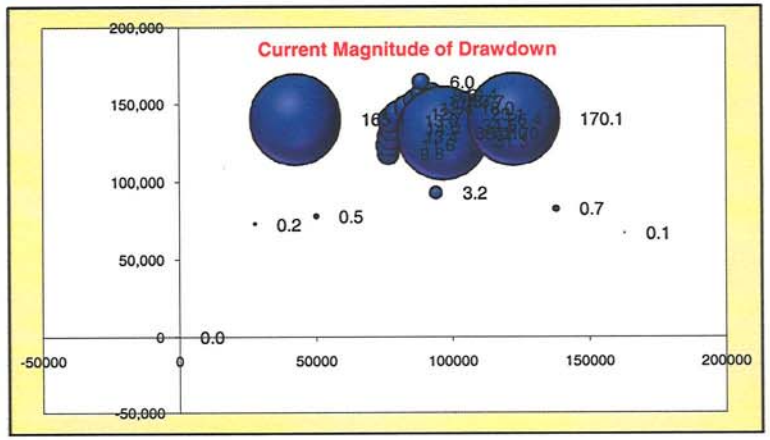
Kaiser Pumping 17 Years @ K=25 ft/day

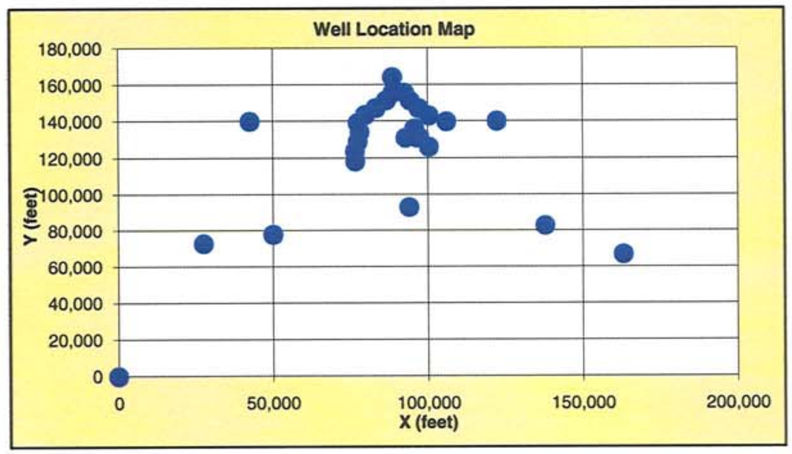
			T		K		b		Max contribution from adjacent well	
Transmissivity (T)	348	m^2/d	3,743	ft^2/d	25.0	ft/d	150	b (ft)	50%	%
Storage Coefficient (S)	5.00E-02	unitless	28,000	gal/d/ft	186.67	$gal/d/ft^2$				
Time (t)	6205	Days								

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		9.8	-
OW02	76582	123564		11.6	-
OW03	77513	128854		13.4	-
OW04	78123	134152		14.0	-
OW05	77586	139175		13.0	-
OW06	79932	143615		12.7	-
OW07	83363	147349		12.4	-
OW08	86660	151487		11.3	-
OW09	88842	155752		9.6	-
OW10	92566	155866		10.4	-
OW11	94364	151469		13.7	-
OW12	97228	147233		18.0	-
OW13	100489	143155		23.1	-
OW14	106161	139900		26.4	-
OW15	50085	77990		0.5	-
CW1	92912	130967		38.0	-
CW2	95770	136110		34.5	-
CW3	97472	131206		62.0	-
CW4	100476	126092		31.3	-
CWuc	96645	131107	variable	170.7	Dry
OW17	137873	82786		0.7	-
OW16	93990	93057		3.2	-
IWuc1	122403	140173	variable	170.1	Dry
IWuc2	42646	140148	variable	165.4	Dry
OW18	88706	164240		6.0	-
OW19	27591	72923		0.2	-
OW20	163091	66971		0.1	-
1	0	0		0.0	-
2	0	0		0.0	-
3	0	0		0.0	-
Maximum				170.7	

Total Amount of Water - acre-ft/yr 0 gpm 0.00 MGD





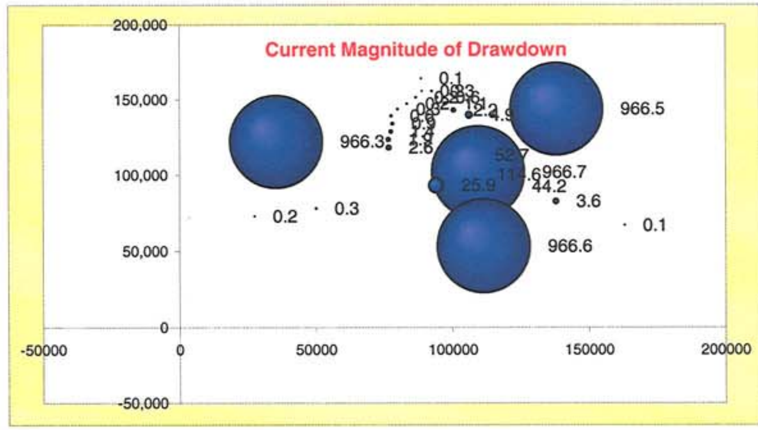
Proposed Pumping: Aq 6 years @ 25 ft/day

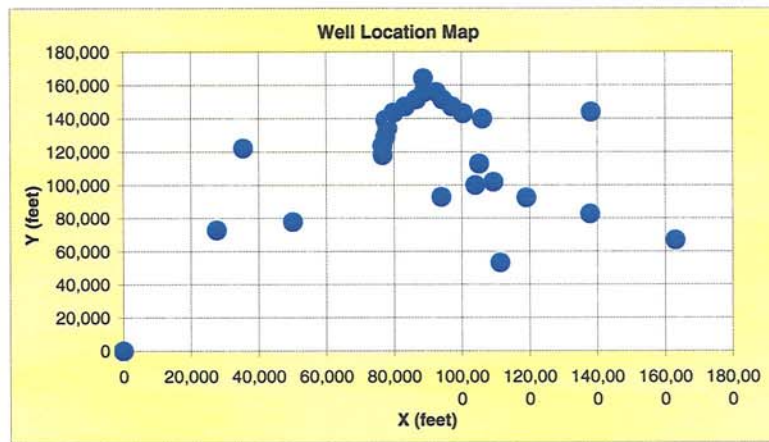
Transmissivity (T)	323	m^2/d	T: 3,476	ft^2/d	K: 24.8	ft/d	b: 140 b (ft)
Storage Coefficient (S)	5.00E-02	unitless	26,000	gal/d/ft	185.71	$gal/d/ft^2$	Max contribution from adjacent well: 10% %
Time (t)	2190	Days					

Press to update data

Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		2.6	-
OW02	76582	123564		1.9	-
OW03	77513	128854		1.4	-
OW04	78123	134152		0.9	-
OW05	77586	139175		0.6	-
OW06	79932	143615		0.3	-
OW07	83363	147349		0.2	-
OW08	86660	151487		0.2	-
OW09	88842	155752		0.2	-
OW10	92566	155866		0.3	-
OW11	94364	151469		0.6	-
OW12	97228	147233		1.1	-
OW13	100489	143155		2.2	-
OW14	106161	139900		4.9	-
OW15	50085	77990		0.3	-
WS1dc	105147	113006		52.7	-
WS2dc	104059	100068		114.6	-
WS3dc	119052	92612		44.2	-
CWdc	109389	101945	10,700	966.7	Dry
OW17	137873	82786		3.6	-
OW16	93990	93057		25.9	-
IW1dc	138151	144025	10,700	966.5	Dry
IW2dc	35469	122291	10,700	966.3	Dry
IW3dc	111364	53406	10,700	966.6	Dry
OW18	88706	164240		0.1	-
OW19	27591	72923		0.2	-
OW20	163091	66971		0.1	-
1	0	0		0.0	-
2	0	0		0.0	-
3	0	0		0.0	-
Maximum				966.7	

Total Amount of Water 69,028 acre-ft/yr 42,800 gpm 61.63 MGD





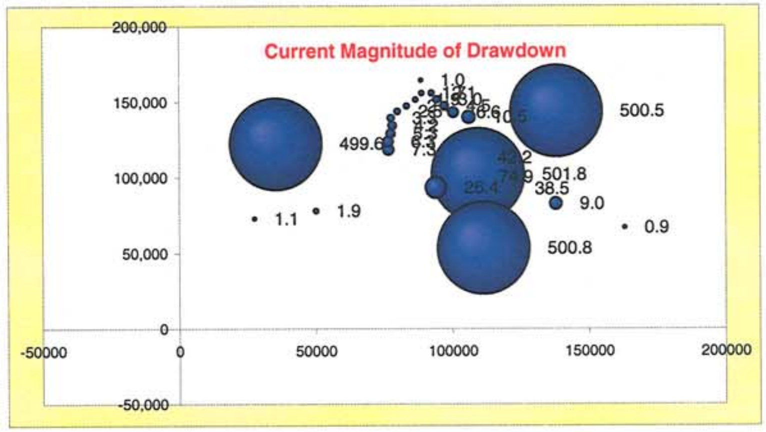
Proposed Pumping: Ag 6 years @ 50 ft/day

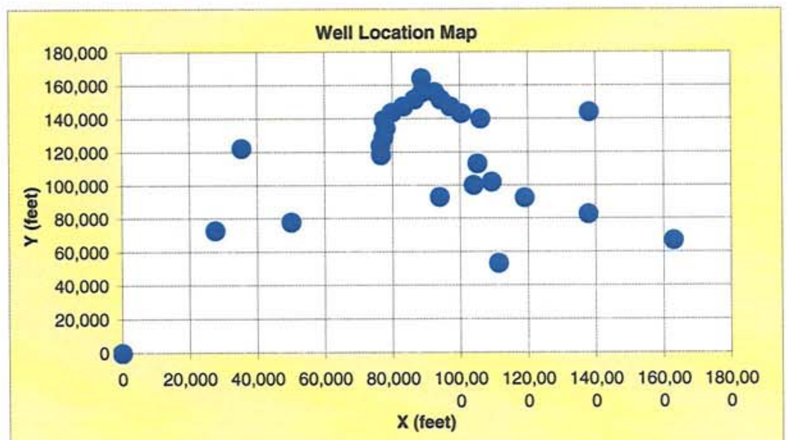
			T		K		b		Max contribution from adjacent well	
Transmissivity (T)	646	m²/d	6,952	ft²/d	49.7	ft/d	140	b (ft)	10%	%
Storage Coefficient (S)	5.00E-02	unitless	52,000	gal/d/ft	371.43	gal/d/ft²				
Time (t)	2190	Days								

Press to update data

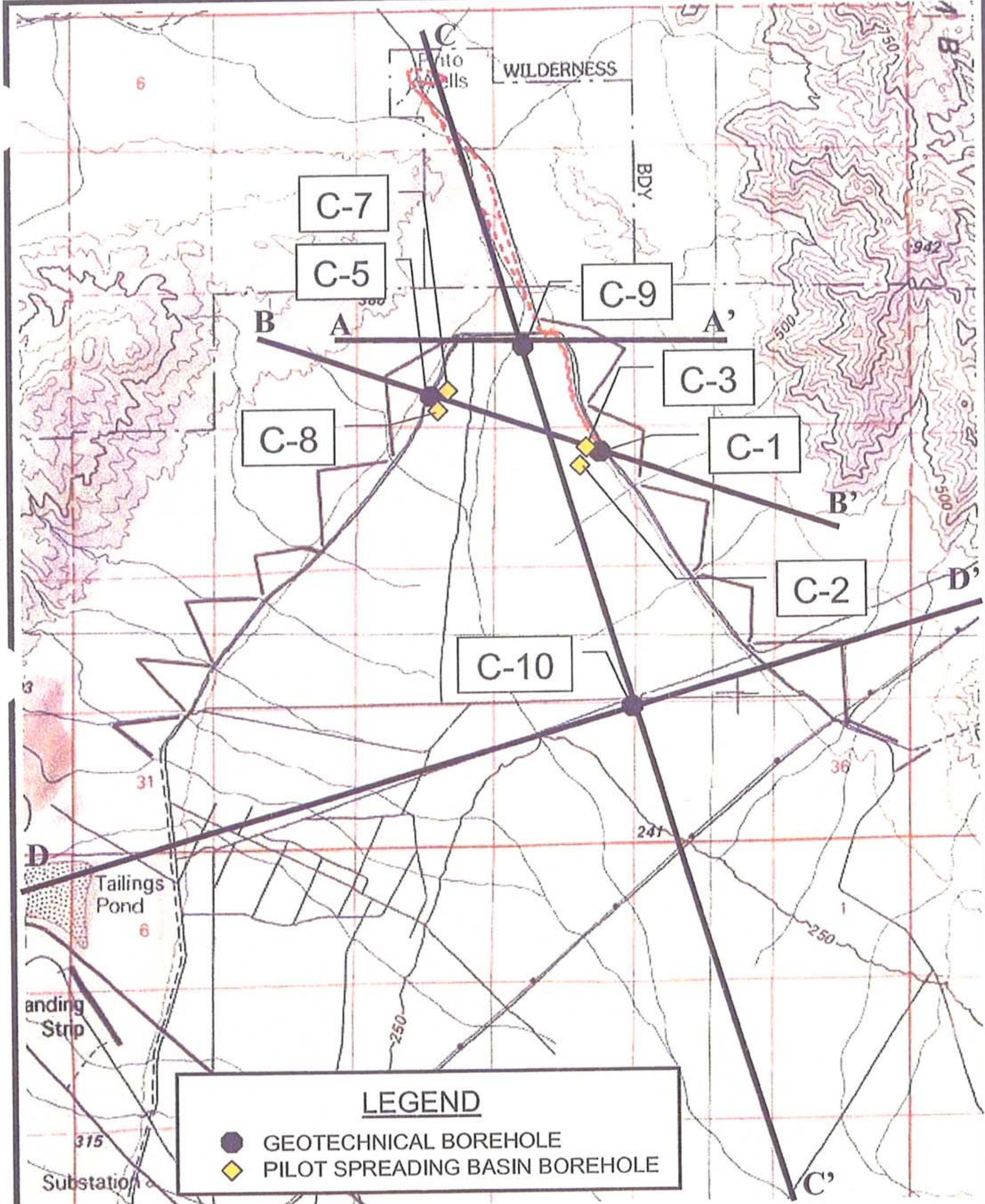
Well Name	X (feet)	Y (feet)	Flow Rate (Q, gpm)	Drawdown (ft)	Comments
OW01	76693	118214		7.3	-
OW02	76582	123564		6.3	-
OW03	77513	128854		5.3	-
OW04	78123	134152		4.2	-
OW05	77586	139175		3.3	-
OW06	79932	143615		2.5	-
OW07	83363	147349		2.1	-
OW08	86660	151487		1.9	-
OW09	88842	155752		1.7	-
OW10	92566	155866		2.1	-
OW11	94364	151469		3.0	-
OW12	97228	147233		4.5	-
OW13	100489	143155		6.6	-
OW14	106161	139900		10.5	-
OW15	50085	77990		1.9	-
WS1dc	105147	113006		42.2	-
WS2dc	104059	100068		74.9	-
WS3dc	119052	92612		38.5	-
CWdc	109389	101945	10,700	501.8	Dry
OW17	137873	82786		9.0	-
OW16	93990	93057		26.4	-
IW1dc	138151	144025	10,700	500.5	Dry
IW2dc	35469	122291	10,700	499.6	Dry
IW3dc	111364	53406	10,700	500.8	Dry
OW18	88706	164240		1.0	-
OW19	27591	72923		1.1	-
OW20	163091	66971		0.9	-
1	0	0		0.0	-
2	0	0		0.0	-
3	0	0		0.0	-
Maximum				501.8	

Total Amount of Water	69,028 acre-ft/yr	42,800 gpm	61.63 MGD





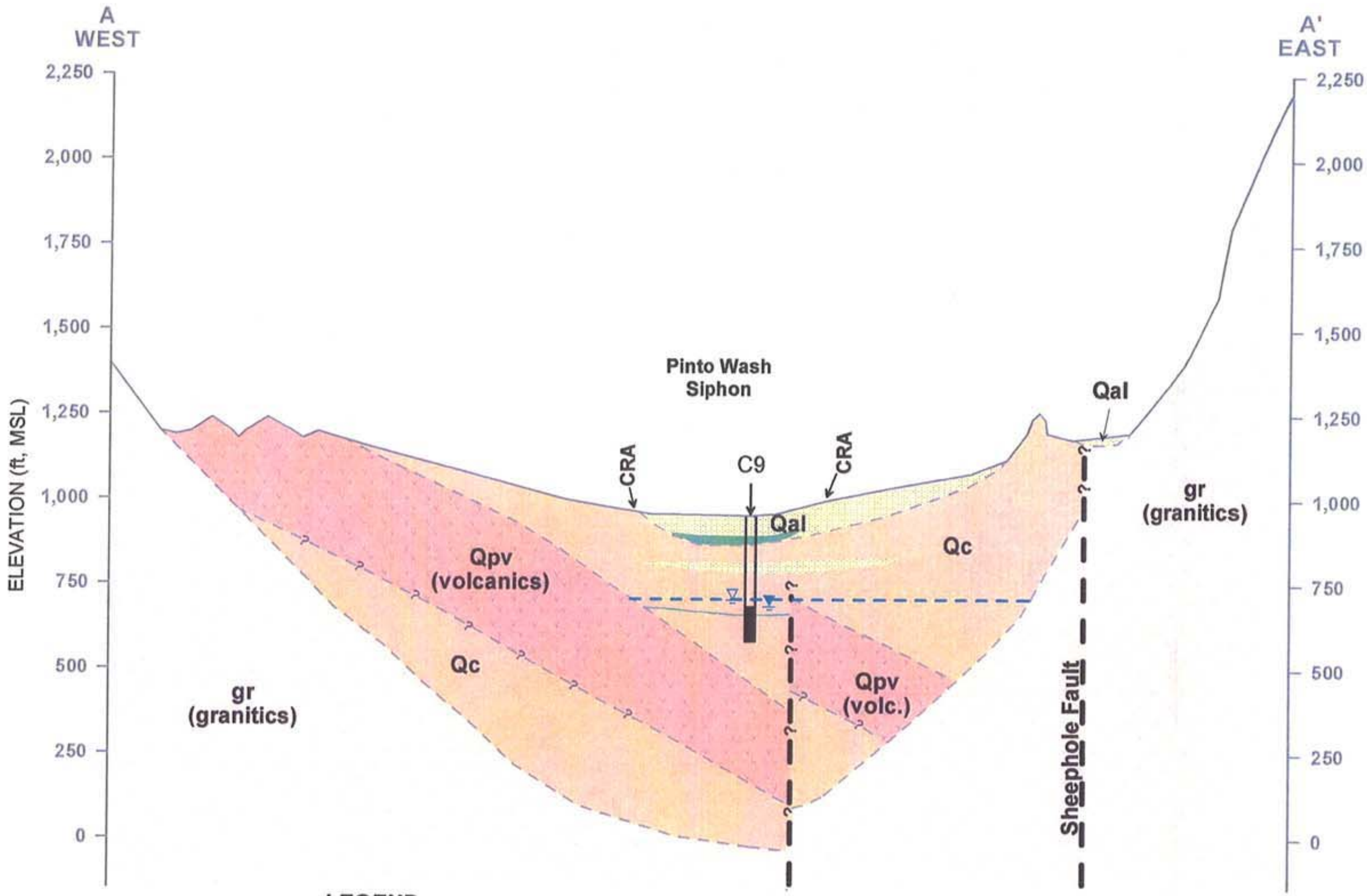
Attachment D



DRAFT

FIGURE D-1
LOCATION OF BOREHOLES

DRAFT



LEGEND

Geotechnical Boring

- Predominantly Sand and Silty Sand Deposits
- Sand with Gravel, Cobbles and Boulders
- Predominantly Clay Deposits
- Granitics
- Volcanics
- Water Level Observed during drilling
- Static Water Level Observed in Piezometers

GeoPentech

Groundwater Storage & Dry Year Supply Project Upper Chuckwalla Valley

Section A-A'

Proj. No. 00019A

Figure D-2

File: SecAA.grf

Pinto Basin Inflow to Chuckwalla Basin
Project Pumping Effects
19-Apr-09
R. Shatz

Pre 1950 - gradient

			Ground Surface El
Pinto	OW-18		1040 ft el.
Chuckwalla	OW-10		987 ft el.
	dh		53 ft
	dl		9,200
		i =	**0.00576 ft/ft**

Post 50 years of Pumping - gradient

		drawdown
	OW-18	3.4
	OW-10	3.7
Pinto	OW-18	1,036.6 ft el.
Chuckwalla	OW-10	983.3 ft el.
	dh	53.3 ft
	dl	9,200
	i =	**0.00579 ft/ft**

Area — **From Geopentec A-A' (above basalt)**

	west of fault	east of fault
width	1,015	1,353 ft
height	319	229 ft
	323,815	309,424 sq ft
	Total Area	**633,239 sq ft**

From Geopentec A-A' after 50 years (reduce area by 4.9 feet) (above basalt)

	west of fault	east of fault	
width	1,015	1,353 ft	
height	316	225 ft	reduced by 3.8 feet
	320,366	304,824 sq ft	
	Total Area	**625,190 sq ft**	

Hydraulic Conductivity (K) **50 ft/day**

		Pre 1950	After 50 years
Q=KiA		182,400 cu ft/day	181,101 cu ft/day
		4 AF/day	4 AF/day
		1,528 AFY	**1,517 AFY**
From Pinto Basin (above basalt)	increased/decrease outflow		**-11 AFY**
			-0.00712

Area — **From Geopentec A-A' (below basalt)**

	west of fault	east of fault
width	5,411	1,420 ft
height	213	149 ft
	1,151,343	211,559 sq ft
	Total Area	1,362,903 sq ft

From Geopentec A-A' after 50 years (below basalt)

	west of fault	east of fault	
width	5,411	1,420 ft	
height	209	146 ft	reduced by 3.8 feet
	1,132,945	206,730 sq ft	
	Total Area	1,339,675 sq ft	

K **25 ft/day**

		Pre 1950	50 year
Q=KiA		196,288 cu ft/day	194,034 cu ft/day
		5 AF/day	4 AF/day
		1,645 AFY	**1,626 AFY**
From Pinto Basin (below basalt)	increased/decrease outflow		**-19 AFY**
			-0.01148

Total Inflow from Pinto Basin	**3,173 AFY**	**3,143 AFY**

Pinto Basin Inflow to Chuckwalla Basin
Cumulative Pumping Effects
19-Apr-09
R. Shatz

Pre 1950 - gradient

		Ground Surface El	
Pinto	OW-18	1040	ft el.
Chuckwalla	OW-10	987	ft el.
	dh	53	ft
	dl	9,200	
	i =	**0.00576**	**ft/ft**

Post 50 years of Pumping - gradient

		drawdown	
	OW-18	9.5	
	OW-10	10.1	
Pinto	OW-18	1,030.5	ft el.
Chuckwalla	OW-10	976.9	ft el.
	dh	53.6	ft
	dl	9,200	
	i =	**0.00583**	**ft/ft**

Area — From Geopentec A-A' (above basalt)

	west of fault	east of fault	
width	1,015	1,353	ft
height	319	229	ft
	323,815	309,424	sq ft
Total Area		**633,239**	**sq ft**

From Geopentec A-A' after 50 years (reduce area by 4.9 feet) (above basalt)

	west of fault	east of fault		
width	1,015	1,353	ft	
height	310	219	ft	reduced by 11 feet
	314,176	296,572	sq ft	
Total Area		**610,748**	**sq ft**	

Hydraulic Conductivity (K) **50 ft/day**

	Pre 1950		After 50 years	
Q=KiA	182,400	cu ft/day	177,914	cu ft/day
	4	AF/day	4	AF/day
	1,528	**AFY**	**1,491**	**AFY**
From Pinto Basin (above basalt)	increased/decrease outflow		**-38**	**AFY**
			-0.0246	

Area — From Geopentec A-A' (below basalt)

	west of fault	east of fault	
width	5,411	1,420	ft
height	213	149	ft
	1,151,343	211,559	sq ft
Total Area		1,362,903	sq ft

From Geopentec A-A' after 50 years (below basalt)

	west of fault	east of fault		
width	5,411	1,420	ft	
height	203	139	ft	reduced by 11 feet
	1,099,936	198,065	sq ft	
Total Area		1,298,001	sq ft	

K **25 ft/day**

	Pre 1950		50 year	
Q=KiA	196,288	cu ft/day	189,057	cu ft/day
	5	AF/day	4	AF/day
	1,645	**AFY**	**1,584**	**AFY**
From Pinto Basin (below basalt)	increased/decrease outflow		**-61**	**AFY**
			-0.03684	

Total Inflow from Pinto Basin **3,173 AFY** **3,075 AFY**

Attachment E

Eagle Mountain Pumped Storage Project – Lake Tamarisk Water Use Estimates

Prepared by: David Fairman, Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

October 6, 2009

GEI Consultants, Inc. (GEI) prepared this data transmittal to present estimates of the water use at the Lake Tamarisk development.

In the Final License Application (FLA), a value of 1,200 acre-feet per year (AFY) was used in water balance calculations for the Lake Tamarisk development also known as County Service Area 51. This was based on personal communication with the plant operator who quoted a 2007 value. Since that time, recordation data has been obtained from the State Water Resources Control Board and is attached to this transmittal. Table 1 shows a summary of this data. Measurements from 2005 appear to be incomplete and possibly unreported. Therefore, the average value does not include 2005. For water balance calculations, a value of 1,090 will be used.

References

GEI Consultants, Inc. (2009). Final License Application submitted to the Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

Table 1
Acre-Feet of Groundwater Extracted at Lake Tamarisk

Riverside Co Service Area 51

Well	14E	14G	14D	AF
2003		250	1090	1340
2004		200	990	1190
2005	0			0
2006		210	990	1200
2007		200	1000	1200
2008		210	320	530

Average (excluding 2005) 1092

Groundwater Information Request

GW NUMBER *PRIMARY OWNER*
G331518 **CHUCKWALLA VALLEY MUTUAL WATER COMPANY**

STATE WELL NUMBER:	STATUS:	PARCEL NUMBER:	COUNTY	ANNUAL EXT (AF):	FILE DATE:
05S/15E-01E01 S	ACTIVE		RIVERSIDE		4/25/1985

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G331518			2005		8/14/2006	A	
G331518	0		2006	Y	6/19/2007	A	RECORD
G331518	0		2007	Y	6/13/2008	A	RECORD

GW NUMBER *PRIMARY OWNER*
G331606 **RIVERSIDE CO SERVICE AREA NO 51**

STATE WELL NUMBER:	STATUS:	PARCEL NUMBER:	COUNTY	ANNUAL EXT (AF):	FILE DATE:
05S/15E-14E S	ACTIVE		RIVERSIDE		5/17/1984

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G331606			2004	$0.00	5/27/2005		
G331606			2005		9/12/2006	A	
G331606	0		2006	N	6/28/2007	A	DO NOT RECORD
G331606			2007	N	7/22/2008	A	DO NOT RECORD
G331606			2008	N	7/1/2009	A	DO NOT RECORD

GW NUMBER *PRIMARY OWNER*
G331704 **RIVERSIDE CO SERVICE AREA NO 51**

STATE WELL NUMBER:	STATUS:	PARCEL NUMBER:	COUNTY	ANNUAL EXT (AF):	FILE DATE:
05S/15E-14G S	ACTIVE		RIVERSIDE		5/17/1984

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G331704	250		2003	$115.00	6/18/2004		
G331704	200		2004	$115.00	6/13/2005		
G331704			2005			A	
G331704	210		2006	Y	6/28/2007	A	RECORD
G331704	200		2007	Y	7/22/2008	A	RECORD
G331704	210		2008	Y	7/1/2009	A	RECORD

GW NUMBER **PRIMARY OWNER**
G331806 **KAISER EAGLE MOUNTAIN LLC**

STATE WELL NUMBER:	STATUS:	PARCEL NUMBER:	COUNTY	ANNUAL EXT (AF):	FILE DATE:
04S/15E-02D S	ACTIVE		RIVERSIDE		7/10/1984

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G331806	0		2003	$115.00	6/14/2004		
G331806	0.132		2004	$115.00	5/11/2005		
G331806			2005		8/21/2006	A	
G331806	0		2006	Y	6/11/2007	A	RECORD
G331806	0		2007	Y	6/11/2008	A	RECORD
G331806	0		2008	Y	5/15/2009	A	RECORD

GW NUMBER **PRIMARY OWNER**
G331807 **KAISER EAGLE MOUNTAIN LLC**

STATE WELL NUMBER:	STATUS:	PARCEL NUMBER:	COUNTY	ANNUAL EXT (AF):	FILE DATE:
04S/15E-11C S	ACTIVE		RIVERSIDE		7/10/1984

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G331807	4.51		2003	$115.00	6/14/2004		
G331807	5		2004	$115.00	5/11/2005		
G331807			2005		8/21/2006	A	
G331807	95.31		2006	Y	6/11/2007	A	RECORD
G331807	1.6		2007	Y	6/11/2008	A	RECORD
G331807	1.34		2008	Y	5/15/2009	A	RECORD

GW NUMBER **PRIMARY OWNER**
G331986 **RIVERSIDE CO SERVICE AREA NO 51**

STATE WELL NUMBER:	STATUS:	PARCEL NUMBER:	COUNTY	ANNUAL EXT (AF):	FILE DATE:
06S/15E-14D S	ACTIVE		RIVERSIDE		5/17/1984

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G331986	1090		2003	$115.00	6/18/2004		
G331986	990		2004	$115.00	6/13/2005		
G331986			2005		9/12/2006	A	
G331986	990		2006	Y	6/28/2007	A	RECORD
G331986	1000		2007	Y	7/22/2008	A	RECORD
G331986	320		2008	Y	7/1/2009	A	RECORD

GW NUMBER ***PRIMARY OWNER***
G332251 **KAISER EAGLE MOUNTAIN LLC**

STATE WELL NUMBER:	*STATUS:*	*PARCEL NUMBER:*	*COUNTY*	*ANNUAL EXT (AF):*	*FILE DATE:*
04S/15E-11WR S	ACTIVE		RIVERSIDE		7/10/1984

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G332251	470.78		2003	$115.00	6/14/2004		
G332251	137		2004	$115.00	5/11/2005		
G332251	8.38		2006	Y	6/11/2007	A	RECORD
G332251	97.78		2007	Y	6/11/2008	A	RECORD
G332251	76.76		2008	Y	5/15/2009	A	RECORD

GW NUMBER ***PRIMARY OWNER***
G332408 **CHUCKWALLA VALLEY MUTUAL WATER COMPANY**

STATE WELL NUMBER:	*STATUS:*	*PARCEL NUMBER:*	*COUNTY*	*ANNUAL EXT (AF):*	*FILE DATE:*
05S/16E-06N01 S	ACTIVE		RIVERSIDE		4/1/1984

Annual Notices

GW NUMBER	GW EXTRACTED	SW EXTRACTED	YEAR REPORTED	AMT PAID	DATE REC'D	STATUS	REQ ACTION
G332408	0		2006	Y	6/19/2007	A	RECORD
G332408	0		2007	Y	6/13/2008	A	RECORD

Eagle Mountain Pumped Storage Project – Landfill Water Use Estimates

Prepared by: Richard Shatz [C.E.G. 1514], David Fairman, GEI Consultants, Inc.

October 6, 2009

GEI Consultants, Inc. (GEI), prepared this data transmittal to present estimates of the Eagle Mountain Landfill and Recycling Center (Landfill) water use. The Eagle Mountain Landfill and Recycling Center Project Final EIR/EIS, Vol. 1 states that 173 acre-feet per year (AFY) will be consumed by the town site while the landfill will use 1,070 AFY.

The EIR/EIS for the Landfill water use shows the water use will not be instantaneous but will be incrementally ramped up over time. The Landfill will use about 245 acre-feet of water for the initial 6-month construction window. During the first year of operations the water use will be 185 AFY and subsequent years the water use will gradually increase and will reach a maximum demand of 1,070 AFY when the rate of landfilling peaks at 20,000 tons per day in year 25 (CH2MHill, 1996).

Table 1 shows the construction and annual water use distributed over the water balance period. The annual water use is not linear but is stepped as the number of trains bringing trash to the Landfill increases, as projected in the EIR/EIS. The water use is projected over 50 years, the initial license period for the Landfill project. This distribution of Landfill water use will be used in the ECE water balance and cumulative drawdown estimates.

References

CH2MHill (1996). Draft Environmental Impact Statement/ Environmental Impact Report Eagle Mountain Landfill and Recycling Center Project. State Clearinghouse No. 95052023. Pages 2-19, 4.1-3 and 4.1-2.

GEI Consultants, Inc. (2009). Final License Application submitted to the Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

Table 1
Landfill Water Useage in Acre Feet

Year	Proposed Landfill Water Usage [2]
2008	0
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
2016	0
2017	0
2018	0
2019	0
2020	245
2021	185
2022	185
2023	185
2024	185
2025	365
2026	365
2027	365
2028	365
2029	365
2030	581
2031	581
2032	581
2033	581
2034	581
2035	823
2036	823
2037	823
2038	823
2039	823
2040	823
2041	823
2042	823
2043	823
2044	823
2045	1,070
2046	1,070

Year	Proposed Landfill Water Usage [2]
2047	1,070
2048	1,070
2049	1,070
2050	1,070
2051	1,070
2052	1,070
2053	1,070
2054	1,070
2055	1,070
2056	1,070
2057	1,070
2058	1,070
2059	1,070
2060	1,070
2061	1,070
2062	1,070
2063	1,070
2064	1,070
2065	1,070
2066	1,070
2067	1,070
2068	1,070
2069	1,070
2070	1,070

Eagle Mountain Pumped Storage Project – Project Construction Water Use Estimates

Prepared by: David Fairman, Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

October 6, 2009

GEI Consultants, Inc. (GEI) prepared this data transmittal to present estimates of the Pumped Storage Project construction water use. The project will be constructed over a four year period, between 2012 and 2015. However, most of the construction water use will occur in the first three years between 2012 and 2014. Filling of the reservoirs will begin in 2015. For the purposes of water balance calculations, the construction water use is distributed over these three years. Table 1 shows the various construction activities that will require water during construction. An annual average construction water use of 106 acre-feet will be used in the water balance and drawdown calculations.

References

GEI Consultants, Inc. (2009). Final License Application submitted to the Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

Table 1
Pumped Storage Project Construction Water Usage

Project Component	Area Disturbed Acres	Water Usage Acre-Feet
Water Supply Lines	7.1	4
Transmission Lines[1]		2
Project Road Dust Control	36.4	473
Tunnel		41
Access Roads		10
Powerhouse		37
Staging and Storage Area	26.2	16
Brine Pond , RO System	62.8	38
Switch Yard	12.3	7
Water Supply Wells		2
Reservoir Linings		134
Dams	20.0	160
Total		924

Average Annual Water Use [2]	**308**	**AFY**
Average Annual Pumping Rate	13,419,866	cu ft
	100,380,598	gallons
	275,015	gallons/day
	1,440	mins/day
	191	**gpm**

[1] Assumes concrete is 10.3 Sack Mix.

[2] Annual water use projected over a three year period starting in 2012

Eagle Mountain Pumped Storage Project – Chuckwalla Valley Raceway Water Use Estimates

Prepared by: David Fairman, Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

October 8, 2009

GEI Consultants, Inc. (GEI) prepared this data transmittal to present estimates of water use for the Desert Center Raceway.

ECE owners meet with the Chuckwalla Valley Raceway owners in August 2008. The project at that time was in conceptual planning and when asked directly about their amount of anticipated annual and construction water use, estimates were unavailable.

In order to account for the cumulative effects of the Pumped Storage Project and all other uses – existing and reasonably foreseeable – on the Chuckwalla Groundwater Basin, we have included this potential use. GEI personnel made estimates of the potential water use using available information. We understand the project will consist of three phases of construction. Phase 1 will consist of one race track that is 2.68 miles long and 36 feet wide. Two additional race tracks are proposed but there are no additional details. Table 1 estimates the construction water use for excavation and recompaction of soils 5 feet deep to construct the Phase 1 race track. We assumed that the first track would be built in 2010 and that one track of similar size would be built every 3 years.

Limited information is available regarding the potential use of the race tracks and their potential annual water use. The raceway will be a private membership with daily track rentals available. We understand that there will be a clubhouse, a restaurant, a swimming pool and that there will be about 170 parking spots. There will be an overnight camping area but no hookups will be provided.

Because there are no sewers the raceway will likely have a septic leach field which will return virtually all indoor water use to the aquifer. Therefore, water use in the club house and at the restaurant will be essentially a net zero change to the groundwater basin. However, outdoor water use, such as the proposed swimming pool, is almost entirely lost due to evaporation. For estimating purposes we have assumed a 100 by 200 foot swimming pool will be constructed. Table 2 shows the estimation of the annual water evaporative water losses by the swimming pool.

Table 3 shows summarizes the estimated construction and annual water use for the raceway that will be used in the water balance and cumulative drawdown calculations.

References

GEI Consultants, Inc. (2009). Final License Application submitted to the Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

Table 1

GEI Consultants, Inc.
80474 Eagle Mountain Pumped Storage Project
Water Balance for Race Track in Chuckwalla Valley
10/6/2009
NDM/MN

DATA AND ASSUMPTIONS

Modified Proctor Compaction Test Results	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Description
TP-1, 0-3 ft depth	123	9.0%	Brown Silty Sand (SM)
TP-1, 3-5 ft depth	121	10.0%	Brown Silty Sand (SM)
TP-2, 0-5 ft depth	123	10.5%	Brown Widely-graded sand with silt (SW-SM)
Average:	122	9.8%	

CALCULATIONS

Parameter	Value	Unit	Notes
Total Area:	510,000	ft^2	(PHASE 1)
Assume Excavate and recompact to:	5	ft depth	
Total Volume Removed:	2,550,000	ft^3	
Natural Moisture Content:	0.5%		MC not given for TP samples, but moisture contents were taken for selected samples from borings. Granular materials at 15-ft depth or more typically have Moisture Contents <5%, with some as low as 1%. Assume MC of near-surface material is 0.5%.
In-situ Dry Density:	105	pcf	Average dry density of samples from borings is 110 pcf. Near-surface density would be lower, so assume 105 pcf.
To Recompact Excavated Material:			
Total Dry Weight of Excavated Material:	267,750,000	lb	
Total Water Needed to Recompact:	26,328,750	lb	
Total Water in-situ:	1338750	lb	
Additional Water Needed:	24,990,000	lb	
Volume of Additional Water Needed:	400,481	ft^3 =	2,995,596 gallons
Add Borrow to get back to Original Grade:			
Recompacted Volume:	2,191,678	ft^3	
Additional Borrow Needed:	358,322	ft^3	
Dry Weight of Borrow Needed:	43775000	lb	
Water Needed to Recompact:	4,304,542	lb	
Water already in Borrow:	218,875	lb	
Additional Water Needed:	4,085,667	lb	
Volume of Additional Water Needed:	65,475	ft^3 =	489,756 gallons
Total Volume of Water Needed:	**465,956**	**ft^3 =**	**3,485,352 gallons =11 Acre-Feet**

Table 2
Estimated Chuckwalla Valley Raceway Annual Water Use

Assumed Swimming Pool Dimensions - 100 by 200 feet

Swimming pool area	20000	square feet
	0.46	acres
Evaporation	7.5	feet/year
Annual Water Losses	3	acre-feet/year

Table 3
Raceway Water Useage in Acre-Feet

Year	Proposed Raceway Water Usage
2008	0
2009	0
2010	11
2011	3
2012	3
2013	14
2014	3
2015	3
2016	14
2017	3
2018	3
2019	3
2020	3
2021	3
2022	3
2023	3
2024	3
2025	3
2026	3
2027	3
2028	3
2029	3
2030	3
2031	3
2032	3
2033	3
2034	3
2035	3
2036	3
2037	3
2038	3
2039	3
2040	3
2041	3
2042	3
2043	3
2044	3
2045	3
2046	3

Year	Proposed Raceway Water Usage
2047	3
2048	3
2049	3
2050	3
2051	3
2052	3
2053	3
2054	3
2055	3
2056	3
2057	3
2058	3
2059	3
2060	3
2061	3
2062	3
2063	3
2064	3
2065	3
2066	3
2067	3
2068	3
2069	3
2070	3
2071	3
2072	3
2073	3
2074	3
2075	3
2076	3
2077	3
2078	3
2079	3
2080	3
2081	3
2082	3
2083	3
2084	3
2085	3

Year	Proposed Raceway Water Usage
2086	3
2087	3
2088	3
2089	3
2090	3
2091	3
2092	3
2093	3
2094	3
2095	3
2096	3
2097	3
2098	3
2099	3
2100	3

GEI Consultants

Eagle Mountain Pumped Storage Project – Solar Facilities Water Use Estimates

Prepared by: David Fairman, Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

October 6, 2009

In response to questions raised by the National Park Service (NPS) in review of the Final License Application (FLA) for the Eagle Mountain Pumped Storage Project, GEI Consultants, Inc. (GEI) prepared this data transmittal to revise the number of solar facilities and estimates of construction and annual water use for potential projects relying upon groundwater from the Chuckwalla Valley Groundwater Basin.

In May 2009, Eagle Crest Energy Company (ECE) submitted their Final License Application (FLA) for the Eagle Mountain Pumped Storage Project which contained a list of ten solar facilities located in the Chuckwalla Groundwater Basin. The facility locations and list were obtained from the BLM website geodatabase. Figure 1 shows the location of the facilities and Table 1 lists the applicants. At that time, none of the applicants had provided publically available estimates of construction or annual water usage. In order to estimate water use for the solar projects, GEI obtained from the California Energy Commission and the US Department of Energy standard annual water use values. These values were used to estimate the cumulative impact of the solar projects and Eagle Mountain Pumped Storage Project in the FLA.

By September 2009, this same website contained additional and different information. Figure 2 shows the location of proposed solar facilities and Table 2 summarizes the facilities. The changes included:

- Two new facilities CACA 050379 and CACA 049047 had been added
- CACA 049488 had been moved from the central portion of the basin to the upper Chuckwalla basin near the Iron Mountain Mine
- CACA 049489 had been dropped from the central portion of the basin

GEI was directed by the National Park Service (NPS) to a new BLM website, which contained a mapping interface called geocommunicator, that is supposed to contain the most recent information regarding proposed solar applicants. Figure 3 shows this new map. Figure 4 shows the comparison of the BLM geodatabase locations and the locations of the geocommunicator site locations. A comparison of the maps showed:

- CACA 049488 had been relocated back to its original location in the central portion of the basin.

- Two new applilcants CACA 050437 and 051017 were added to the central portion of the basin.
- CACA 049492 had been added in the upper Chuckwalla basin.
- CACA 049494, originally located in Palen Valley, appears to have been split into two sites. Part of the site had moved to the upper Chuckwalla basin near the Iron Mountain Mine while a portion remains in the Palen Valley but is currently unlabeled.
- CACA 050379 located in the eastern portion of the Chuckwalla basin, appears to have been split into two locations but one of the properties is not labeled.
- As shown many of the property shapes vary somewhat between the two databases.

In order to resolve the discrepancies between the databases and to obtain more accurate estimates of the potential water use, GEI compiled both databases to create one list of 14 applicants (see Table 3), conducted a web-based search of the applicants, and with assistance from NPS obtained Plans of Development (POD) from the BLM. Facility locations were verified from these applications and information and are presented on Figure 5. Only 6 of the 14 applicants have detailed information so there is still considerable uncertainty. Attachments 1 though 6 contains the facility descriptions. For those facilities without any additional information the geocommunicator database locations was used. During this evaluation we found:

- Four applications have been made by EnXco Development group (CACA 049486 through CACA 049492). Two of the applications indicate solar thermal types of developments while the other two applications indicate photovoltaic facilities. PODs have been submitted for the photovoltaic locations. To resolve the inconsistency in the type of proposed facilities a web-based search showed that EnXco is involved in construction of both photovoltaic and solar thermal facilities. It appears both types of facilities may be constructed and both types will be accounted for in the water balance estimates.
- CACA 048880 application was originally submitted by Florida Power and Light. It appears that the project has been purchased by Genesis Solar. For the water balance we will use Genesis Solar project description.
- CACA 048649 application was originally submitted by OptiSolar Inc. OptiSolar sold 400 projects to First Solar in April 2009. Although a specific project list could not be obtained, subsequent news releases indicate a 250 MW Desert Sunlight photovoltaic project will be constructed near Desert Center by First Solar, likely on the property previously applied for by OptiSolar. However, the size of First Solar facility does not match the capacity provided in the geocommunicator database. No POD or project description could be located; therefore, to conservatively estimate the water use the original application plant capacities will be used to estimate water consumption in the water balance estimates. In addition the property size does not match with the megawatt (MW) production. Therefore, we have conservatively estimated additional solar and water use for the oversized portions of the property.
- CACA 048810 and CACA 049486 applicants are Chevron Energy Solutions Co. #2 and Solar Millennium based on the May 2009 geodatabase with a combined capacity total of 600 MW. A joint POD has been submitted to develop a 500 MW facility. We

have accumulated both original applications into one for purposes of the water balance under CACA 049486 as shown on Table 3.

Construction and annual water use estimates are only available for six facilities in the Chuckwalla groundwater basin. Table 4 lists these facilities along with other nearby projects by their solar technology and creates average uses to be applied to those facilities where no information is currently available. Annual water use can vary greatly for solar thermal depending upon the type of cooling, either wet or dry methods. As shown on Table 5 only one facility in the Chuckwalla groundwater basin is currently proposing wet cooling because it uses large quantities of water and the groundwater in that portion of the basin does not meet drinking water quality standards. A California state policy currently prevents the use of drinking-quality water for power plant cooling water. A Legislative Bill has been recently introduced to allow renewable energy power plants to use drinking water for cooling, if certain conditions are met. The outcome of the bill is currently unknown. Solar Millennium (CACA 049486) has changed their proposal from wet cooling to dry cooling in order to permit their facilities in the Chuckwalla groundwater basin and elsewhere in California. The California Energy Commission, NPS and the Sierra Club all intend to advocate dry cooling methods.

Table 5 shows the water use for solar thermal facilities without information assuming dry cooling methods would be about 4,000 acre-feet per year (AFY). Current regulatory standards encourage water use efficiency, and discourage use of wet cooling. It does not appear to be a reasonably foreseeable condition that solar projects – for which dry cooling technology is readily available – will be approved for the use of wet cooling methods. Therefore, for water balance and drawdown estimates, water use estimates for dry cooling will be used.

Table 6 summarizes the construction and annual water use by solar operations that will be used in the water balance. For the six verified projects, the start of construction was determined from known information, the latest starting in 2012. For the unverified projects, it was assumed that the earliest that they might start would be one year after the latest verified project, or 2013. It was assumed that two projects would come on line each year from 2013 to 2018, that each would have a construction period of three years, and that each would be licensed for 30 years. Attachment 7 shows the detailed distribution of the construction and 30 years of annual water use. This is considered to be an extreme “worst-case” analysis, since it is not likely that all proposed solar projects will be developed.

References

GEI Consultants, Inc. (2009). Final License Application submitted to the Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

http://www.energy.ca.gov/sitingcases/solar_millennium_palen/documents/

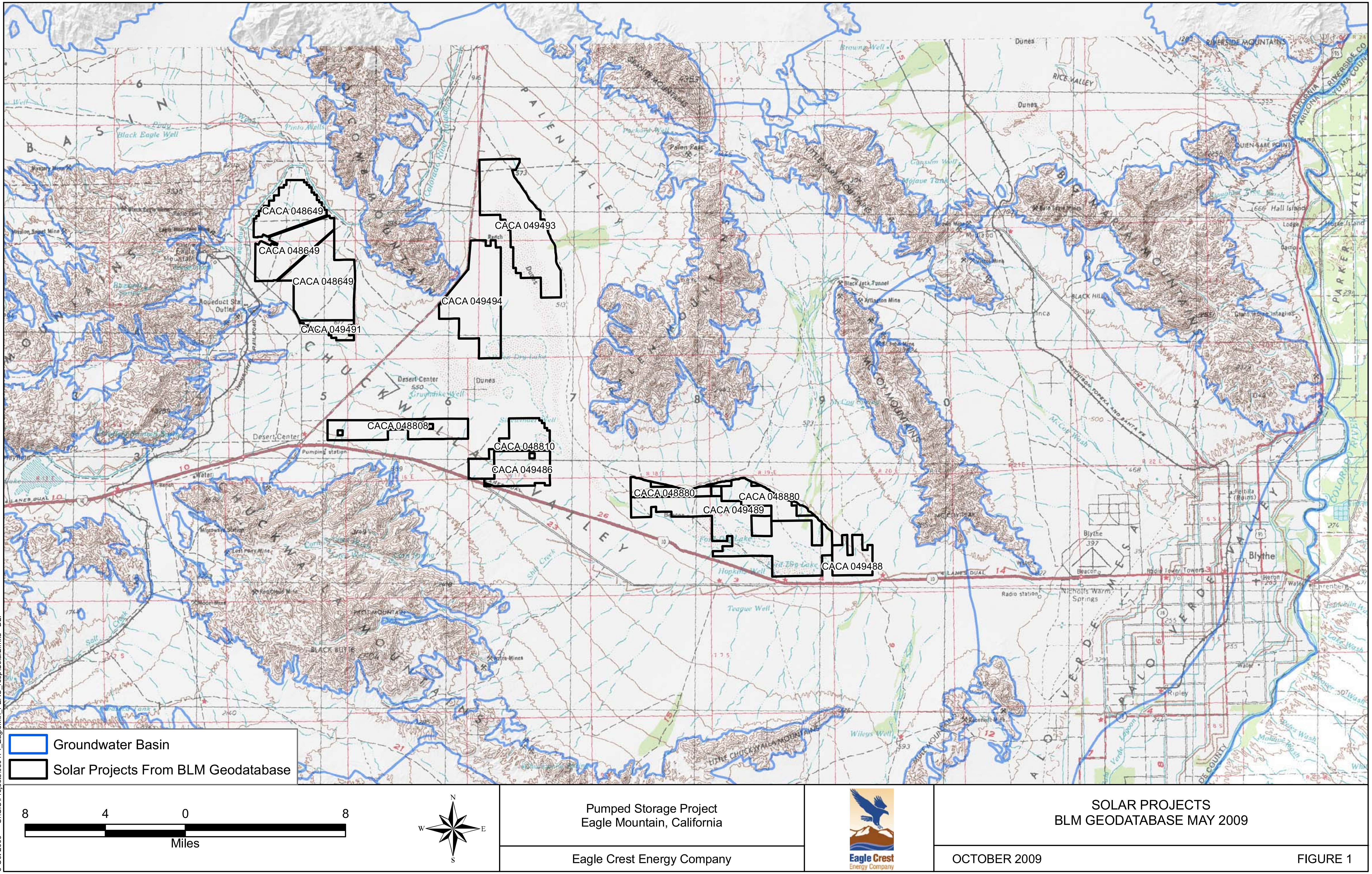
http://www.energy.ca.gov/sitingcases/genesis_solar/index.html

Plan of Development for Chuckwalla Solar I. Submitted to Bureau of Land Management, February 2009.

Plan of Development for Mule Mountain Solar Project. Submitted to Bureau of Land Management, March 2008.

Plan of Development for Ford Dry Lake Soleil. Submitted by EnXco to Bureau of Land Management, November 2008.

Plan of Development for Desert Lily Soleil. Submitted by EnXco to Bureau of Land Management, October 2008.



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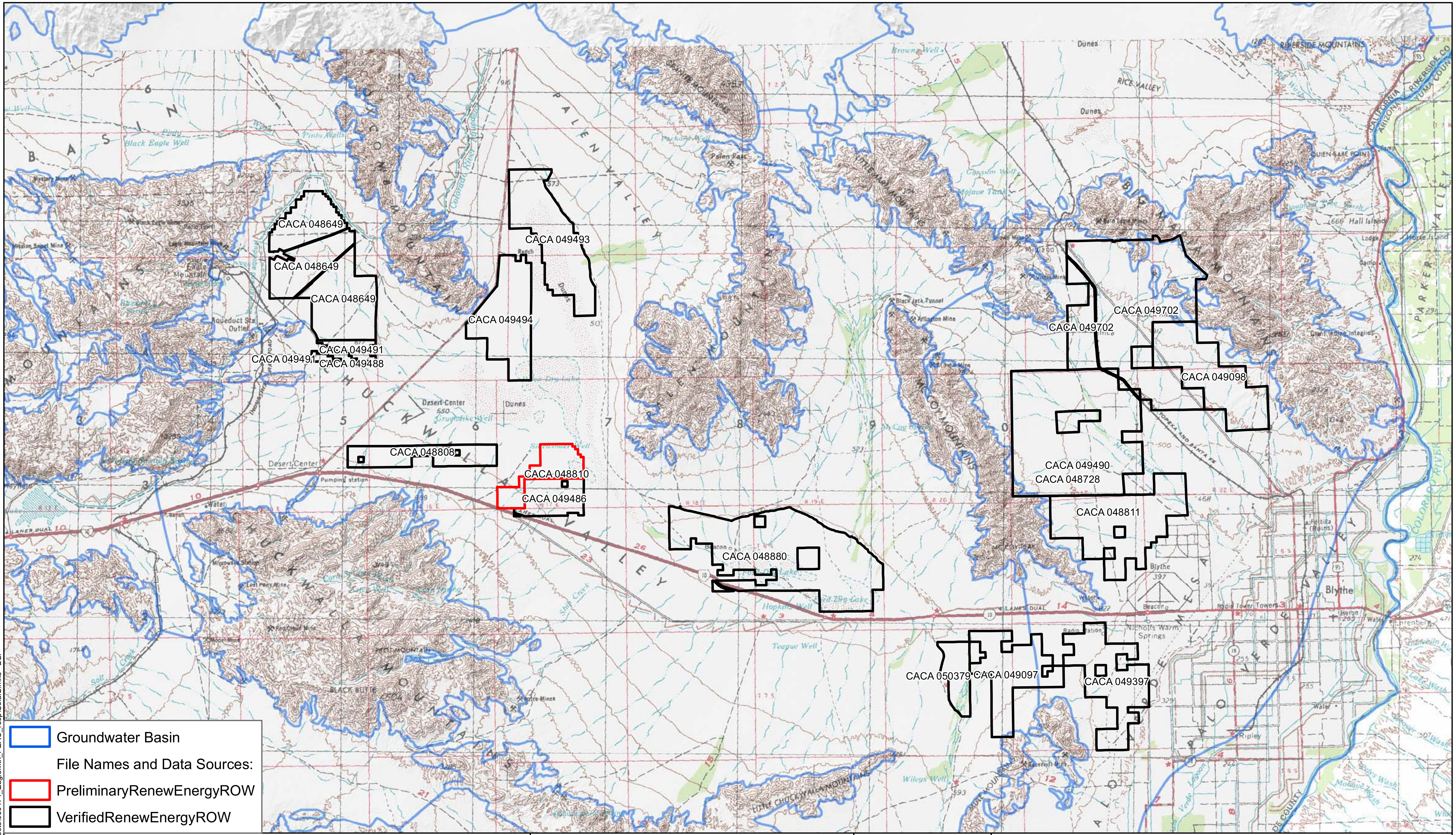
Pumped Storage Project
Eagle Mountain, California

Eagle Crest Energy Company

SOLAR PROJECTS
BLM GEODATABASE MAY 2009

OCTOBER 2009

FIGURE 1



Pumped Storage Project
Eagle Mountain, California

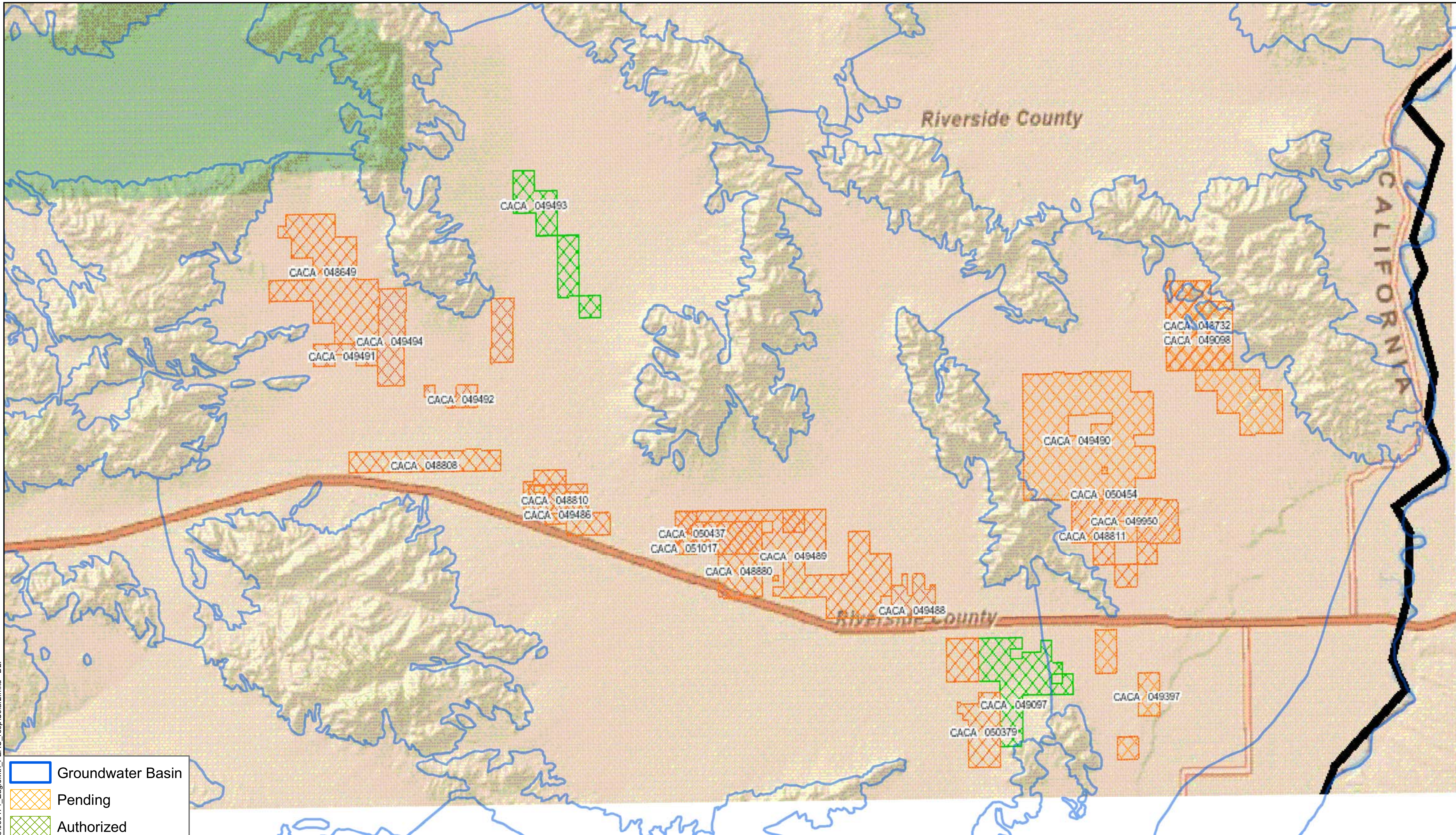
Eagle Crest Energy Company

SOLAR PROJECTS
BLM GEODATABASE SEPT 2009

OCTOBER 2009

FIGURE 2

5-Oct-2009 S:\GIS\Projects\080474_EagleMtn_FERC_resp\Solar2.mxd DLF



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Pumped Storage Project
Eagle Mountain, California

Eagle Crest Energy Company

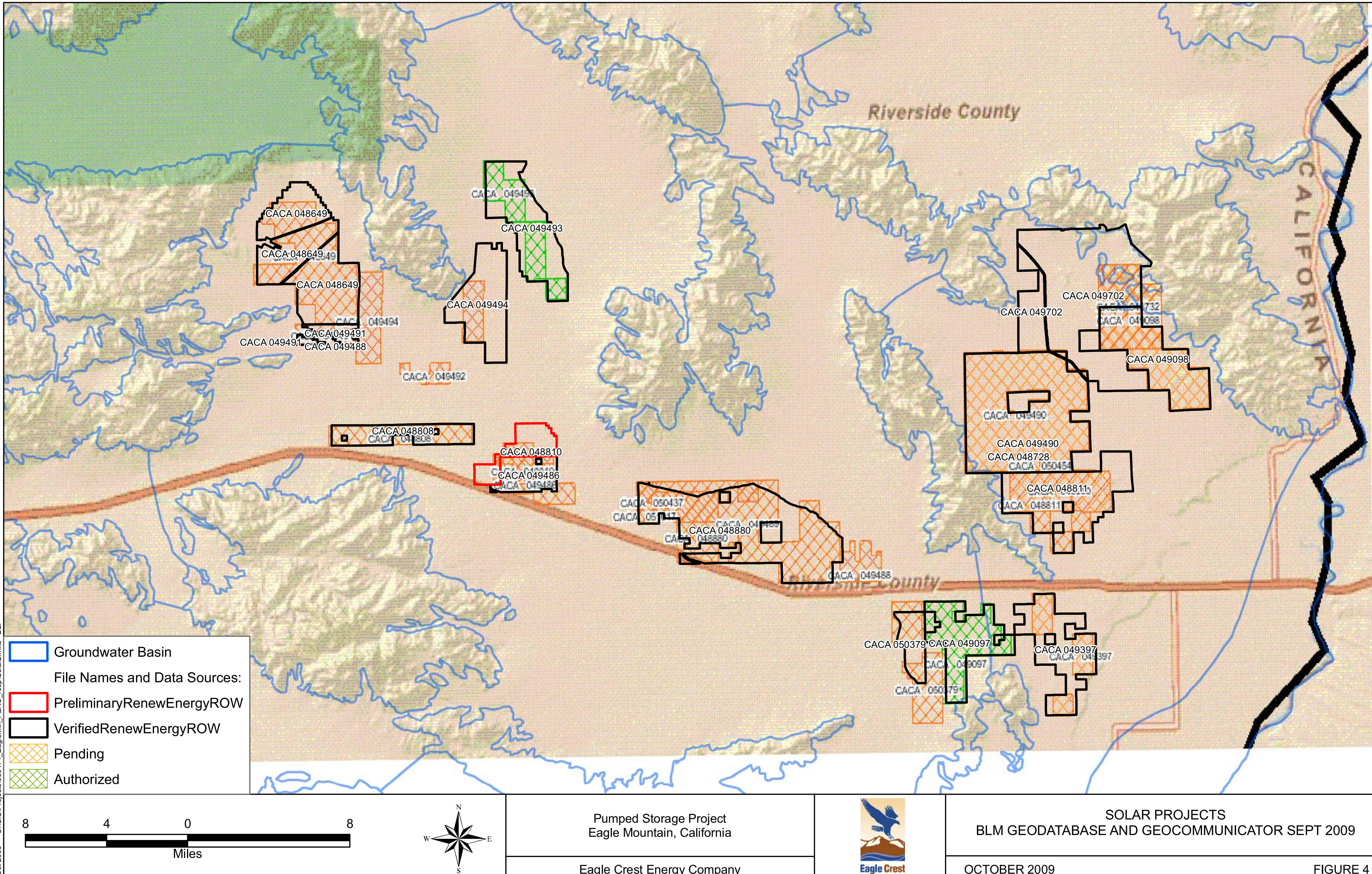
Eagle Crest Energy Company

SOLAR PROJECTS
BLM GEOCOMMUNICATOR SEPT 2009

OCTOBER 2009

FIGURE 3

5-Oct-2009 S:\GIS\Projects\080474_EagleMtn_FERC_resp\Solar2.mxd DLF



5-Oct-2009 S:\GIS\Projects\080474_EagleMtn_FERC_resp\Solar2.mxd DLF

Pumped Storage Project
Eagle Mountain, California

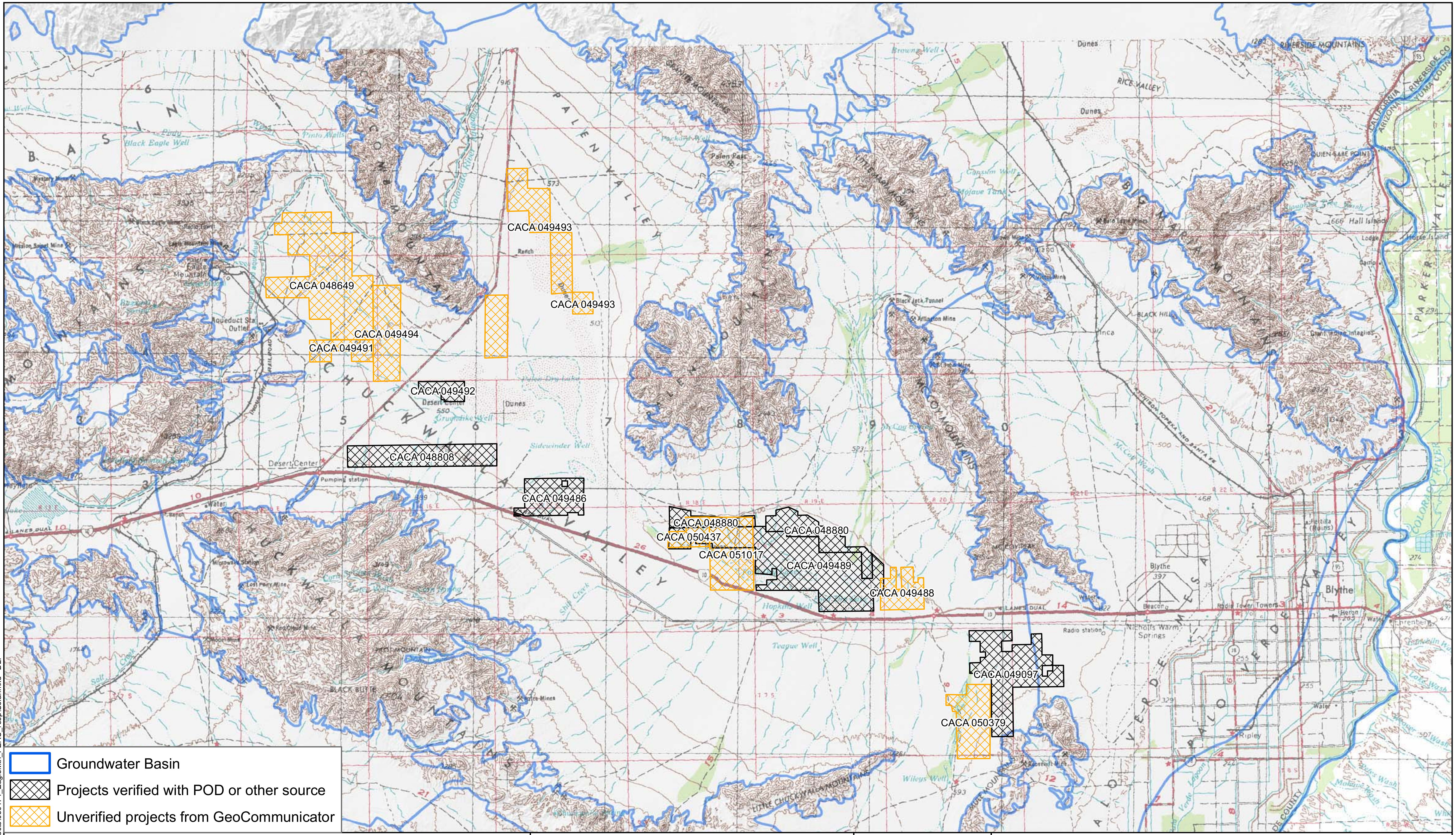
Eagle Crest Energy Company

Eagle Crest
Energy Company

SOLAR PROJECTS
BLM GEODATABASE AND GEOCOMMUNICATOR SEPT 2009

OCTOBER 2009

FIGURE 4



Pumped Storage Project
Eagle Mountain, California

Eagle Crest Energy Company

SOLAR PROJECTS
SEPT 2009

OCTOBER 2009

FIGURE 5

5-Oct-2009 S:\GIS\Projects\080474_EagleMtn_FERC_resp\Solar.mxd DLF

Table 1

Water Useage By Proposed Solar Plants (Geodatabase, May 2009)

Project Serial Number[1]	Type[1]	General Location	Capacity[1] (MW)	Water Useage[2, 3,4] (AFY/(MW of plant capacity))	Water Useage (AFY)	Water Useage (gpm)
CACA 048649	Photovoltaic	Upper Chuckwalla Valley	350	0.16	56	35
CACA 048808	Photovoltaic	Desert Center	200	0.16	32	20
CACA 048810	Solar Thermal	East of Desert Center	100	0.25	25	15
CACA 048880	Solar Thermal	East of Desert Center	250	0.25	63	39
CACA 049486	Solar Thermal	East of Desert Center	500	0.25	125	77
CACA 049488	Solar Thermal	East of Desert Center	300	0.25	75	46
CACA 049489	Solar Thermal	East of Desert Center	300	0.25	75	46
CACA 049491	Solar Thermal	Upper Chuckwalla Valley	300	0.25	75	46
CACA 049493	Solar Thermal	Desert Center	500	0.25	125	77
CACA 049494	Solar Thermal	Desert Center	500	0.25	125	77
				Upper Chuckwalla Valley (WSuc) Subtotal	131	81
				Near Date and Citrus Grower East of Desert Center (OW-17) Subtotal	363	225
				Desert Center (WSdc) Subtotal	282	175
				Total	776	480

Notes:

[1] Source: Bureau of Land Management

[2] For Solar Thermal, water use based on 100 AFY for 400 MW facility at Ivanpah (California Energy Commission)

[3]For Photovoltaic, based on 0.050 gallons/(kWh produced) (US Dept. of Energy) and capacity factor of about 20% (http://en.wikipedia.org/wiki/Capacity_factor)

[4] Water use for construction of the projects not included.

Table 2 Solar Projects in the Sept 2009 Geodatabase

District	Field Office	Serial Number	Listed in BLM Applications Table	In BLM Geodatabase	In BLM Geocommunicator	In Chuckwalla Valley	Applicant	Date Application Received	Acres	Megawatts (Mw)	Project Type	Geographic Area	Project Description Available	Status of Application	Notes
CDD	Palm Springs	CACA 48649	X	X	X	X	OptiSolar, Inc. (Desert Sunlight)	11/7/06	7,040	350	Solar: pending photovoltaic	Desert Center Area		Received cost recovery funds. Received POD. POD to be sent to NFO Contractors. Completing aerial topo mapping; initiating bio, cult surveys.	
CDD	Palm Springs	CACA 48808	X	X	X	X	Chuckwalla Solar LLC	9/15/06	4,098	200	Solar: pending photovoltaic	Desert Center area I		Received cost recovery funds. NOI being sent out (for publication) in Federal Register 11/9/07	
CDD	Palm Springs	CACA 48810	X	X	X	X	Chevron Energy Solutions Co. #2	3/14/07	3,119	484	Solar: pending solar thermal	Desert Center area in Eastern RIVCO		Received cost recovery funds. Requested updated POD 9/9/09 within 30 days. AFC filed w/ CEC 8/24/09.	Cojoined with CACA 49486
CDD	Palm Springs	CACA 48880	X	X	X	X	NextEra - Genesis Solar LLC	1/31/07	4,491	250	Solar: pending solar thermal	Blythe Area, Eastern Riverside County		Received cost recovery funds. Application complete pending 30% engineering design 9/9/09.	
CDD	Palm Springs	CACA 49097	X	X	X	X	Bullfrog Green Energy, LLC	6/13/07	6,629	2,500	Solar: pending photovoltaic	Blythe Ca area S. of I-10 in Eastern RIVCO		Received cost recovery funds. Received POD.	
	Palm Springs	CACA 049486		X	X	X	Solar Millennium Chevron Energy Solutions		3,100	500			X		Cojoined with CACA 48810, POD says acres = 5200
CDD	Palm Springs	CACA 49491	X	X	X	X	EnXco Development, Inc.	11/13/07	1,071	300	Solar: pending solar thermal	Blythe area in Eastern RIVCO		Proffer Established. Received POD.	
CDD	Palm Springs	CACA 49493	X	X	X	X	Solel Inc.	11/6/07	8,775	500	Solar: pending solar thermal	Desert Center N. on Hwy 177 in Eastern RIVCO		Received cost recovery funds. Received POD.	
CDD	Palm Springs	CACA 49494	X	X	X	X	Solel Inc.	11/6/04	7,511	500	Solar: pending solar thermal	Desert Center N. on Hwy 177 in Eastern RIVCO		Received cost recovery funds. Received POD. Area of App being revised pending Boulevard withdrawal of 49003.	
CDD	Palm Springs	CACA 50379	X	X	X	X	Lightsource Renewables, LLC	8/8/08	7,920	550	Solar: pending solar thermal	Blythe Ca area S. of I-10 in Eastern RIVCO		Cost recovery agreement and MOU sent 11/14/08	

Table 3 Solar Projects in the Chuckwalla Valley

District	Field Office	Serial Number	Listed in BLM Applications Table	In BLM Geodatabase	In BLM Geocommunicator	In Chuckwalla Valley	Applicant	Date Application Received	Acres	Megawatts (Mw)	Project Type	Geographic Area	Project Description Available	Status of Application	Notes
CDD	Palm Springs	CACA 48649	X	X	X	X	OptiSolar, Inc. (Desert Sunlight)	11/7/06	7,040	350	Solar: pending photovoltaic	Desert Center Area		Received cost recovery funds. Received POD. POD to be sent to NFO Contractors. Completing aerial topo mapping; initiating bio, cult surveys.	
CDD	Palm Springs	CACA 48808	X	X	X	X	Chuckwalla Solar LLC	9/15/06	4,098	200	Solar: pending photovoltaic	Desert Center area I		Received cost recovery funds. NOI being sent out (for publication) in Federal Register 11/9/07	
~~CDD~~	~~Palm Springs~~	~~CACA 48810~~	~~X~~	~~X~~	~~X~~	~~X~~	~~Chevron Energy Solutions Co. #2~~	~~3/14/07~~	~~3,119~~	484	~~Solar: pending solar thermal~~	~~Desert Center area in Eastern RIVCO~~		~~Received cost recovery funds. Requested updated POD 9/9/09 within 30 days. AFC filed w/ CEC 8/24/09.~~	Cojoined with CACA 49486
CDD	Palm Springs	CACA 48880	X	X	X	X	NextEra - Genesis Solar LLC	1/31/07	4,491	250	Solar: pending solar thermal	Blythe Area, Eastern Riverside County		Received cost recovery funds. Application complete pending 30% engineering design 9/9/09.	
CDD	Palm Springs	CACA 49097	X	X	X	X	Bullfrog Green Energy, LLC	6/13/07	6,629	2,500	Solar: pending photovoltaic	Blythe Ca area S. of I-10 in Eastern RIVCO		Received cost recovery funds. Received POD.	
	Palm Springs	CACA 049486		X	X	X	Solar Millennium Chevron Energy Solutions		3,100	500			X		Cojoined with CACA 48810, POD says acres = 5200
CDD	Palm Springs	CACA 49488	X			X	EnXco Development, Inc.	11/13/07	2,070	300	Solar: pending solar thermal	Blythe area in Eastern RIVCO		Proffer Established. Received POD.	
CDD	Palm Springs	CACA 49489	X		X	X	EnXco Development, Inc.	11/13/07	11,603	300	Solar: pending solar thermal	Blythe area in Eastern RIVCO		Proffer Established. Received POD.	May include acres from CACA 48880
CDD	Palm Springs	CACA 49491	X	X	X	X	EnXco Development, Inc.	11/13/07	1,071	300	Solar: pending solar thermal	Blythe area in Eastern RIVCO		Proffer Established. Received POD.	
	Palm Springs	CACA 049492			X	X	EnXco Development, Inc.		1,216						

District	Field Office	Serial Number	Listed in BLM Applications Table	In BLM Geodatabase	In BLM Geocommunicator	In Chuckwalla Valley	Applicant	Date Application Received	Acres	Megawatts (Mw)	Project Type	Geographic Area	Project Description Available	Status of Application	Notes
CDD	Palm Springs	CACA 49493	X	X	X	X	Solel Inc.	11/6/07	8,775	500	Solar: pending solar thermal	Desert Center N. on Hwy 177 in Eastern RIVCO		Received cost recovery funds. Received POD.	
CDD	Palm Springs	CACA 49494	X	X	X	X	Solel Inc.	11/6/04	7,511	500	Solar: pending solar thermal	Desert Center N. on Hwy 177 in Eastern RIVCO		Received cost recovery funds. Received POD. Area of App being revised pending Boulevard withdrawal of 49003.	
CDD	Palm Springs	CACA 50379	X	X	X	X	Lightsource Renewables, LLC	8/8/08	7,920	550	Solar: pending solar thermal	Blythe Ca area S. of I-10 in Eastern RIVCO		Cost recovery agreement and MOU sent 11/14/08	
	Palm Springs	CACA 050437			X	X									
	Palm Springs	CACA 051017			X	X									

Table 4

Projection of Average Water Usage from Various Solar Projects

Project Name	Solar Type	Cooling Type	Construction Water (AF)	Annual Water Usage (AFY)	Plant Capacity (MW)	Construction Water Usage (AF per MW)	Annual Water Usage (AFY per MW)
Genesis Solar project apparer	Solar Thermal	Wet	2,440	1,644	250	9.76	6.58
Abengoa Mojave Solar	Solar Thermal Trough	Wet	1,090	2,163	250	4.36	8.65
					Average	7.06	7.61
Solar Millennium Palen	Solar Thermal Trough	Dry	1,560	300	500	3.12	0.60
Solar Millennium Blythe	Solar Thermal Trough	Dry	3,100	600	1,000	3.10	0.60
Solar Millennium Ridgecrest	Solar Thermal Trough	Dry	1,500	150	250	6.00	0.60
					Average	4.07	0.60
Chuckwalla Solar LLC	Photovoltaic		60	40	200	0.30	0.20
Bullfrog Green Energy	Photovoltaic		40	12	500	0.08	0.02
EnXco Development, Inc.	Photovoltaic		20	5	200	0.10	0.03
EnXco Development, Inc.	Photovoltaic		20	5	100	0.20	0.05
					Average	0.17	0.07

Table 5
Water Useage By Proposed Solar Plants (Assuming Dry Solar Thermal Cooling for Unverified Projects)

Project Serial Number[1]	Applicant[1]	Acres from Website [1]	Acres from Shapefile[1]	Type[1]	General Location	Construction Water Usage (AF)	Construction Water Usage (gpm/yr) [5]	Capacity[1] (MW)	Water Usage[2, 3,4] (AFY/(MW of plant capacity))	Water Usage (AFY)	Water Usage (gpm/yr)
CACA 048649	First Solar (assumed Phase 1)	7040	14772	Photovoltaic	Upper Chuckwalla Valley	60	12	350	0.07	26	16
	First Solar (assumed Phase 2)	7732		Photovoltaic	Upper Chuckwalla Valley	66	14	390	0.07	29	18
CACA 048808	Chuckwalla Solar LLC	4098	4099	Photovoltaic	Desert Center	**60**	**12**	**200**	**0.20**	**40**	25
CACA 048880	Genesis Solar/Florida Power & Light	4491	4492	Solar Thermal	Ford Dry Lake	**2440**	**504**	**250**	**6.58**	1644	1019
CACC 049097	Bullfrog Green Energy	6629		Photovoltaic	Lower Chuckwalla Valley	**85**	**26**	**500**	**0.02**	**12**	7
CACA 049486	Solar Millennium, LLC/Chevron	2753	3136	Solar Thermal	East of Desert Center	**1560**	**322**	**500**	**0.60**	300	186
CACA 049488	EnXco Development, Inc.	2070	2070	Solar Thermal	Ford Dry Lake	1222	252	300	0.60	180	112
CACA 049489	EnXco Development, Inc.	11603	16088	Photovoltaic	Ford Dry Lake	**20**	**6**	**200**	**0.03**	**5**	3
CACA 049491	EnXco Development, Inc.	1071	1052	Solar Thermal	Desert Center	1222	252	300	0.60	180	112
CACA 049492	EnXco Development, Inc.		1216	Photovoltaic	Desert Center	**20**	**6**	**100**	**0.05**	**5**	3
CACA 049493	Solel Inc.	8775	8770	Solar Thermal	Desert Center	2037	421	500	0.60	300	186
CACA 049494	Solel Inc.	7511	7399	Solar Thermal	Desert Center	2037	421	500	0.60	300	186
CACA 050379	Lightsource Renewables, LLC	7920		Solar Thermal	Lower Chuckwalla Valley	2240	463	550	0.60	330	204
CACA 050437				Solar Thermal	Ford Dry Lake	2037	421	500	0.60	300	186
CACA 051017				Solar Thermal	Ford Dry Lake	2037	421	500	0.60	300	186
					Total	17142	3553		Total	3951	2448
					Upper Chuckwalla Valley (CWuc) Subtotal	126	26			55	34
					Desert Center (CWdc) Subtotal	5375	1112			825	511
					East of Desert Center (OW17) Subtotal	1560	322			300	186
					Ford Dry Lake (OW20) Subtotal	7755	1604			2429	1505
					Lower Chuckwalla (unassigned) Subtotal	2325	489			342	212
					Total	17142	3553		Total	3951	2448

Notes:
[1] Source: Bureau of Land Management
[2] For Solar Thermal, water use based on other projects in area
[3] Assumes 3 year construction period unless bolded

Estimated values, no information currently available

Bolded value is verified

Table 6

Solar Water Use for Water Balance

Year	Construction (AFY)	Yearly (AFY)
2008	0	0
2009	0	0
2010	10	0
2011	73	0
2012	92	5
2013	885	17
2014	1,783	62
2015	2,849	88
2016	3,439	1,761
2017	3,870	2,241
2018	2,783	2,721
2019	1,358	3,351
2020	0	3,951
2021	0	3,951
2022	0	3,951
2023	0	3,951
2024	0	3,951
2025	0	3,951
2026	0	3,951
2027	0	3,951
2028	0	3,951
2029	0	3,951
2030	0	3,951
2031	0	3,951
2032	0	3,951
2033	0	3,951
2034	0	3,951
2035	0	3,951
2036	0	3,951
2037	0	3,951
2038	0	3,951
2039	0	3,951
2040	0	3,946
2041	0	3,894
2042	0	3,863
2043	0	2,190
2044	0	1,710
2045	0	1,230
2046	0	600
2047	0	0
2048	0	0
2049	0	0
2050	0	0
2051	0	0
2052	0	0
2053	0	0
2054	0	0
2055	0	0
2056	0	0
2057	0	0
2058	0	0
2059	0	0
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2061	0	0
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2063	0	0
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2073	0	0
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2076	0	0
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2078	0	0
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2080	0	0
2081	0	0
2082	0	0
2083	0	0
2084	0	0
2085	0	0
2086	0	0
2087	0	0
2088	0	0
2089	0	0
2090	0	0
2091	0	0
2092	0	0
2093	0	0
2094	0	0
2095	0	0
2096	0	0
2097	0	0
2098	0	0
2099	0	0
2100	0	0

Attachment E-1

CACA 049486 2nd
CACA 048810

1.0 Executive Summary

Solar Millennium, LLC and Chevron Energy Solutions (joint developers who are hereafter referred to as the Applicants) propose to construct, own, and operate the Palen Solar Power Project (PSPP or Project). The Project is a concentrated solar thermal electric generating facility with two adjacent, independent, and identical solar plants of 250 megawatt (MW) nominal capacity each for a total capacity of 500 MW nominal.

As a solar thermal project over 50 MW located on land managed by the Bureau of land Management (BLM), the Project is under the jurisdiction of both the California Energy Commission (CEC) and BLM. In 2007, the BLM California Desert District and the CEC executed a Memorandum of Understanding to establish a policy for the joint environmental review of solar thermal power plant projects. As a California agency, the CEC must comply with the requirements of the California Environmental Quality Act (CEQA), and as a Federal agency, the BLM must comply with the requirements of the National Environmental Policy Act (NEPA). The two agencies are conducting a joint review of the Project and a combined CEQA/NEPA document will be prepared.

Although CEQA and NEPA differ in several respects, they are sufficiently similar and flexible that a single environmental document can be prepared that will comply with both laws. This Application for Certification (AFC) is intended to address BLM needs as well as those of the CEC in order to support preparation of the joint NEPA/CEQA document.

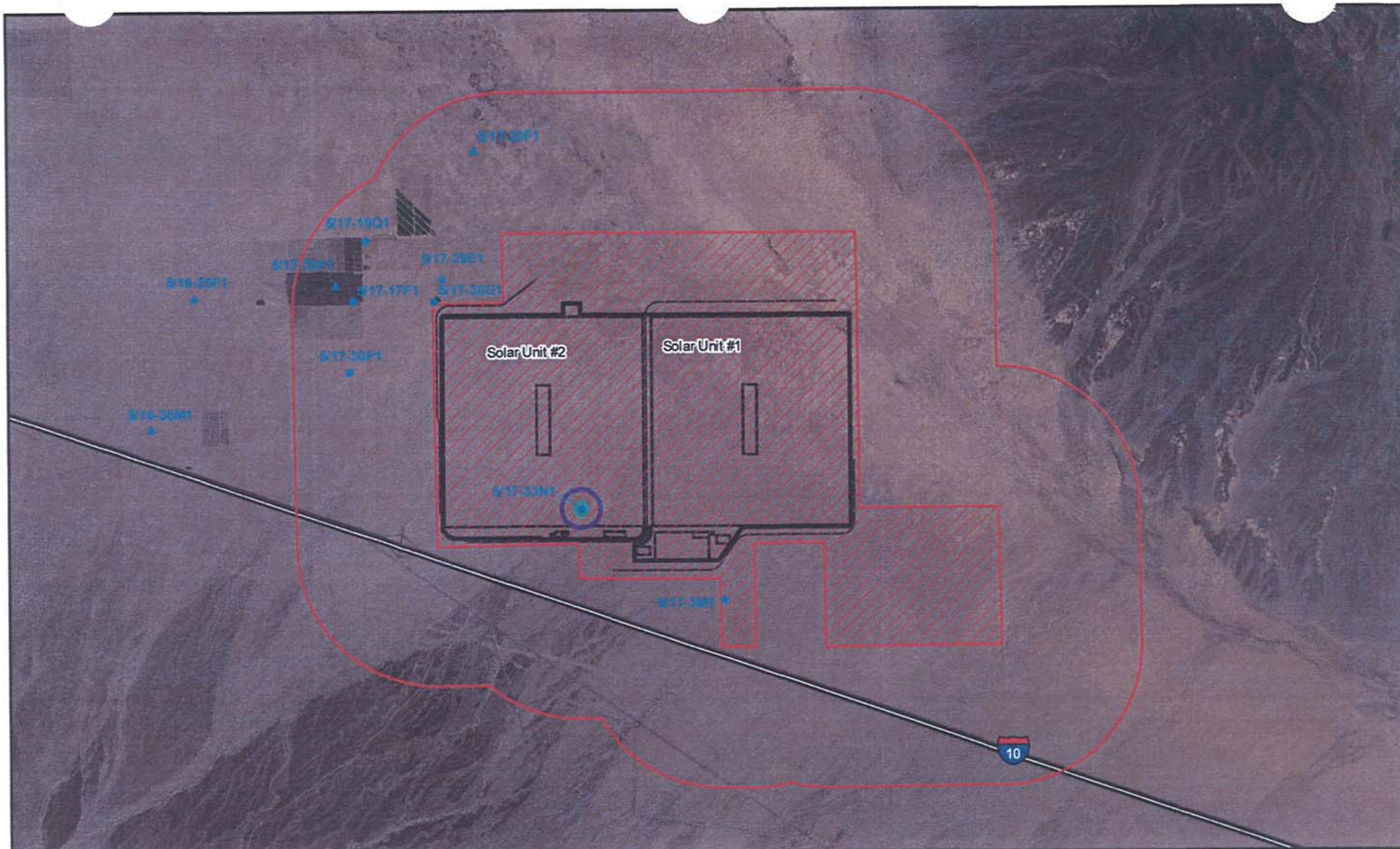
1.1 Project Description

The PSPP is proposed on BLM land approximately 10 miles east of Desert Center, Riverside County, California (see Figure 1-1). Desert Center (population 125) is located along U.S. Interstate 10 (I-10) approximately halfway between the cities of Indio and Blythe, California and about three miles east of the southeast end of Joshua Tree National Park. An application has been filed with BLM for a right-of-way (ROW) grant of approximately 5,200 acres.

The Project will utilize solar parabolic trough technology to generate electricity. With this technology, arrays of parabolic mirrors collect heat energy from the sun and refocus the radiation on a receiver tube located at the focal point of the parabola. A heat transfer fluid (HTF) is heated to high temperature (750 degrees Fahrenheit) as it circulates through the receiver tubes. The heated HTF is then piped through a series of heat exchangers where it releases its stored heat to generate high-pressure steam. The steam is then fed to a traditional steam turbine generator where electricity is produced.

The Applicants' primary objectives for the PSPP are to construct, operate and maintain an efficient, economic, reliable, safe and environmentally-sound utility-scale solar generating facility utilizing proven, reliable, and efficient parabolic trough technology. The Project supports both State and national goals and objectives of energy independence, environmental protection, and economic prosperity. It helps meet specific legal and policy mandates in support of these goals. These include Senate Bill 1078 (California Renewable Portfolio Standard Program); Assembly Bill (AB) 32 (California Global Warming Solutions Act of 2006); and Executive Orders by Governor Schwarzenegger. On the national level, the Project implements Federal law (Energy Policy Act of 2005), and orders by Secretary of the Interior Salazar and his predecessor aimed at significantly increasing the supply of renewable energy from public lands. On an economic and social level, the Project creates jobs and helps ensure an adequate supply of electric energy to power and sustain the economy of Riverside County and the rest of California.

I1



Map Location

Legend

- Project Right-of-Way
- Facility Footprint
- 1 Mile Radius of Right-of-Way
- ● Location of Groundwater Well Location based on Latitude and Longitude in USGS Database
- ▲ Approximate Location of Groundwater Well Location based on the State Well Number (No other coordinates available)
- Drawdown at 5 Feet Assuming T-6300ft^2/d S-0.2; Q-200gpm
- Drawdown at 5 Feet Assuming T-6300ft^2/d S-0.05; Q-200gpm

Data Sources:
Air Photo, California Spatial Information Library, NAIP, 2005 Riverside County

N W E S

0 1 2 Miles

Palen Solar Power Project

Figure 5.17-16
Predicted Drawdown during Operational Period
(30 years)

Solar Millennium

AECOM

Project: 12944-001
Date: August 2009

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CACA 049486

5.17 Water Resources

This section analyses the potential impacts of the Palen Solar Power Project (PSPP or Project) on water resources. The section provides a narrative of applicable laws, ordinances, regulations and standards (LORS) and discusses their applicability to the Project, describes existing conditions with respect to surface and groundwater resources, and evaluates potential Project impacts to these resources. The section discusses both water supply and water quality issues during Project construction and operation.

Appendix J contains the data used for the groundwater study gathered from various public and private sources. The appendix provides the results of a groundwater model and model files to assess potential groundwater pumping impacts, as well as conceptual engineering reports on Project water / wastewater system design. Conceptual engineering reports for channel diversion are provided in Appendix L.1.

The water resources evaluation presented in the following pages is intended to support compliance both by the California Energy Commission (CEC) with the requirements of the California Environmental Quality Act (CEQA), and by the Bureau of Land Management (BLM) with the requirements of the National Environmental Policy Act (NEPA). The two agencies are conducting a joint review of the Project and a combined CEQA/NEPA document will be prepared.

Summary:

The Project is a dry-cooled facility that will use about 300 acre-feet per year (afy) of groundwater from two onsite wells for all operational activities. This is approximately equivalent to about half the annual water consumption of the municipal golf course in the area. During construction, the PSPP will use an average of approximately 480 afy over a 39-month period.

The Project would not have significant impacts on groundwater or surface water resources. The PSPP overlies the Chuckwalla Valley Groundwater Basin. Historical data show that the water table has been stable in the Project vicinity for the last 40 years. Numerical groundwater modeling revealed that pumping from Project construction and operation would not significantly impact offsite water supply wells within a one-mile radius of the PSPP. The Department of Water Resources (DWR) estimated that the recoverable storage within the Chuckwalla Basin is about 15,000,000 af. The proposed annual use of 300 afy is a very small fraction by comparison. Project use would not put the basin into overdraft or cause a significant drawdown in the regional water table. As discussed in Section 4.0, Alternatives, there is no feasible water supply option other than groundwater.

Project surface water impacts also would be less than significant. Impacts to a number of ephemeral washes within the Project site will be mitigated by rerouting the washes in two new channels around the east and west sides of the facility and one through the center of the site (between Units #1 and #2). The new channels will be revegetated with native vegetation, designed to be wildlife friendly, and drainage downstream of the site restored as best as possible to their pre-existing condition. Storm Water Pollution Prevention Plans (SWPPP) and a CEC-mandated Drainage, Erosion, and Sediment Control Plan (DESCP), which contain Best Management Practices (BMPs), will be implemented to avoid significant drainage/stormwater runoff and water quality impacts.

The various cumulative projects in the Project vicinity potentially could consume substantial amounts of water, particularly a number of proposed wet-cooled solar thermal projects and a proposed pumped storage project. The individual projects would undergo separate environmental review and would have to address their water needs and impacts separately. The Project's impacts would not be cumulatively considerable.

Attachment E-2

CACA 04880

see May 2009 map for Location
2nd in Line for same property – ENXCO

The California ENERGY COMMISSION

Genesis Solar Energy Project

Docket Number: 09-AFC-8 (Application For Certification)

Committee Overseeing This Case:

TBD, Commissioner Presiding Member	TBD, Commissioner Associate Member

Hearing Officer: TBA

Key Dates

- 8/31/2009 - Application for Certification (AFC) filed

GENERAL DESCRIPTION OF PROJECT

Genesis Solar LLC, a Delaware limited liability company and wholly owned subsidiary of NextEra™ Energy Resources LLC, submitted an Application for Certification (AFC) to the California Energy Commission on August 31, 2009, to construct, own, and operate the Genesis Solar Energy Project. The project is a concentrated solar electric generating facility that would be located in Riverside County, California.

Parabolic trough solar thermal technology

The project consists of two independent solar electric generating facilities with a nominal net electrical output of 125 megawatts (MW) each, for a total net electrical output of 250 MW. Electrical power would be produced using steam turbine generators fed from solar steam generators. The solar steam generators receive heated transfer fluid from solar thermal equipment comprised of arrays of parabolic mirrors that collect energy from the sun.

The project would use a wet cooling tower for power plant cooling. Water for cooling tower makeup, process water makeup, and other industrial uses such as mirror washing would be supplied from on-site groundwater wells. Project cooling water blowdown will be piped to lined, on-site evaporation ponds.

The project is located approximately 25 miles west of the city of Genesis, California, on lands managed by the Bureau of Land Management (BLM). The project is an undeveloped area of the Sonoran Desert. Surrounding features include the McCoy Mountains to the east, the Palen Mountains (including the Palen/McCoy Wilderness Area) to the north, and Ford Dry Lake, a dry lakebed, to the south. I-10 is located to the south of the project facility. The Chuckwalla Mountains and Little Chuckwalla Mountains Wilderness Areas are also located farther south-southwest. The project area is currently undisturbed, although the area has been used for grazing and off-highway vehicle recreation in the past. Ford Dry Lake

1.0 EXECUTIVE SUMMARY

Project Description

Genesis Solar, LLC, a Delaware limited liability company and wholly owned subsidiary of NextEra Energy Resources, LLC, submits this Application for Certification (AFC) to the California Energy Commission (CEC) to construct, own, and operate the Genesis Solar Energy Project (the Project). The Project is a concentrated solar electric generating facility that would be located in Riverside County, California.

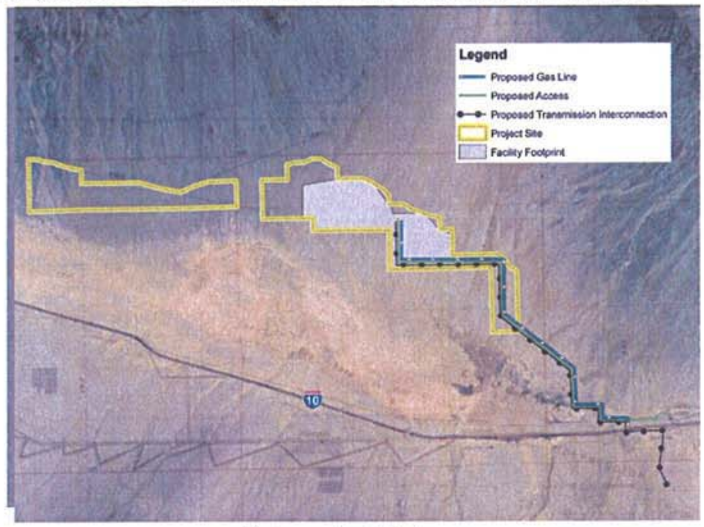
The Project consists of two independent solar electric generating facilities with a nominal net electrical output of 125 megawatts (MW) each, for a total net electrical output of 250 MW. Parabolic trough technology is widely considered a cost-effective and commercially proven technology for utility-scale solar electric power generating facilities. Electrical power would be produced using steam turbine generators fed from solar steam generators. The solar steam generators receive heated transfer fluid from solar thermal equipment comprised of arrays of parabolic mirrors that collect energy from the sun.

The Project proposes to use a wet cooling tower for power plant cooling. Water for cooling tower makeup, process water makeup, and other industrial uses such as mirror washing would be supplied from onsite groundwater wells. Project cooling water blowdown will be piped to lined, onsite evaporation ponds.

A transmission line, access road, and natural gas pipeline will be co-located in one linear corridor to serve the main Project facility. This corridor would exit the facility to the south and would be approximately 6.5 miles long. The generation tie-line would cross Interstate 10 (I-10), and tie into the Blythe Energy Project Transmission Line. The generation tie-line would use the existing pole structures of the Blythe Energy Transmission Line to interconnect with the proposed Colorado River Substation to the east.

Parabolic trough solar thermal technology

After consideration of numerous potential sites, Genesis Solar, LLC filed Right-of-Way (ROW) applications with the BLM on five sites in Riverside County. The ROW application for the Genesis Solar Energy Project was originally 19,000 acres when filed in 2007. In consultation with BLM, preliminary studies were conducted to determine potential environmental impacts. The results of these surveys were used to avoid sensitive cultural and biological resources that were primarily associated with the dry lake bed. These efforts resulted in substantial revisions and reductions to the acreage requested in the ROW application.



Main project features

Today the ROW application with BLM consists of 4,640 acres, with an eastern and western portion. Once constructed, the Project would permanently occupy approximately 1,800 acres within the eastern portion (the Project footprint), plus approximately 90 acres of linear facilities. The remainder of the acreage in the ROW application is not anticipated to be needed for the Project.

Project Objectives and Renewable Initiatives

The United States is currently interested in reducing reliability on foreign oil supplies, and increasing renewable energy production. The State of California has issued a number of executive and legislative measures that have created a need in California for the development of solar and other renewable energy sources.

In response to the growing demand for renewable energy sources in California, the BLM and the CEC have received applications for the development of solar and other renewable energy facilities throughout California. Several planning initiatives have been established to programmatically review California's natural and social resources and identify areas most suitable for development of renewable energy resources.

The primary objective of the Genesis Solar Energy Project is to provide clean, renewable, solar-powered electricity and assist California utilities in meeting their obligations under California's Renewable Portfolio Standard (RPS) Program. A secondary objective is to assist the future off-taker in reducing its greenhouse gas emissions as required by the California Global Warming Solutions Act.

Permitting Process

Because the Project is a solar thermal project greater than 50 MW in size, it will need to be permitted through the CEC. The CEC is also the designated lead agency for all state compliance and permitting activities for these types of projects. The CEC's licensing and certification process is a certified regulatory program under the California Environmental Quality Act (CEQA). This

- **Water Resources**

The Project would use a wet cooling tower for power plant cooling utilizing groundwater from wells that would be installed on the Project site. The average total annual water usage for each 125 MW power plant is estimated to be about 822 acre-ft/yr, or 1,644 acre-ft/yr for the entire Project, which corresponds to an average daily flow rate of about 1,000 gallons per minute (gpm). The groundwater contains high levels of total dissolved solids, and would not be considered a potential potable water source. Initial testing indicates water quantity is adequate for the Project demand and the water quality can be treated to levels that can be used for the wet cooling tower. Based on the results of the drawdown impact modeling, groundwater pumping for the Project is not predicted to significantly impact nearby water supply wells.

- **Geologic Resources and Hazards**

The project site lies within the eastern part of Riverside County in a part of California considered to be not very seismically active. Faults are presumed Tertiary (2 million years before present) and likely inactive with very low chance of earthquakes. Based on the available data, the Project is subject to low to moderate seismic ground shaking hazard. Ground rupture and slope stability are not considered to be significant hazards at the Project site. To address the management of sediment transport, erosion, and sedimentation during operation, the Project design would incorporate diversion berms, channels, and detention basins.

- **Agriculture and Soils**

The Project site soils would be subject to wind and water erosion during facility construction and operation activities. The United States Department of Agriculture soil survey classifies the soil onsite as typical durorthids, (soils characterized by shallow compact layer "hard pan"), loamy-skeletal, mixed hyperthermic, and shallow, and typical torripsamments. Construction activities would be in conformance with applicable regulatory requirements and sound construction practices. The soils on the Project site have a moderate to high hazard for wind erosion. Systematic watering of active grading areas during construction at least twice daily is expected to significantly reduce wind-borne dust. With implementation of the required Storm Water Pollution Prevention Plans (SWPPP) and a CEC-required Drainage Erosion Sediment Control Plan (DESCP) during and after construction, soil erosion impacts are expected to be less than significant.

- **Land Use**

The land use is currently undeveloped desert managed by the BLM as Class M land. Class M (Moderate Use) lands are managed to provide for a wide variety of uses such as mining, livestock grazing, recreation, utilities, and energy development. A ROW for a solar power generation facility effectively precludes other uses of the land and resources subject to the ROW for at least the term of the ROW and may extend to the time needed to reclaim the lands disturbed. An amendment to the BLM's California Desert Conservation Area Plan would likely be required for all solar power generation facilities, including the Genesis Solar Energy Project.

Attachment E-3

CACA 048808

PLAN OF DEVELOPMENT
FOR

CHUCKWALLA SOLAR I

Submitted by Chuckwalla Solar I, LLC
February 2009

Water usage, amounts, sources (during construction and operations)

Approximately 36,000 gallons of water per day will be required for mirror washing and ancillary requirements when the facility is complete. Construction water requirements will be approximately half this amount. Water will be supplied by on-site wells.

Erosion control and stormwater drainage

Erosion control and the quality of stormwater drainage will be maintained through "best practices" developed pursuant to the facility's NPDES General Permit.

Because facility components will not be located within the site's drainage channels, historic levels of runoff will be maintained.

The final engineering site plan will be based on detailed topographic and hydrologic studies of the site, and incorporate appropriate erosion control and drainage recommendations.

Vegetation treatment and weed management

The site is sparsely vegetated and no treatment is anticipated. Should the addition of mirror washing water result in the introduction of noxious plants in the vicinity of the trackers, those plants will be treated after consultation with the BLM.

Waste and hazardous materials management

Construction and operations personnel follow all federal, state, and local governmental regulation and guidelines when using, storing, transporting, or disposing of any hazardous material which may be used in conjunction with the construction and operation of the facility. Transformer, hydraulic and lubricating oils are the only materials expected to be stored on site in bulk, with smaller amounts of cleaners and degreasers. The facility will not use, store, transport of dispose of extremely hazardous material (40 Code of Federal Regulation 335). All lubricants, oils, greases, cleaners and degreasers will be kept in approved containers.

All construction vehicles and equipment will be maintained and serviced in accordance with manufacturer recommendations to minimize leaks of motor oils, hydraulic fluids and fuels. The refueling and maintenance of vehicles that are authorized for highway travel will be performed off-site at an appropriate facility. A fueling service will be engaged to refuel equipment that cannot be refueled off-site.

Fire protection

There is little potential for wildfire in the project site. Vegetation is sparse with little potential for fuel build-up. On site facility fire protection and the local fire protection district will be relied on to protect the site. A fire protection plan will be in place during construction and operations of the facility. All contractors will follow California Code of Regulations (CCR), Title 8, CCR Title 24 California Building Standards Code, Uniform Fire Code standards as applicable.

Site security and fencing (during construction and operations)

Barbed-wire fencing will surround the facility during construction and operations. While providing basic facility security, the barbed wire installation will allow for small animal pass-through and blend with the natural landscape.

2. Construction of Facilities

a. Solar field design, layout, installation and construction processes including timetable and sequence of construction

The surveys and studies undertaken during the NEPA process will identify exclusion areas and inform the final solar field layout. During Phase 1 construction, exclusion areas will be flagged in the area of construction, those primary roads necessary to connect the operations and maintenance (O&M) facility with the project substation and the first 25 MW of trackers will be staked, and they will be graded and graveled as necessary. Work on the project substation and the O&M facility will commence. Locations for Phase 1 trackers will be surveyed and graded, as necessary. Trackers will be installed and the collector system will be trenched to the project substation. For each subsequent phase, exclusion areas will be flagged, primary roads servicing that phase will be surveyed, and graded and graveled as necessary. Locations for that phase's trackers will be surveyed and graded as necessary. Trackers will be installed and the collector system trenched to connect to the existing collector network.

Processes	Phase	Anticipated Completion
Final facility design and layout	ROW	June 30, 2010
Grading and construction plans	Permitting	December 31, 2010
Roads, substation, O&M facility, trackers, collector system	1	June 30, 2011
Roads, trackers, collector system	2	December 31, 2011
Roads, trackers, collector system	3	June 30, 2012
Roads, trackers, collector system	4	December 31, 2012
Roads, trackers, collector system	5	December 31, 2013

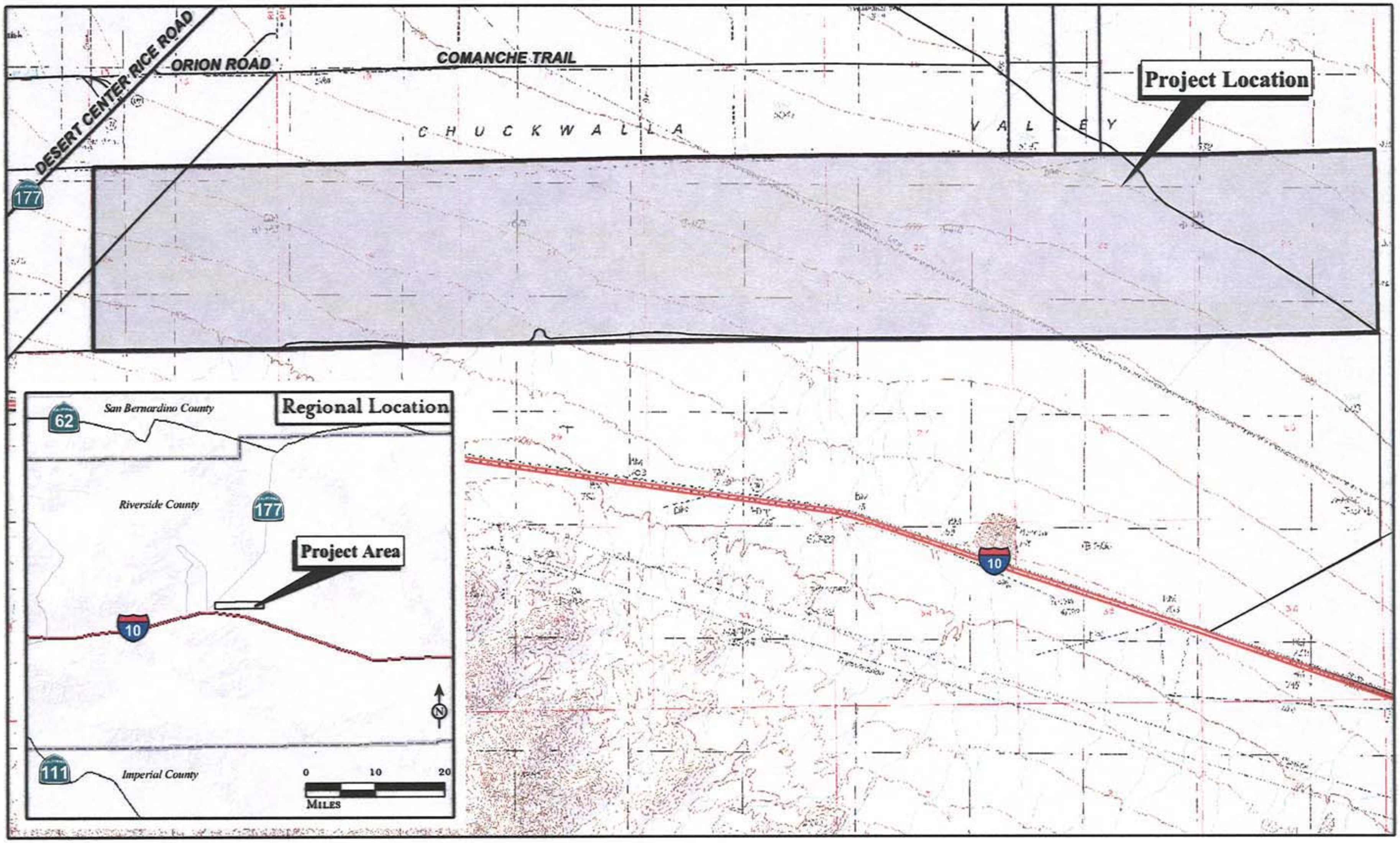
b. Phased projects, describe approach to construction and operations

Phase	Size	Anticipated Completion
1	25 MW	June 30, 2011
2	25 MW	December 31, 2011
3	25 MW	June 30, 2012
4	25 MW	December 31, 2012
5	100 MW	December 31, 2013

Each phase will be interconnected and become operational as completed.

c. Access and transportation system, component delivery, worker access

Site access, including worker access, is from State Highway 177 and Ragsdale Road, a frontage road to the project site. Facility components will be trucked to the facility site and delivered to the substation, tracker, or operations and maintenance construction area as appropriate.



LSA

0 2,000 4,000
FEET

SOURCE: USGS 7.5' Quads: Corn Spring (1986), Desert Center (1986) CA; Thomas Bros, 2007

I:\PZC0702\reports\BioResources\reg_loc.mxd (07/11/08)

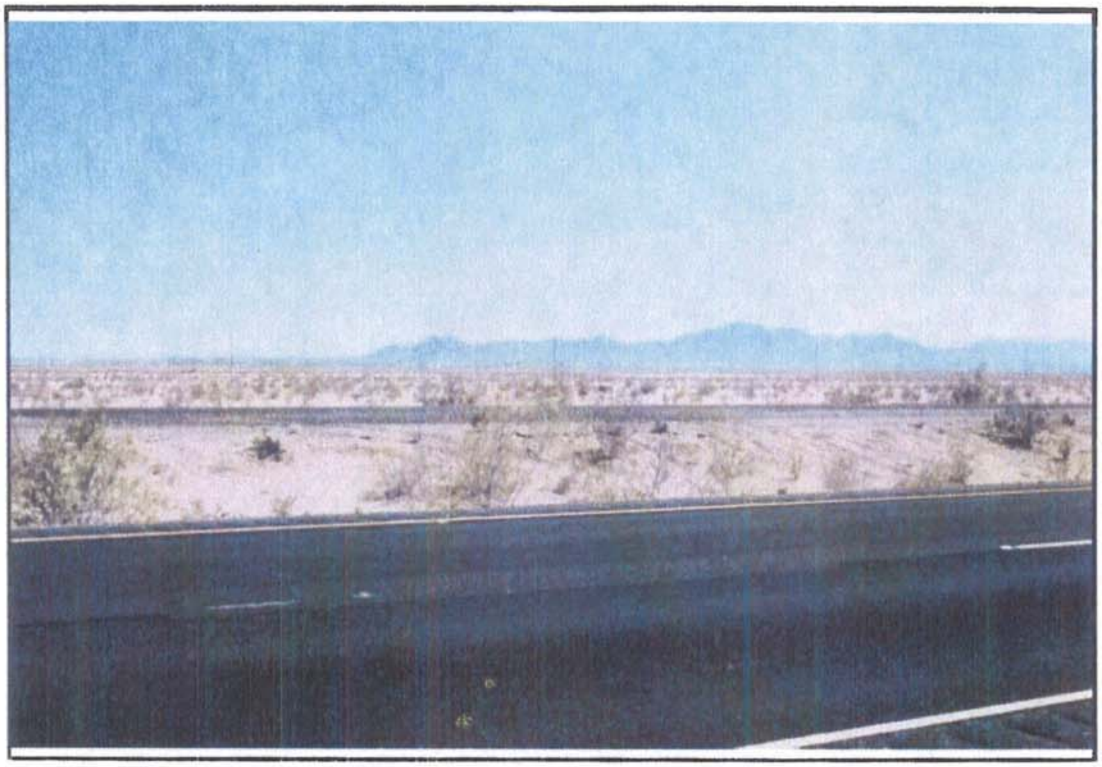
FIGURE 1

Chuckwalla Solar I
Biological Resources Assessment Report

Regional and Project Location

Attachment E-4

CACA 049097



MULE MOUNTAIN SOLAR PROJECT

SOLAR POWER GENERATION
PLAN OF DEVELOPMENT

March 2008
Revised May 18, 2009

1) SOLAR PROJECT DESCRIPTION

a) **Introduction** - Bullfrog Green Energy, LLC, (BFGE) is requesting a right-of-way (ROW) grant from the Bureau of Land Management (BLM) Palm Springs Field Office to develop, construct, and following construction and testing, own and operate up to a 500 MW "Concentrating Photovoltaic" (CPV) solar power generation facility with an estimated minimum service life of 30 years. The project will be developed and constructed in multiple phases over a period of several years.

i) **Type of Facility** - This proposed facility is a 500 MW "Concentrating Photovoltaic" (CPV) solar power generation facility will include access roads and service lanes, an underground electrical collection system, underground communication lines, concrete foundations, CPV solar power arrays with integrated dual axis tracking systems, electrical inverters to convert the DC generated solar power into AC power, transformers to step-up the generation voltage to collector system voltage, a fenced electrical switchyard and main transformer to step-up the collector system voltage to transmission voltage, and an operations & maintenance facility.

(1) **Planned Uses** - This facility will be exclusively used for utility scale solar power production.

(2) **Generation output** - The proposed facility will have a gross output Capacity of 500MW- AC with an anticipated annual output of around 1,400MWH.

ii) **Project Schedule** - The project will be developed and constructed in multiple phases over a period of several years. For simplicity's sake, assume this Proposed Schedule begins June 1, 2009, then the following calendar timeline would be as follows which includes these anticipated major Project Milestones:

(1) **BLM NOI**

(a) 4 months duration

(b) Ends September 30, 2009

(2) **BLM EIS**

(a) 12 months duration

(b) Ends September 30, 2010

(3) **Transmission Interconnection Studies**

(a) 12 months duration in parallel with EIS

(b) slack time

(4) **Project Design and Equipment Selections**

(a) 9 months duration

(b) Ends June, 2010

(5) **Project Construction**

(a) Phase A, 170 MW

(i) 9 months duration

(ii)Ends March 2011

(b) Phase B, 170 MW

(i) 9 months duration

(ii) plus 3 months lag from Phase A - Ends March 2012

(c) Phase C, 170 MW

(i) 9 months plus 3 months lag from Phase B

(ii)Ends March 2013

(6) **Start-up and Commissioning**

(a) Phase A, 170 MW

(i) 5 months duration

(ii)Ends August 2011

(b) Phase B, 170 MW

(i) 4 months duration

(ii) Ends July 2012

(c) Phase C, 170 MW

(i) 4 months duration

(ii)Ends July 2013

b) Proponents Purpose and Need for the Project

i) Bull Frog Green Energy, LLC. is investigating the Potential of the site for solar energy purposes, in response to the growing need for renewable electric power in the western United States. Increasing demand for low cost renewable energy results from both state and federal policies and goals, as well as increased retail demand for electricity. Federal policies include most recently President Obama's American Recovery and Reinvestment Act of 2009, (Appendix B), the National Energy Policy Report, May 2001, President Bush's May 18, 2001 Executive Order on Actions to Expedite Energy-Related Projects and the Clinton Administration's Solar Powering America initiative. Additionally, Individual States through out the South Western United States have adopted various Renewable Portfolio Standard (RPS) mandates, on average, that by the year 2010 a full 20% of the these state's electric generation come from renewable (green) resources. The target rises to 30% by the year 2017 to 2020. Such aggressive goals, coupled with projected energy demand growth, dictate that large scale renewable generation projects are of utmost importance for state regulators, utilities, and citizens alike.

type construction. This building will house the administration offices, operation/control room, maintenance area, tool shed, spare parts, locker rooms and bathrooms. The building will be located in an approximate 2 acre fenced area with a parking area for staff and visitors as well as a separate parking area for the company maintenance vehicles. The balance of the fenced area will be utilized for out door storage and work areas.

(b) The main substation will be approximately 3 acres in size and will include the main collector bus, the interconnection switchgear, main transformer, utility metering and dead-end structure.

ix) Water Usage

(1) **During construction**

(a) the roads will be sprayed with water twice daily to control dust. If feasible, water supplies will be provided from wells developed onsite by Mule Mountain Solar Project.

(b) Alternatively, if suitable water sources cannot be found within the project, water will be purchased from private or public water supplies in the vicinity. Blythe has already offered limited water access.

(2) **During the operation phase,**

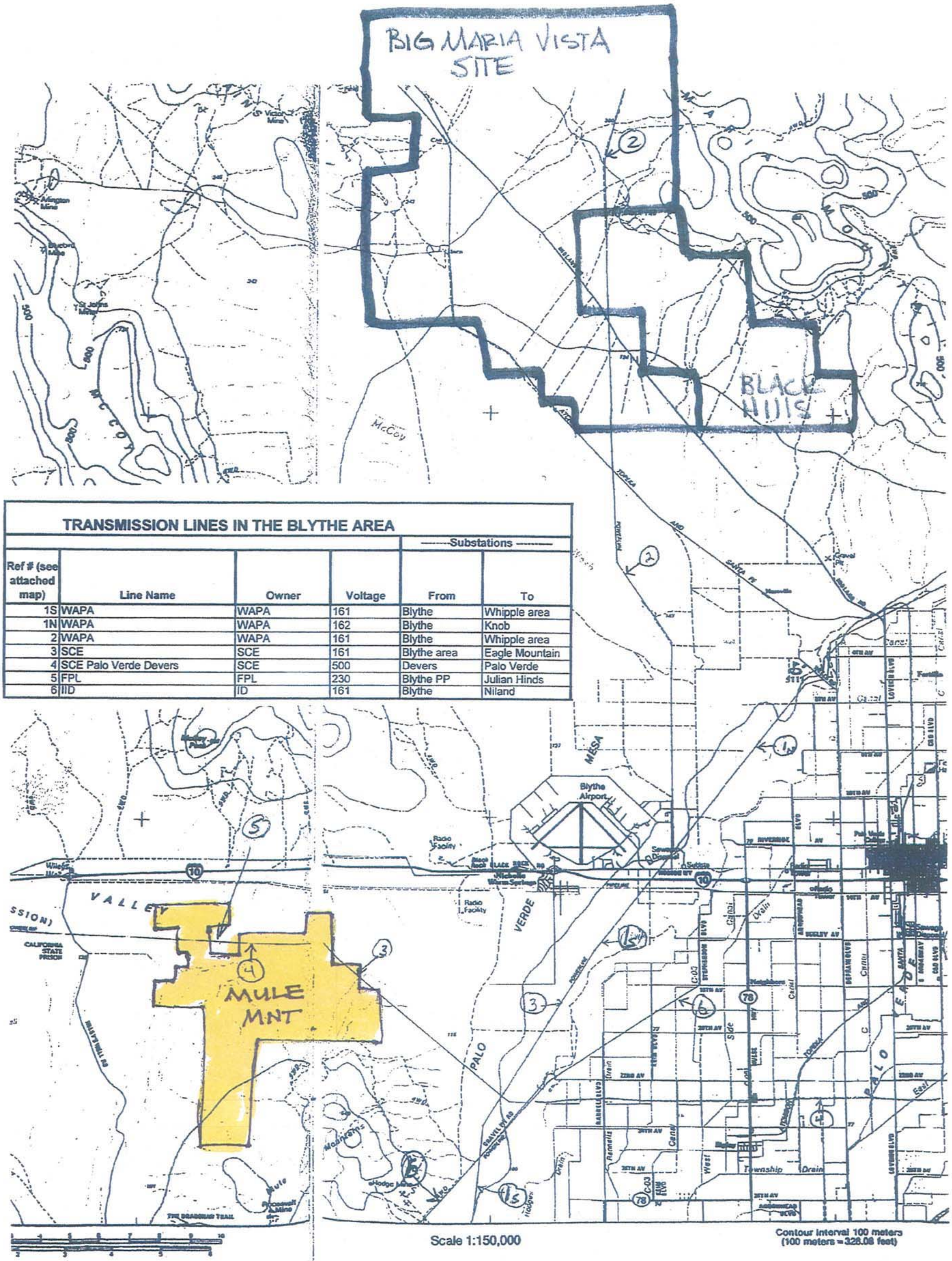
(a) Roads will be inspected at least twice annually. Periodic grading and placement of gravel may be required to maintain road quality. Maintenance of roads will be scheduled during times of low or no wind so as to minimize airborne dust. As a guideline, when wind speeds within two feet of ground level exceed 12 miles per hour (mph), road maintenance that would result in raising significant dust will be suspended until winds drop below this speed. Speed limits of 20 mph will be posted and required of all operation and maintenance personnel so as to minimize airborne dust and erosion of roads.

(b) We are planning the ability to drill for water to be used to wash the panels thereby keeping the panel performance as high as possible. If, however, a well is not possible, then we would anticipate the water will be trucked onto the facility once a month for washing. Each washing truck will hold approximately 3,000 gallons of water and will clean via a high pressure washer about 3,000 panels. Therefore, if we clean 33% of the total array per month, two washing trucks will be required each month.

x) Erosion Control and Storm Water Drainage

(1) This Project shall comply with all State and Local requirements of the Water Quality Control Board. These requirements are in accordance with key minimum Construction Best Management Practices (BMP's). These requirements are summarized below:

(a) The Applicant shall be responsible for clean-up of all silt and mud on adjacent roadways due to construction vehicles or any other construction



TRANSMISSION LINES IN THE BLYTHE AREA

Ref # (see attached map)	Line Name	Owner	Voltage	From (Substations)	To (Substations)
1S	WAPA	WAPA	161	Blythe	Whipple area
1N	WAPA	WAPA	162	Blythe	Knob
2	WAPA	WAPA	161	Blythe	Whipple area
3	SCE	SCE	161	Blythe area	Eagle Mountain
4	SCE Palo Verde Devers	SCE	500	Devers	Palo Verde
5	FPL	FPL	230	Blythe PP	Julian Hinds
6	IID	ID	161	Blythe	Niland

FIGURE A
BLYTHE AREA TRANSMISSION MAP

Attachment E-5

CACA 049489

Ford Dry Lake Soleil

Plan of Development

Confidential

Submitted to:
Bureau of Land Management Palm Springs Field Office, California

Submitted by:

enXco Development Corp.

The layout of facilities in this POD is contingent upon further biological and cultural surveys and thus the 2000 acre footprint within the project area may change. enXco would like to request additional time for these surveys before relinquishing any of the applied-for lands.

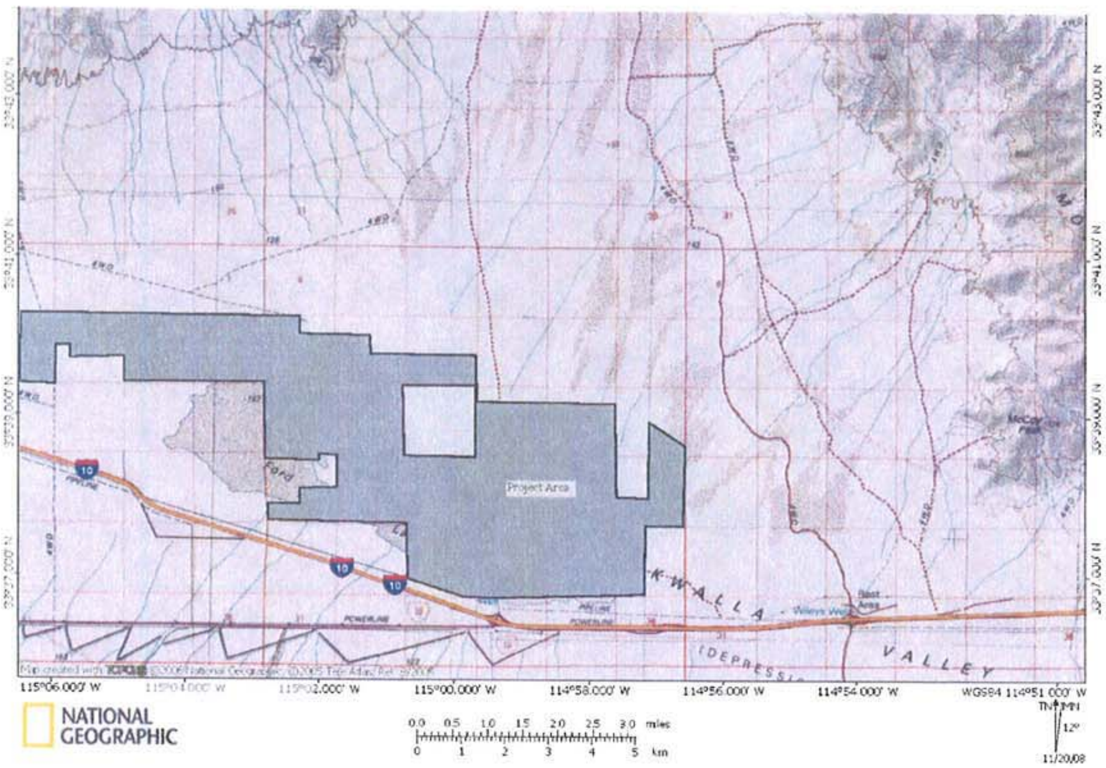


Figure 1: Map of Project Location

March, 2011 Begin installation of frames for photovoltaic panel
March 2011 Transmission Distribution system commences construction
July., 2011 Panel installation commences
Nov., 2011 Start-up testing of equipment commences
Dec, 2011 Commercial operation

4.2 PROJECT SCHEDULE

Task Name	2010				2011			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Detailed Engineering & Procurement		X						
Major Equipment Procurement, Bar & Delivery					X			
Construction Site Preparation, surveying and staking			X					
Solar Field frame installation					X	X	X	
Photovoltaic Panel Installation							X	X
Transmission Distribution line & Switch yard					X	X		
Start-up							X	X
Commercial Operation								X

Figure 10: Project Schedule

4.3 Construction Workforce and Vehicles

The on-site workforce will consist of laborers, craftsmen, supervisory personnel, supply personnel, and construction management personnel. The on-site workforce is expected to reach its peak of approximately 300 individuals. There will be an average workforce of approximately 100 construction craft people, supervisory, support, and construction management personnel on site during construction.

Construction will generally occur between 7 a.m. and 7 p.m., Monday through Friday. Additional hours may be necessary to correct Ford Dry Lake Soleil schedule deficiencies or to complete critical construction activities. For instance, during hot weather, it may be necessary to start work earlier to avoid pouring concrete during high ambient temperatures or to avoid heat stroke. During the startup phase of the project, some activities might be performed over the weekend.

Board, that the Palm Springs Field Office is now the point agency for water issues regarding solar development in the area.

7.16.2 Estimate of Daily and Annual Water Consumption Requirements

Panel washing is infrequent, but might occur as often as bi-anually and will require less than 5 acre-feet per year. Construction will require additional water for dust mitigation but should remain under 10 acre-feet per year. Drinking water will be provided by an off-site source during construction.

7.16.3 Waste Water

There will be no waste water during plant construction or operation. Water used to wash panels will be demineralized, and not contain any chemicals. The quantity will be carefully monitored to produce no appreciable runoff; that is, the water will soak directly into the ground below the panels, or evaporate, and not travel across the ground. Portable bathrooms will be provided during construction and operation, as needed, and will be emptied offsite per regulations.

7.17 Permitting

enXco is currently completing initial environmental surveys of the entire project area of Ford Dry Lake Soleil. Based upon this work, a complete list of permits required by Federal, State and local agencies will be assembled. After the EIS is complete, the Bureau of Land Management (BLM) will prepare a final record of decision (ROD).

The primary permitting for Ford Dry Lake Soleil will be carried out through the NEPA process by the BLM.

A complete list of required permits will be generated after the initial environmental surveys are complete. In [Figure 16], enXco has identified the agencies, permits and timeline that will likely be required for Ford Dry Lake Soleil.

enXco will also meet with BLM to satisfy the BLM requirements under NEPA, and understands that clear communication and early information will help BLM in this regard. Sections that would be particularly helpful to BLM have been identified as existing conditions, proposed alternatives, and biological resources. A detailed grading plan that identifies all potential surface disturbances will be created shortly.

Figure 11: Required Permits and Permit Schedule

Required Permits and Permit Schedule		
Air Quality	DOC	An application will be submitted to the Mojave Desert Air Quality Management District (MDAQMD) about the same time as the NEPA documents to obtain a determination of compliance (DOC).
	Federal Title V	May require Federal Operating Permit.

Attachment E-6

CACA 049492

enXco

Desert Lily Soleil

Plan of Development

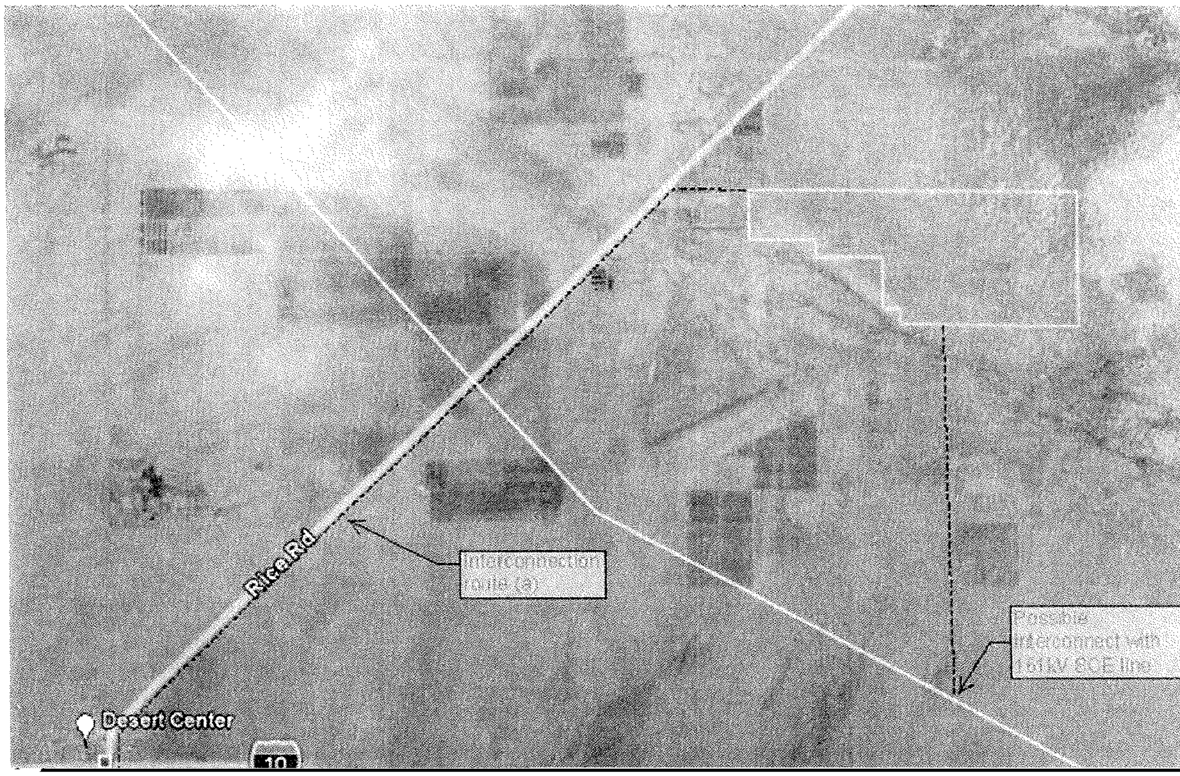
Confidential

Submitted to:
Bureau of Land Management Palm Springs Field Office, California

Submitted by:

enXco Development Corp.

enXco



Interconnection route (a)
Possible interconnect with 161kV SCE line
Rice Rd
Desert Center
10

March 2013	Transmission Distribution system commences construction
July, 2013	Panel installation commences
Nov., 2013	Start-up testing of equipment commences
Dec, 2013	Commercial operation

4.2 PROJECT SCHEDULE

Task Name	2012				2013			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Detailed Engineering & Procurement		X						
Major Equipment Procurement, Bar & Delivery					X			
Construction Site Preparation, surveying and staking			X					
Solar Field frame installation					X	X	X	
Photovoltaic Panel Installation							X	X
Transmission Distribution line & Switch yard					X	X		
Start-up							X	X
Commercial Operation								X

Figure 10: Project Schedule

4.3 Construction Workforce and Vehicles

The on-site workforce will consist of laborers, craftsmen, supervisory personnel, supply personnel, and construction management personnel. The on-site workforce is expected to reach its peak of approximately 300 individuals. There will be an average workforce of approximately 100 construction craft people, supervisory, support, and construction management personnel on site during construction.

Construction will generally occur between 7 a.m. and 7 p.m., Monday through Friday. Additional hours may be necessary to correct Desert Lily Soleil schedule deficiencies or to complete critical construction activities. For instance, during hot weather, it may be necessary to start work earlier to avoid pouring concrete during high ambient temperatures or to avoid heat stroke. During the startup phase of the project, some activities might be performed over the weekend.

100 construction craft people, supervisory, support, and construction management personnel on site during construction.

During construction, the number of truck loads and the tonnage delivered will be on the order of 600 loads totaling about 15,000 tons of equipment and materials. The timeframe and specific delivery schedule is still under development.

7.13 Transmission Line safety

A detailed study will be performed to determine any increases in EMF levels or audible noise due to construction or operation.

7.14 Visual resources

As mentioned above, the BLM land classification is currently Class M for Desert Lily Soleil, which may allow solar development. The project is approximately three miles from the Joshua Tree National Park. However, the photovoltaic array has a very low profile so the project is predicted to have a less than significant impact on visual resources. A more detailed treatment of visual resources will be undertaken during the EIS.

7.15 Waste Management

The Desert Lily Soleil will produce maintenance and plant wastes typical of photovoltaic power generation operations. Generation plant wastes include oily rags, broken and rusted metal and machine parts, defective or broken panels and electrical materials, empty containers, and other miscellaneous solid wastes including the typical refuse generated by workers. These materials will be collected by the local waste disposal. The broken panels will be collected by First Solar and recycled.

There is no daily volume of waste generated by the cycle. There will be some removal of office waste and broken components from time to time, but these volumes will be small. Project wastes are not projected to significantly affect the capacity of local hazardous and non-hazardous waste facilities.

7.16 Water

7.16.1 Water Availability

Desert Lily Soleil is located in the watershed to the west of the Colorado River that is considered "the accounting surface" for the Colorado River. This means that pumping groundwater in this area will require a contract with the Bureau of Reclamation, and require replacement with Colorado River water.

Given the complexity of water in the basin, enXco may opt to truck in water for its limited water requirements. Depending on on-going discussions with the BLM and the Bureau of Reclamation, enXco may also decide that installing a well on-site is the prudent course of action. enXco appreciates the work of BLM to help clarify how water will be obtained for the solar projects in the Desert Lily-Blythe corridor, and looks forward to working as a partner with BLM in the effort. It is enXco's understanding from extensive discussions with the Lake Havasu

Office, the Palo Verde Irrigation District, the Bureau of Reclamation, and the Colorado River Board, that the Palm Springs Field Office is now the point agency for water issues regarding solar development in the area.

7.16.2 Estimate of Daily and Annual Water Consumption Requirements

Panel washing is infrequent, but might occur as often as bi-anually and will require less than 5 acre-feet per year. Construction will require additional water for dust mitigation but should remain under 10 acre-feet per year. Drinking water will be provided by an off-site source during construction.

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7.17 Permitting

enXco is currently completing initial environmental surveys of the entire project area of Desert Lily Soleil. Based upon this work, a complete list of permits required by Federal, State and local agencies will be assembled. After the EIS is complete, the Bureau of Land Management (BLM) will prepare a final record of decision (ROD).

The primary permitting for Desert Lily Soleil will be carried out through the NEPA process by the BLM.

A complete list of required permits will be generated after the initial environmental surveys are complete. In [Figure 16], enXco has identified the agencies, permits and timeline that will likely be required for Desert Lily Soleil.

enXco will also meet with BLM to satisfy the BLM requirements under NEPA, and understands that clear communication and early information will help BLM in this regard. Sections that would be particularly helpful to BLM have been identified as existing conditions, proposed alternatives, and biological resources. A detailed grading plan that identifies all potential surface disturbances will be created shortly.

Figure 11: Required Permits and Permit Schedule

Required Permits and Permit Schedule		
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	Federal Title V	May require Federal Operating Permit.

Attachment E-7

Attachment 7

Year	**CACA 048649**		Project 2		**CACA 048808**		CACA 048880		**CACC 049097**		CACA 049486		CACA 049488		**CACA 049489**		CACA 049491		**CACA 049492**		CACA 049493		CACA 049494		CACA 050379		CACA 050437		CACA 051017		Sum		Constr	Annual	Sum
	Construction	**Annual**	Constructi	Annual	**Constructi**	**Annual**	Constructi	Annual	**Constructi**	**Annual**	Constructi	Annual	Constructi	Annual	**Constructi**	**Annual**	Constructi	Annual	**Constructi**	**Annual**	Constructi	Annual	Constructi	Annual	Constructi	Annual	Constructi	Annual	Constructi	Annual	Constructi	Annual	(gpm	(gpm)	(gpm)
2008																															0	0	0	0	0
2009																															0	0	0	0	0
2010															**10**																10	0	6	0	6
2011					**20**				**43**						**10**																73	0	45	0	45
2012	**20**				**20**				**43**							**5**			**10**												92	5	57	3	60
2013	**20**		22		**20**		813			**12**						**5**			**10**												885	17	548	11	559
2014	**20**		22			**40**	813			**12**	520		407			**5**				**5**											1,783	62	1,104	38	1,143
2015		**26**	22			**40**	813			**12**	520		407			**5**	407			**5**	679										2,849	88	1,765	55	1,820
2016		**26**		29		**40**		1,644		**12**	520		407			**5**	407			**5**	679		679		747						3,439	1,761	2,131	1,091	3,222
2017		**26**		29		**40**		1,644		**12**		300		180		**5**	407			**5**	679		679		747		679		679		3,870	2,241	2,397	1,389	3,786
2018		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300	679		747		679		679		2,783	2,721	1,724	1,686	3,410
2019		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330	679		679		1,358	3,351	841	2,076	2,918
2020		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2021		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2022		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2023		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2024		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2025		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2026		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2027		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2028		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2029		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2030		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2031		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2032		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2033		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2034		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2035		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2036		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2037		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2038		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2039		**26**		29		**40**		1,644		**12**		300		180		**5**		180		**5**		300		300		330		300		300	0	3,951	0	2,448	2,448
2040		**26**		29		**40**		1,644		**12**		300		180				180		**5**		300		300		330		300		300	0	3,946	0	2,445	2,445
2041		**26**		29				1,644				300		180				180		**5**		300		300		330		300		300	0	3,894	0	2,413	2,413
2042				29				1,644				300		180				180				300		300		330		300		300	0	3,863	0	2,393	2,393
2043												300		180				180				300		300		330		300		300	0	2,190	0	1,357	1,357
2044																		180				300		300		330		300		300	0	1,710	0	1,059	1,059
2045																								300		330		300		300	0	1,230	0	762	762
2046																												300		300	0	600	0	372	372
2047																															0	0	0	0	0
2048																															0	0	0	0	0
2049																															0	0	0	0	0
2050																															0	0	0	0	0
2051																															0	0	0	0	0
2052																															0	0	0	0	0
2053																															0	0	0	0	0
2054																															0	0	0	0	0
2055																															0	0	0	0	0
2056																															0	0	0	0	0
2057																															0	0	0	0	0
2058																															0	0	0	0	0
2059																															0	0	0	0	0
2060																															0	0	0	0	0
2061																															0	0	0	0	0
2062																															0	0	0	0	0
2063																															0	0	0	0	0
2064																															0	0	0	0	0
2065																															0	0	0	0	0
2066																															0	0	0	0	0
2067																															0	0	0	0	0

Eagle Mountain Pumped Storage Project – Water Use Distribution

Prepared by: David Fairman, Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

October 23, 2009

GEI Consultants, Inc. (GEI) prepared this data transmittal to present the distribution of water use throughout the Chuckwalla groundwater basin for use in drawdown modeling.

Previously submitted data transmittals contain water use estimates for the project construction water, proposed solar facilities, landfill, Coachella Valley raceway, and the Lake Tamarisk development which are scattered throughout the basin. Existing water use by domestic, agriculture and the state prisons are also spread throughout the basin. To account for the distribution of these water uses by the drawdown modeling the pumping is accumulated and assigned to centroid (CW) or observation wells (OW). Generally the pumping was grouped and assigned to the Upper Chuckwalla, Desert Center, East of Desert Center, Ford Dry Lake or the Lower Chuckwalla areas. Tables 1 through 5 summarize the distribution of pumping for modeling purposes. Figure 1 shows the location of wells where the pumping will be distributed.

References

GEI Consultants, Inc. (2009). Final License Application submitted to the Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

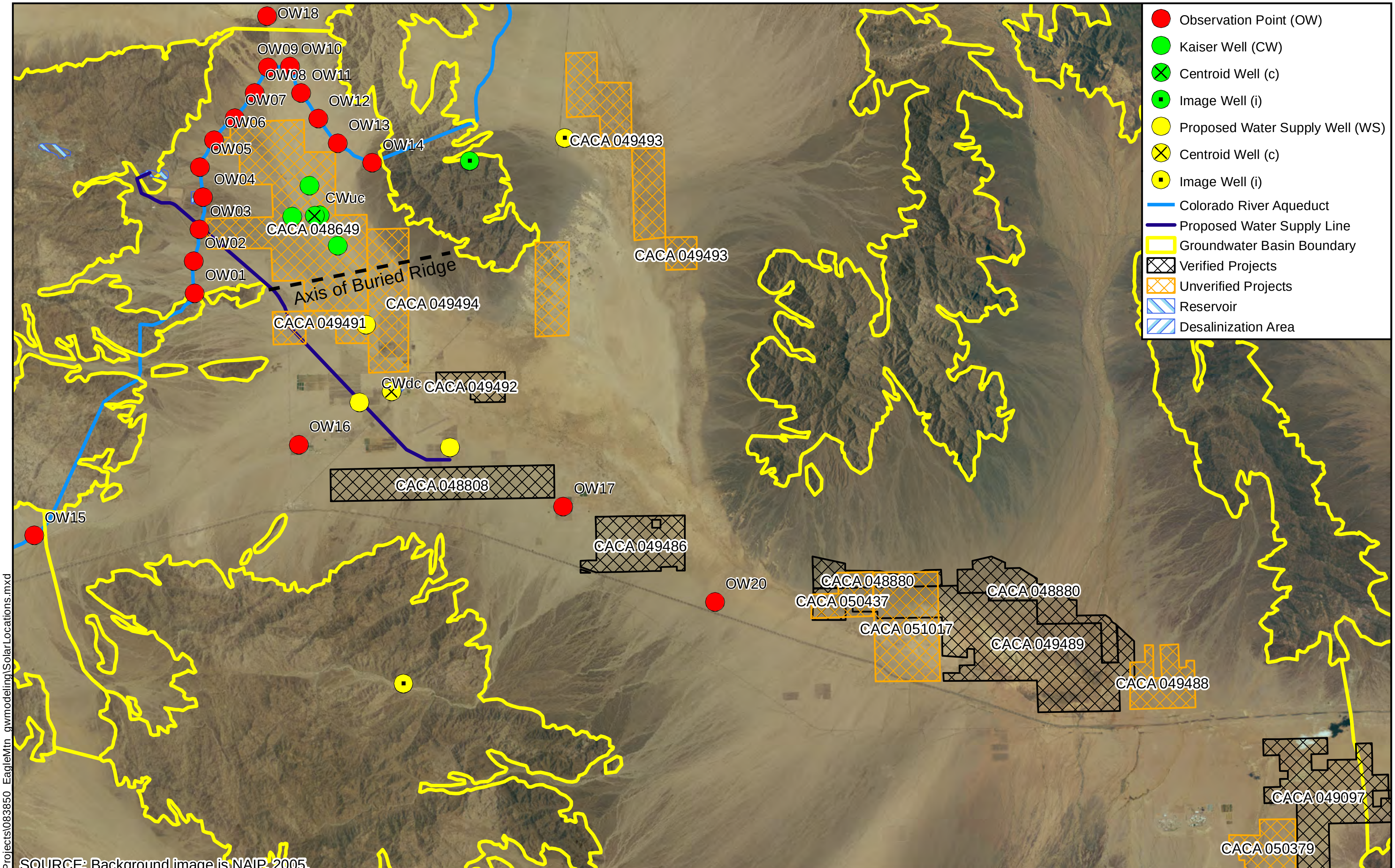
GEI Consultants, Inc. (2009). Project Construction Water Use.

GEI Consultants, Inc. (2009). Lake Tamarisk Water Use Estimates

GEI Consultants, Inc. (2009). Landfill Water Use Estimates

GEI Consultants, Inc. (2009). Chuckwalla Valley Raceway Water Use Estimates

GEI Consultants, Inc. (2009). Solar Facilities Water Use Estimates



4 2 0 4

Miles

N W E S

Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy Company

PROPOSED SOLAR PROJECT LOCATIONS

OCTOBER 2009

FIGURE 1

25-Mar-09 S:\GIS\Projects\083850_EagleMtn_gwmodeling\SolarLocations.mxd

Table 1
Desert Center Area (assigned to well CWdc)

Year	Existing (AFY) Aquaculture Pumping/Open Water Evap	Desert Center Domestic	So. Cal Gas	Lake Tamarisk	Agricultural Pumping	Sum (AFY)	Project (AFY) Eagle Mountain Pumped Storage Project Water Supply Wells	Eagle Mountain Pumped Storage Project Construction Water Usage	Sum (AFY)	Proposed (AFY) Raceway	Solar Facilities CACA 048808	CACA 049492	CACA 049493	CACA 049494	CACA 049491	Sum (AFY)	Sum (gpm)
2010	215	50	1	1,090	1,800	**3,156**	0	0	**0**	11						**11**	**7**
2011	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3	20					**23**	**14**
2012	215	50	1	1,090	1,800	**3,156**	0	308	**308**	3	20	10				**33**	**20**
2013	215	50	1	1,090	1,800	**3,156**	0	308	**308**	14	20	10				**44**	**27**
2014	215	50	1	1,090	1,800	**3,156**	7,758	308	**8,066**	3	40	5				**48**	**30**
2015	215	50	1	1,090	1,800	**3,156**	8,066	0	**8,066**	3	40	5	679		407	**1,134**	**703**
2016	215	50	1	1,090	1,800	**3,156**	8,066	0	**8,066**	14	40	5	679	679	407	**1,824**	**1,130**
2017	215	50	1	1,090	1,800	**3,156**	8,066	0	**8,066**	3	40	5	679	679	407	**1,813**	**1,123**
2018	215	50	1	1,090	1,800	**3,156**	2,688	0	**2,688**	3	40	5	300	679	180	**1,207**	**748**
2019	215	50	1	1,090	1,800	**3,156**	1,767	0	**1,767**	3	40	5	300	300	180	**828**	**513**
2020	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2021	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2022	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2023	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2024	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2025	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2026	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2027	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2028	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2029	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2030	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2031	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2032	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2033	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2034	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2035	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2036	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2037	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2038	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2039	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2040	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3	40	5	300	300	180	**828**	**513**
2041	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3		5	300	300	180	**788**	**488**
2042	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3			300	300	180	**783**	**485**
2043	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3			300	300	180	**783**	**485**
2044	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3			300	300	180	**783**	**485**
2045	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3				300		**303**	**188**
2046	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2047	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2048	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2049	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2050	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2051	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2052	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2053	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2054	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2055	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2056	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2057	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2058	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2059	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2060	215	50	1	1,090	1,800	**3,156**	1,763	0	**1,763**	3						**3**	**2**
2061	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2062	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2063	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2064	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2065	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2066	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2067	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2068	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2069	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
2070	215	50	1	1,090	1,800	**3,156**	0	0	**0**	3						**3**	**2**
Average							2,237				38	5	338	338	**203**	**922**	

Table 2
Upper Chuckwalla Valley (assigned to well CWuc)

Year	Existing (AFY)	Project (AFY)	Proposed (AFY)		Solar Facilities			
	Sum (AFY)	Sum (AFY)	Eagle Mountain Town Site	Proposed Landfill Water Usage	CACA 048649 Phase 1	CACA 048649 Phase 2	**Sum (AFY)**	**Sum (gpm)**
2010			0	0			**0**	**0**
2011			0	0			**0**	**0**
2012			0	0	20		**20**	**12**
2013			0	0	20	22	**42**	**26**
2014			0	0	20	22	**42**	**26**
2015			0	0	26	22	**48**	**30**
2016			0	0	26	29	**55**	**34**
2017			0	0	26	29	**55**	**34**
2018			0	0	26	29	**55**	**34**
2019			0	0	26	29	**55**	**34**
2020			173	245	26	29	**473**	**293**
2021			173	185	26	29	**413**	**256**
2022			173	185	26	29	**413**	**256**
2023			173	185	26	29	**413**	**256**
2024			173	185	26	29	**413**	**256**
2025			173	365	26	29	**593**	**368**
2026			173	365	26	29	**593**	**368**
2027			173	365	26	29	**593**	**368**
2028			173	365	26	29	**593**	**368**
2029			173	365	26	29	**593**	**368**
2030			173	581	26	29	**809**	**501**
2031			173	581	26	29	**809**	**501**
2032			173	581	26	29	**809**	**501**
2033			173	581	26	29	**809**	**501**
2034			173	581	26	29	**809**	**501**
2035			173	823	26	29	**1,051**	**651**
2036			173	823	26	29	**1,051**	**651**
2037			173	823	26	29	**1,051**	**651**
2038			173	823	26	29	**1,051**	**651**
2039			173	823	26	29	**1,051**	**651**
2040			173	823	26	29	**1,051**	**651**
2041			173	823	26	29	**1,051**	**651**
2042			173	823		29	**1,025**	**635**
2043			173	823			**996**	**617**
2044			173	823			**996**	**617**
2045			173	1,070			**1,243**	**770**
2046			173	1,070			**1,243**	**770**
2047			173	1,070			**1,243**	**770**
2048			173	1,070			**1,243**	**770**
2049			173	1,070			**1,243**	**770**
2050			173	1,070			**1,243**	**770**
2051			173	1,070			**1,243**	**770**
2052			173	1,070			**1,243**	**770**
2053			173	1,070			**1,243**	**770**
2054			173	1,070			**1,243**	**770**
2055			173	1,070			**1,243**	**770**
2056			173	1,070			**1,243**	**770**
2057			173	1,070			**1,243**	**770**
2058			173	1,070			**1,243**	**770**
2059			173	1,070			**1,243**	**770**
2060			173	1,070			**1,243**	**770**
2061			173	1,070			**1,243**	**770**
2062			173	1,070			**1,243**	**770**
2063			173	1,070			**1,243**	**770**
2064			173	1,070			**1,243**	**770**
2065			173	1,070			**1,243**	**770**
2066			173	1,070			**1,243**	**770**
2067			173	1,070			**1,243**	**770**
2068			173	1,070			**1,243**	**770**
2069			173	1,070			**1,243**	**770**
2070			173	1,070			**1,243**	**770**
Average				**819**	**26**	**28**	**54**	

Table 3
East of Desert Center (assigned to well OW17)

Year	Existing (AFY) Agricultural Pumping	Sum (AFY)	Project (AFY) Sum (AFY)	Proposed (AFY) Solar Facilities CACA 049486	Sum (AFY)	Sum (gpm)
2010	4,600	**4,600**			**0**	**0**
2011	4,600	**4,600**			**0**	**0**
2012	4,600	**4,600**			**0**	**0**
2013	4,600	**4,600**			**0**	**0**
2014	4,600	**4,600**		520	**520**	**322**
2015	4,600	**4,600**		520	**520**	**322**
2016	4,600	**4,600**		520	**520**	**322**
2017	4,600	**4,600**		300	**300**	**186**
2018	4,600	**4,600**		300	**300**	**186**
2019	4,600	**4,600**		300	**300**	**186**
2020	4,600	**4,600**		300	**300**	**186**
2021	4,600	**4,600**		300	**300**	**186**
2022	4,600	**4,600**		300	**300**	**186**
2023	4,600	**4,600**		300	**300**	**186**
2024	4,600	**4,600**		300	**300**	**186**
2025	4,600	**4,600**		300	**300**	**186**
2026	4,600	**4,600**		300	**300**	**186**
2027	4,600	**4,600**		300	**300**	**186**
2028	4,600	**4,600**		300	**300**	**186**
2029	4,600	**4,600**		300	**300**	**186**
2030	4,600	**4,600**		300	**300**	**186**
2031	4,600	**4,600**		300	**300**	**186**
2032	4,600	**4,600**		300	**300**	**186**
2033	4,600	**4,600**		300	**300**	**186**
2034	4,600	**4,600**		300	**300**	**186**
2035	4,600	**4,600**		300	**300**	**186**
2036	4,600	**4,600**		300	**300**	**186**
2037	4,600	**4,600**		300	**300**	**186**
2038	4,600	**4,600**		300	**300**	**186**
2039	4,600	**4,600**		300	**300**	**186**
2040	4,600	**4,600**		300	**300**	**186**
2041	4,600	**4,600**		300	**300**	**186**
2042	4,600	**4,600**		300	**300**	**186**
2043	4,600	**4,600**		300	**300**	**186**
2044	4,600	**4,600**			**0**	**0**
2045	4,600	**4,600**			**0**	**0**
2046	4,600	**4,600**			**0**	**0**
2047	4,600	**4,600**			**0**	**0**
2048	4,600	**4,600**			**0**	**0**
2049	4,600	**4,600**			**0**	**0**
2050	4,600	**4,600**			**0**	**0**
2051	4,600	**4,600**			**0**	**0**
2052	4,600	**4,600**			**0**	**0**
2053	4,600	**4,600**			**0**	**0**
2054	4,600	**4,600**			**0**	**0**
2055	4,600	**4,600**			**0**	**0**
2056	4,600	**4,600**			**0**	**0**
2057	4,600	**4,600**			**0**	**0**
2058	4,600	**4,600**			**0**	**0**
2059	4,600	**4,600**			**0**	**0**
2060	4,600	**4,600**			**0**	**0**
2061	4,600	**4,600**			**0**	**0**
2062	4,600	**4,600**			**0**	**0**
2063	4,600	**4,600**			**0**	**0**
2064	4,600	**4,600**			**0**	**0**
2065	4,600	**4,600**			**0**	**0**
2066	4,600	**4,600**			**0**	**0**
2067	4,600	**4,600**			**0**	**0**
2068	4,600	**4,600**			**0**	**0**
2069	4,600	**4,600**			**0**	**0**
2070	4,600	**4,600**			**0**	**0**
Average				322	**322**	

Table 4
Ford Dry Lake (assigned to well OW20)

Year	Existing (AFY) Agricultural Pumping	Sum (AFY)	Project (AFY) Sum (AFY)	Proposed (AFY) Solar Facilities CACA 048880	CACA 049488	CACA 049489	CACA 050437	CACA 051017	Sum (AFY)	Sum (gpm)
2010						10			**10**	**6**
2011						10			**10**	**6**
2012						5			**5**	**3**
2013				813		5			**818**	**507**
2014				813	407	5			**1,226**	**759**
2015				813	407	5			**1,226**	**759**
2016				1,644	407	5			**2,056**	**1,274**
2017				1,644	180	5	679	679	**3,187**	**1,974**
2018				1,644	180	5	679	679	**3,187**	**1,974**
2019				1,644	180	5	679	679	**3,187**	**1,974**
2020				1,644	180	5	300	300	**2,429**	**1,505**
2021				1,644	180	5	300	300	**2,429**	**1,505**
2022				1,644	180	5	300	300	**2,429**	**1,505**
2023				1,644	180	5	300	300	**2,429**	**1,505**
2024				1,644	180	5	300	300	**2,429**	**1,505**
2025				1,644	180	5	300	300	**2,429**	**1,505**
2026				1,644	180	5	300	300	**2,429**	**1,505**
2027				1,644	180	5	300	300	**2,429**	**1,505**
2028				1,644	180	5	300	300	**2,429**	**1,505**
2029				1,644	180	5	300	300	**2,429**	**1,505**
2030				1,644	180	5	300	300	**2,429**	**1,505**
2031				1,644	180	5	300	300	**2,429**	**1,505**
2032				1,644	180	5	300	300	**2,429**	**1,505**
2033				1,644	180	5	300	300	**2,429**	**1,505**
2034				1,644	180	5	300	300	**2,429**	**1,505**
2035				1,644	180	5	300	300	**2,429**	**1,505**
2036				1,644	180	5	300	300	**2,429**	**1,505**
2037				1,644	180	5	300	300	**2,429**	**1,505**
2038				1,644	180	5	300	300	**2,429**	**1,505**
2039				1,644	180	5	300	300	**2,429**	**1,505**
2040				1,644	180		300	300	**2,424**	**1,502**
2041				1,644	180		300	300	**2,424**	**1,502**
2042				1,644	180		300	300	**2,424**	**1,502**
2043					180		300	300	**780**	**483**
2044							300	300	**600**	**372**
2045							300	300	**600**	**372**
2046							300	300	**600**	**372**
2047									**0**	**0**
2048									**0**	**0**
2049									**0**	**0**
2050									**0**	**0**
2051									**0**	**0**
2052									**0**	**0**
2053									**0**	**0**
2054									**0**	**0**
2055									**0**	**0**
2056									**0**	**0**
2057									**0**	**0**
2058									**0**	**0**
2059									**0**	**0**
2060									**0**	**0**
2061									**0**	**0**
2062									**0**	**0**
2063									**0**	**0**
2064									**0**	**0**
2065									**0**	**0**
2066									**0**	**0**
2067									**0**	**0**
2068									**0**	**0**
2069									**0**	**0**
2070									**0**	**0**
Average				1,561	203	5	338	338	**2,445**	

Table 5
Lower Chuckwalla (unassigned) [1]

Year	Existing (AFY) State Prisons	Existing Sum (AFY)	Project (AFY)	Project Sum (AFY)	Proposed (AFY) Solar Facilities CACA 049097	Proposed (AFY) Solar Facilities CACA 050379	Sum (AFY)	Sum (gpm)
2010	2,100	**2,100**					**0**	**0**
2011	1,500	**1,500**			43		**43**	**26**
2012	1,500	**1,500**			43		**43**	**26**
2013	1,500	**1,500**			12		**12**	**7**
2014	1,500	**1,500**			12		**12**	**7**
2015	1,500	**1,500**			12		**12**	**7**
2016	1,500	**1,500**			12	747	**759**	**470**
2017	1,500	**1,500**			12	747	**759**	**470**
2018	1,500	**1,500**			12	747	**759**	**470**
2019	1,500	**1,500**			12	330	**342**	**212**
2020	1,500	**1,500**			12	330	**342**	**212**
2021	1,500	**1,500**			12	330	**342**	**212**
2022	1,500	**1,500**			12	330	**342**	**212**
2023	1,500	**1,500**			12	330	**342**	**212**
2024	1,500	**1,500**			12	330	**342**	**212**
2025	1,500	**1,500**			12	330	**342**	**212**
2026	1,500	**1,500**			12	330	**342**	**212**
2027	1,500	**1,500**			12	330	**342**	**212**
2028	1,500	**1,500**			12	330	**342**	**212**
2029	1,500	**1,500**			12	330	**342**	**212**
2030	1,500	**1,500**			12	330	**342**	**212**
2031	1,500	**1,500**			12	330	**342**	**212**
2032	1,500	**1,500**			12	330	**342**	**212**
2033	1,500	**1,500**			12	330	**342**	**212**
2034	1,500	**1,500**			12	330	**342**	**212**
2035	1,500	**1,500**			12	330	**342**	**212**
2036	1,500	**1,500**			12	330	**342**	**212**
2037	1,500	**1,500**			12	330	**342**	**212**
2038	1,500	**1,500**			12	330	**342**	**212**
2039	1,500	**1,500**			12	330	**342**	**212**
2040	1,500	**1,500**			12	330	**342**	**212**
2041	1,500	**1,500**				330	**330**	**204**
2042	1,500	**1,500**				330	**330**	**204**
2043	1,500	**1,500**				330	**330**	**204**
2044	1,500	**1,500**				330	**330**	**204**
2045	1,500	**1,500**				330	**330**	**204**
2046	1,500	**1,500**					**0**	**0**
2047	1,500	**1,500**					**0**	**0**
2048	1,500	**1,500**					**0**	**0**
2049	1,500	**1,500**					**0**	**0**
2050	1,500	**1,500**					**0**	**0**
2051	1,500	**1,500**					**0**	**0**
2052	1,500	**1,500**					**0**	**0**
2053	1,500	**1,500**					**0**	**0**
2054	1,500	**1,500**					**0**	**0**
2055	1,500	**1,500**					**0**	**0**
2056	1,500	**1,500**					**0**	**0**
2057	1,500	**1,500**					**0**	**0**
2058	1,500	**1,500**					**0**	**0**
2059	1,500	**1,500**					**0**	**0**
2060	1,500	**1,500**					**0**	**0**
2061	1,500	**1,500**					**0**	**0**
2062	1,500	**1,500**					**0**	**0**
2063	1,500	**1,500**					**0**	**0**
2064	1,500	**1,500**					**0**	**0**
2065	1,500	**1,500**					**0**	**0**
2066	1,500	**1,500**					**0**	**0**
2067	1,500	**1,500**					**0**	**0**
2068	1,500	**1,500**					**0**	**0**
2069	1,500	**1,500**					**0**	**0**
2070	1,500	**1,500**					**0**	**0**
Average					14	372	**386**	

[1] State Prison and solar facilities in Lower Chuckwalla Valley not included in the drawdown model due to large distance from project

Attachment F

Eagle Mountain Pumped Storage Project – Recoverable Water Estimates

Prepared by: David Fairman, Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

October 15, 2009

GEI Consultants, Inc. (GEI), prepared this data transmittal to present estimates of natural recharge to the Chuckwalla groundwater basin.

One of the most difficult estimates in desert basins is natural recharge (FAO, 1981). Several authors have made estimates of the groundwater recharge to the Chuckwalla groundwater basin varying from 10,000 to 20,000 acre-feet per year (AFY) as shown in Table 1. ECE in the Final License Application (FLA) submitted to the Federal Energy Regulatory Commission June 2009, reported these estimates and used what was considered to be a conservatively low value of 12,200 AFY (Hanson,1992). The National Park Service (NPS) suggested that the estimate used is too high and recommends using an estimate of 9,800 AFY (NPS 2009). ECE has undertaken this study to estimate recharge to the Chuckwalla basin.

The area evaluated included the Chuckwalla groundwater basin as well as the tributary Pinto and Orocopia groundwater basins. Because the Pinto and Orocopia basins are tributary to the Chuckwalla and they have little to no pumping, deep percolation in these basins would become recharge to the Chuckwalla groundwater basin.

In order to prepare a valid estimate of recharge a literature search was conducted to find a representative method to estimate the deep percolation in the Chuckwalla groundwater basin using available information. Recoverable water estimates have been developed for a nearby basin, Fenner Basin, using a variety of methods. Figure 1 shows the location of the Fenner basin. A groundwater model, a water balance, a chloride mass balance, the Crippen method, and the Maxey-Eakin method were used to develop annual recoverable water estimates in the Fenner Basin (URS, 1999). The estimates also included professional opinions of the recharge using simple estimates by a Metropolitan Water District's Review Panel (Review Panel). Figure 2 shows the results of these studies and the fairly broad range of estimates. An average of the estimates was also developed. Two of these methods were identified that could be used to estimate the recharge in the Chuckwalla groundwater basin using available data. Recharge was estimated using the Maxey-Eakin method (Maxey and Eakin, 1950) as well as using recommendations from the MWD Review Panel.

The Maxey-Eakin method was developed for large alluvial filled valleys that are surrounded by mountainous terrain with either shallow soils or exposed bedrock, similar to that present in the Chuckwalla and tributary basins. The method can be used where limited climatic and hydrogeologic information is available. This method uses average annual precipitation to classify areas of a basin into five recharge zones. Each zone uses a different percentage of average annual precipitation becoming recharge: 0% recharge for less than 8-inches average annual precipitation, 3% for 8- to 12-inches, 7% for 12- to 15-inches, 15% for 15- to 20-

inches, and 25% for 20-inches or greater. The method has since been modified, using a continuous function to determine the fraction of recharge instead of the stepped function first proposed by Maxey-Eakin (Hevesi and Flint, 1998). The modified method has been applied to the Fenner Basin (USGS-WRD, 2000). The method substantially underestimates the recharge in comparison to other, more exhaustive methods as shown on Figure 2. Lawrence-Livermore National Laboratory did a study which calibrated the Maxey-Eakin model to the Fenner basin and came up with values closer to other methods (Davisson and Rose, 2000). The results of these studies are shown on Figure 2. The range of recharge values for Maxey-Eakin estimates are determined by whether the local or regional precipitation curve shown on Figure 3 was used.

For the Chuckwalla and tributary basins, the surface area within the basins was measured from USGS topographic maps to determine the area at 820 foot (250 meter) intervals. Ground surface elevations in the basins range from 400 foot to 5,400 foot elevation. Table 2 presents the areas by elevation within each basin. To determine the precipitation at each elevation range, the local precipitation-elevation curve from Figure 3 was used. Recharge was determined by using the continuous curve developed by Hevesi and Flint shown on Figure 4. This produced a range of recharge values from 600 to 3,100 AFY, much lower than other estimates in Table 1.

Metropolitan Water District's Review Panel applied an empirical approach to recharge in the Fenner Basin. Based on their professional experience they predicted that somewhere between 3% and 7% of precipitation over the area of the basin would become groundwater recharge. These estimates are also shown on Figure 2. These estimates came very close to those from more exhaustive methods such as a water balance model by Geoscience (URS, 1999).

GEI repeated this method for the Chuckwalla and tributary Basins. However, only mountainous areas of the basin were considered, and valley floor areas were considered to contribute zero change. This conservative approach was used because the elevations of the basins are lower than in the Fenner Basin, as shown on Figure 5, and would receive less precipitation in the valley floors. Also, precipitation on the alluvial floor is much less likely to infiltrate and more likely to evaporate due to the presence of fine-grained silts and clays, especially in the dry lake beds. Precipitation was estimated using the local precipitation-elevation curve on Figure 3 and the average elevation of the mountainous regions, 2,800 feet. Recharge using this approach is estimated to be between 7,600 and 17,700 AFY with a mean of 12,700 AFY as shown on Figure 2 and in Tables 3-5.

Given the fact that an uncalibrated Maxey-Eakin method has been shown to substantially underestimate the recharge and that the Review Panel's estimate of percentage of precipitation was in congruence with other estimates, a value of 12,700 AFY will be used as the value for recharge in water balance calculations. This value is in line with previous estimates available in the published literature.

References

CH2MHill (1996). Draft Environmental Impact Statement/ Environmental Impact Report Eagle Mountain Landfill and Recycling Center Project. State Clearinghouse No. 95052023. 3574 pages.

Davisson, M.L. and Rose, T.P. (2000). Maxey-Eakin Methods for Estimating Groundwater Recharge in the Fenner Watershed, Southeastern California. Lawrence Livermore National Laboratory (LLNL).

Food and Agriculture Organization of the United Nations (FAO) (1981). Arid Zone Hydrology. FAO Irrigation and Drainage Paper 37. Pages 223-260.

GEI Consultants, Inc. (2009). Final License Application submitted to the Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

Greystone Environmental Consultants, Inc. (1994). Source, Anticipated Impacts, and Possible Mitigation Measures Associated with the Water Supply for the Eagle Mountain Pumped Storage Project.

Hanson, J.C. (1992). Letter of Geothermal Surveys, Inc. Groundwater Conditions – Eagle Mountain Area.

Hevesi, J.A. and Flint, A.L. (1998). Geostatistical estimates of future recharge for the Death Valley Region. In High Level Radioactive Waste Management, Proceedings of the Ninth Annual International Conference, Las Vegas, Nev., May 11-15, 1998: LaGrange Park, Ill. American Nuclear Society, pages 173-177.

LeRoy Crandall and Associates (LCA) (1981). Report of Phase II Investigation, Feasibility of Storing Colorado River Water in Desert Groundwater Basins. Prepared for Metropolitan Water District of Southern California.

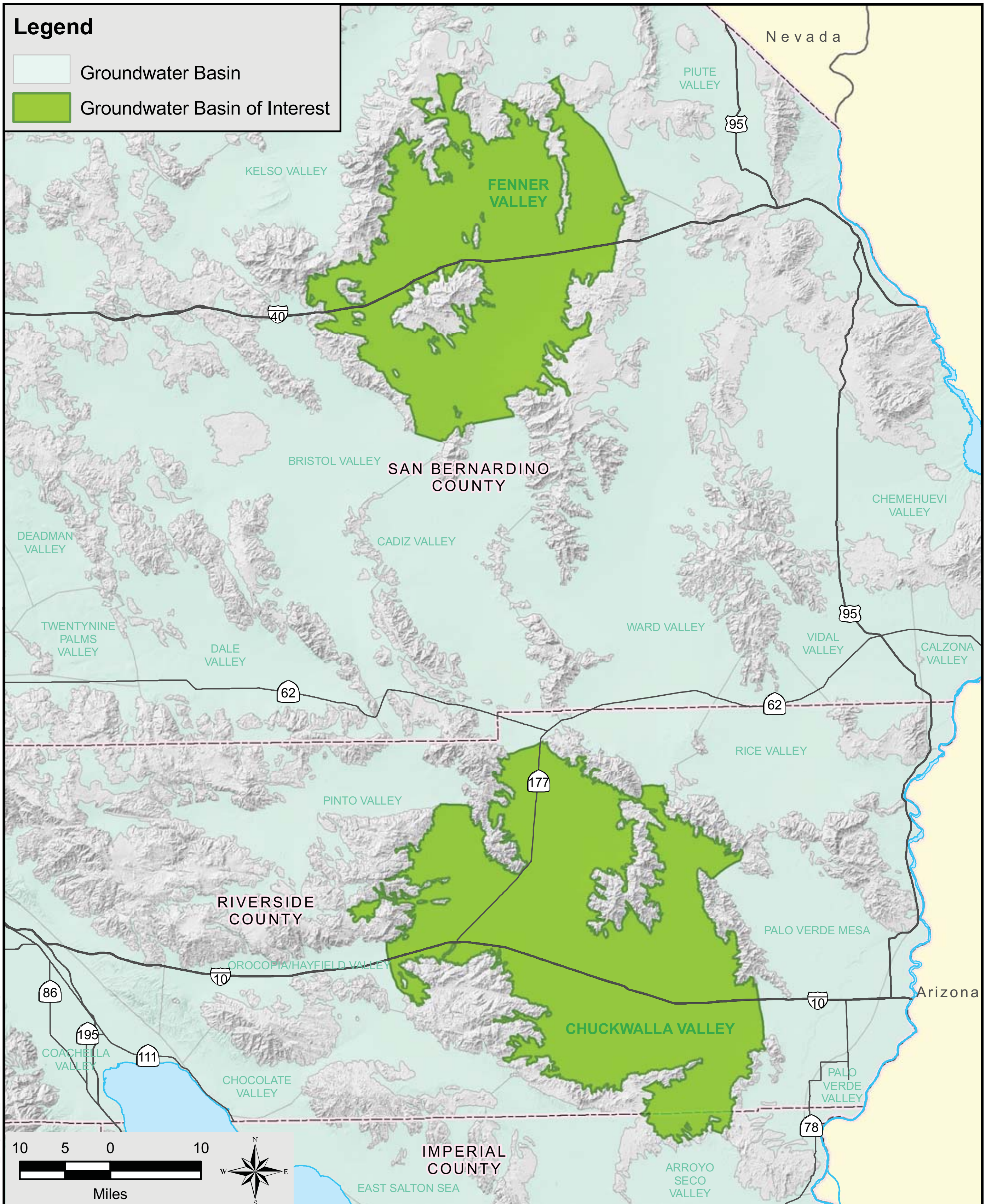
Mann, J.F. (1986). Groundwater conditions in the Eagle Mountain Area.

Maxey G.B. and Eakin T.E. (1950). Ground water in White River Valley, White Pine, Nye and Lincoln Counties, Nevada. Nevada State Engineering Water Resource Bulletin 8, 55pp.

National Park Service (2009). Additional study request submitted to Federal Energy Regulatory Commission for the Eagle Mountain Pumped Storage Project.

United States Geological Survey Water Resources Division (USGS-WRD) (2000). USGS Preliminary Recharge Estimates for the Fenner, Bristol, and Cadiz Watersheds.

URS Corporation (1999). Fenner Basin Precipitation and Recoverable Water Estimates.



Eagle Mountain
Pumped Storage
Eagle Mountain, California

Eagle Crest Energy Company

GROUNDWATER BASINS

Eagle Crest Energy Company | Project 080474 | October 2009 | Figure 1

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Figure 2
Summary of Estimated Annual Recoverable Water

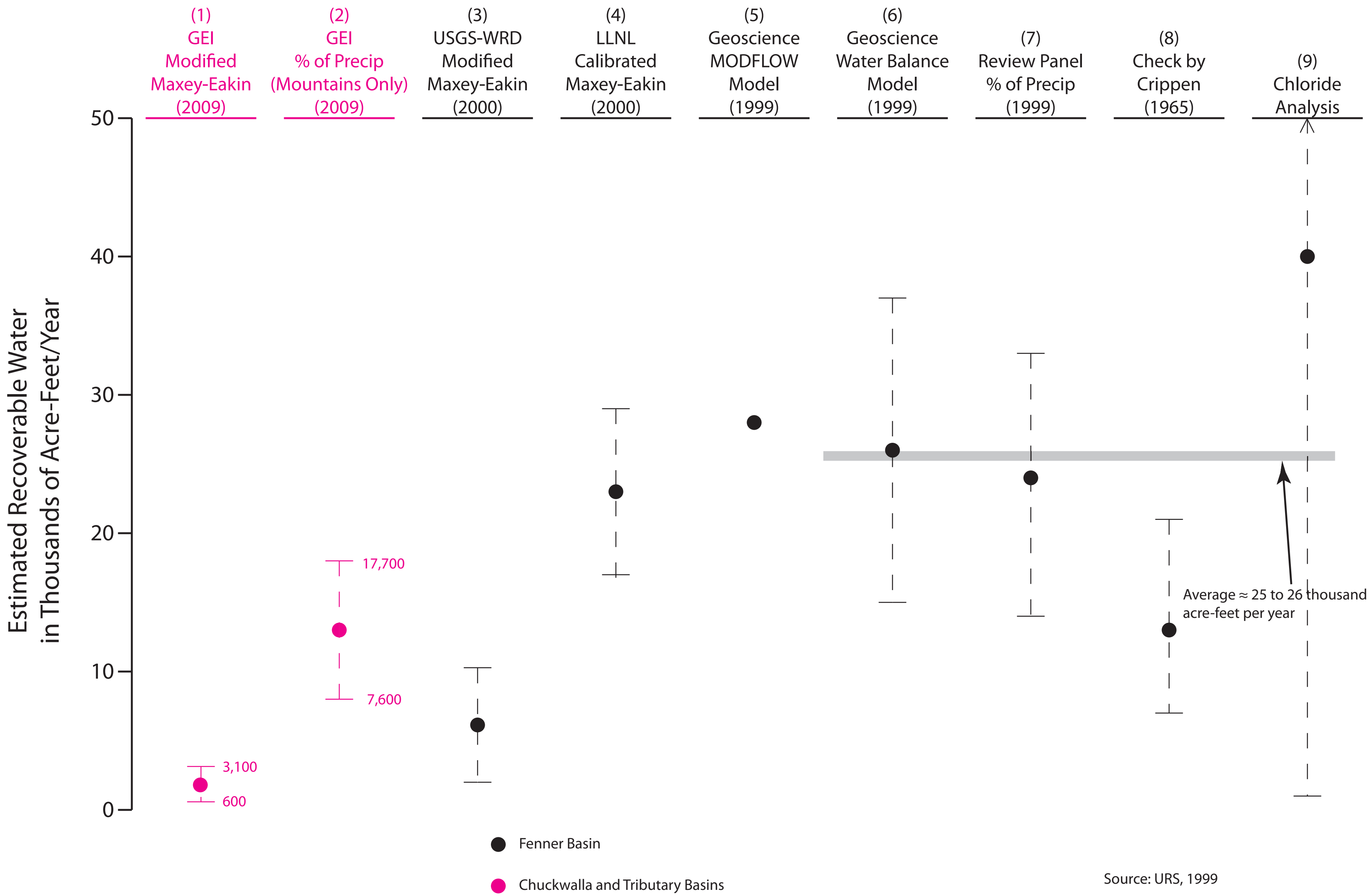
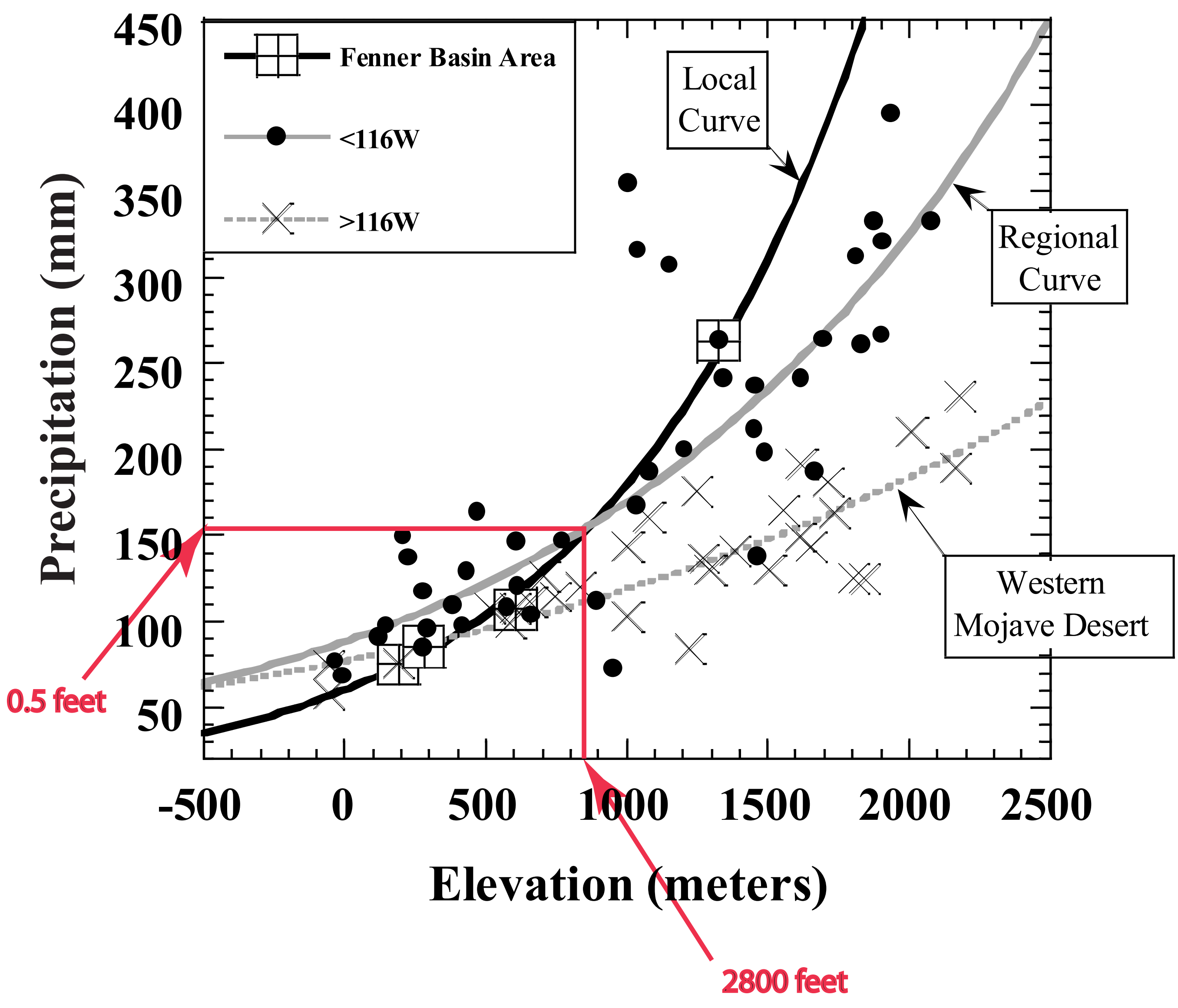
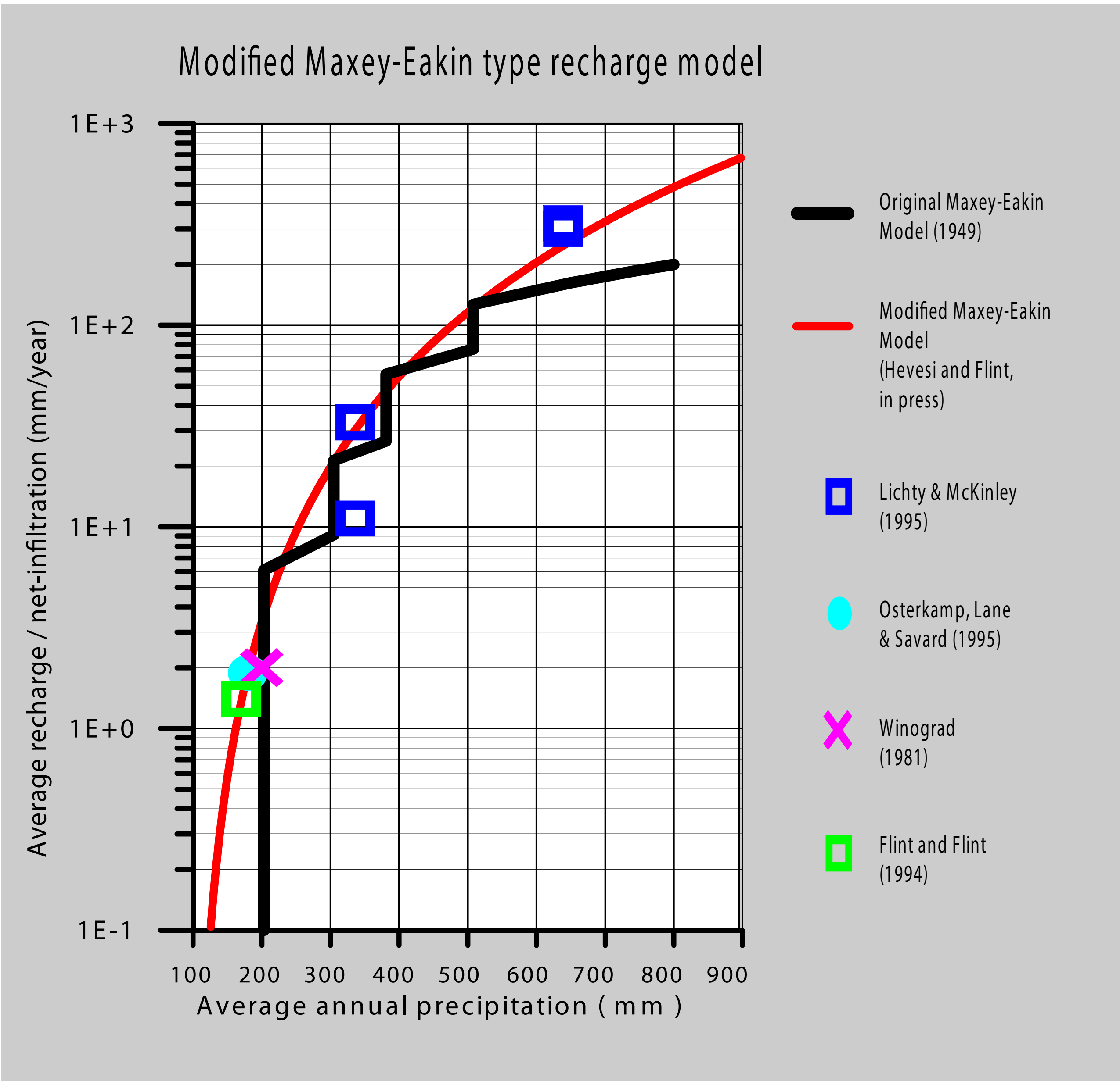


Figure 3
Precipitation - Elevation Curves
for the Fenner Basin



Source: Davisson and Rose, 2000

Figure 4
Maxey-Eakin Model and Recharge Estimates in the
Great Basin and Mojave Deserts



Source: USGS-WRD, 2000

Figure 5
Hypsometric Curves

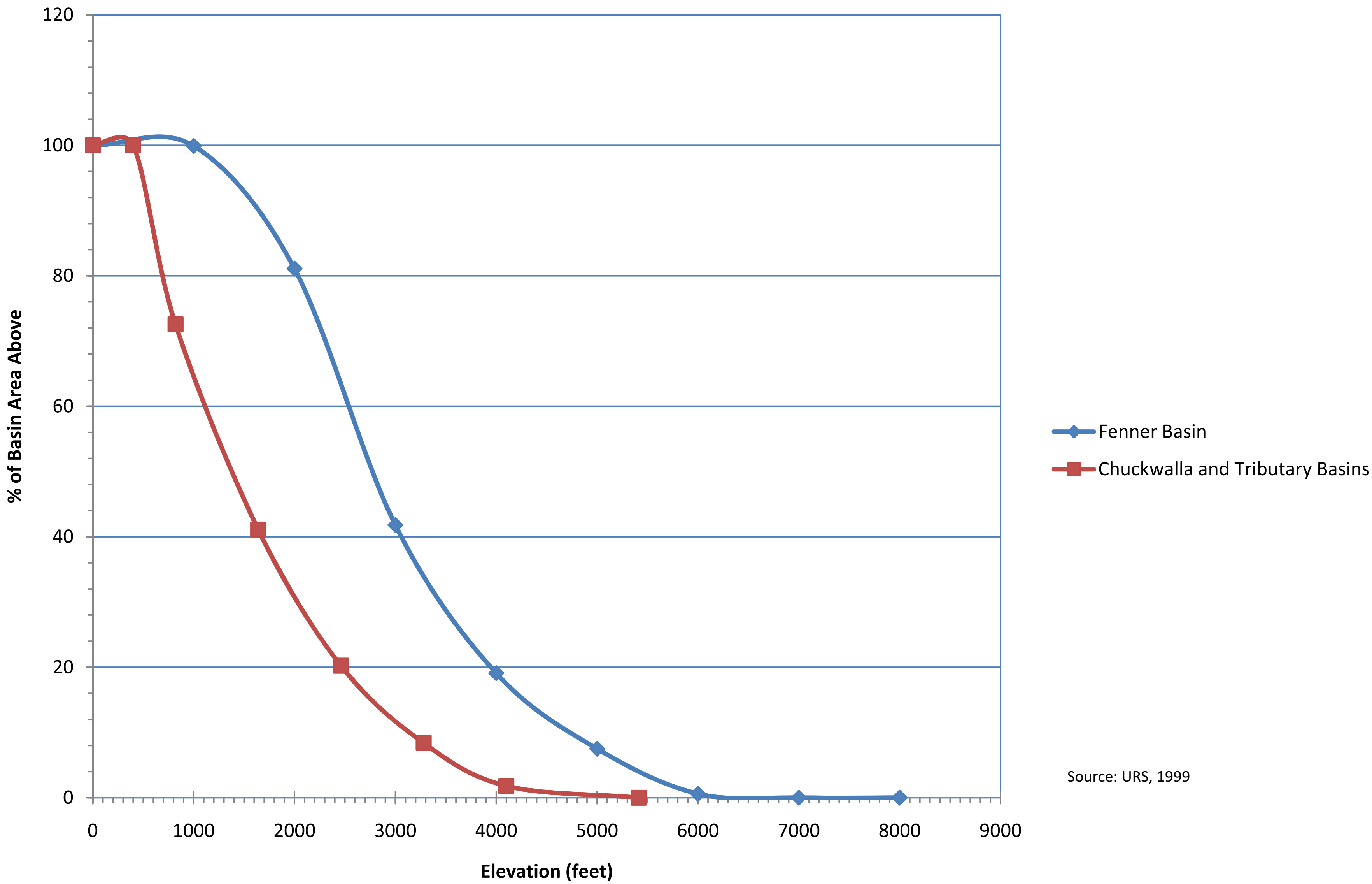


Table 1
Groundwater Basins Inflow Estimates in Acre-Feet/Year

Estimated Recharge to Chuckwalla Basin

Recharge Based on Precipitation Chuckwalla	Inflow from Pinto	Inflow from Orocopia (Hayfield)	Total
5,400 -5,600 [1]	2,500 [2]	1,700 [1]	9,600-9,800
	3,200 [5]		10,300-10,500

Recharge Based on Precipitation Chuckwalla	Subsurface Inflow Pinto + Orocopia	Total
5,400 -5,600 [1]	6,700 [4]	12,100-12,300

Independent Estimates of Total Inflow to Chuckwalla Basin:

Total
10,000-20,000 [2]
12,200 [3]
16,600 [6]
9,800 [7]

References

[1] LeRoy Crandall and Associates (LCA) 1981
[2] Mann 1986
[3] Hanson 1992
[4] CH2MHill 1996
[5] GEI 2009
[6] Greystone 1994
[7] NPS 2009 (total 10,631 AFY = natural recharge 9,800 AFY + wastewater recharge 831 AFY)

Table 2

Calculation of Recharge to Chuckwalla and Tributary Basins Using the Modified Maxey-Eakin Method

Between Elevations (m)	Between Elevations (ft)	Area (acres)		Local Curve Precip (mm)	Local Curve Rechg (mm)	Local Curve Rechg (acre-mm)	Regional Curve Precip (mm)	Regional Curve Rechg (mm)	Regional Curve Rechg (acre-mm)
0-250	0-820	362,297							
0-250	0-820	193							
0-250	0-820	16							
		362,506	Total						
250-500	820-1640	315,004							
250-500	820-1640	82,783							
250-500	820-1640	17,893							
		415,680	Total						
500-750	1640-2460	123,255							
500-750	1640-2460	128,881							
500-750	1640-2460	23,460							
		275,596	Total						
750-1000	2460-3280	51,510							
750-1000	2460-3280	96,732							
750-1000	2460-3280	8,315							
		156,557	Total	160	1	156,557	140	0.3	46,967
1000-1250	3280-4100	8,302							
1000-1250	3280-4100	76,228							
1000-1250	3280-4100	2,569							
		87,099	Total	210	5	435,495	165	1	87,099
1250-1650	4100-5412	0							
1250-1650	4100-5412	23,456							
1250-1650	4100-5412	352							
		23,808	Total	280	15	357,120	190	2.5	59,520
					Total (acre-mm)	949,172			193,586
					Total (acre-feet)	**3,114**			**635**

Note: Elevations with precipitation values below 100 mm were not used.

Table 3
Estimated Average Recharge From Tributary Watershed

Mountain Watershed	Area [1] (acres)	Precip [2] (feet per year)	Fraction of Water That Infiltrates [3]	Recharge (acre-feet per year)
Chuckwalla	245,000	0.5	0.05	6,125
Pinto	235,000	0.5	0.05	5,875
Orocopia	27,000	0.5	0.05	675
Total	507,000	0.5	0.05	12,675

Table 4
Estimated Low Recharge From Tributary Watershed

Mountain Watershed	Area [1] (acres)	Precip [2] (feet per year)	Fraction of Water That Infiltrates [3]	Recharge (Acre-feet per year)
Chuckwalla	245,000	0.5	0.03	3,675
Pinto	235,000	0.5	0.03	3,525
Orocopia	27,000	0.5	0.03	405
Total	507,000	0.5	0.03	7,605

Table 5
Estimated High Recharge From Tributary Watershed

Mountain Watershed	Area [1] (acres)	Precip [2] (feet per year)	Fraction of Water That Infiltrates [3]	Recharge (Acre-feet per year)
Chuckwalla	245,000	0.5	0.07	8,575
Pinto	235,000	0.5	0.07	8,225
Orocopia	27,000	0.5	0.07	945
Total	507,000	0.5	0.07	17,745

[1] Watershed area minus Groundwater basin area
[2] From Davisson and Rose 2000 Precipitation Elevation curves with average elevation of 2800 feet
[3] Review Panel 1999

Attachment G

Eagle Mountain Pumped Storage Project – Additional Studies, Recoverable Water Estimates

Prepared by: Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

June 24, 2011

In review of the Draft Environmental Impact Report, National Park Service (NPS) provided comments that they now estimate the natural recharge in the Chuckwalla Basin to be between 1,650 and 3,000 AFY (NPS 2010). In response, additional studies and investigations were undertaken to further refine estimated natural recharge to the Chuckwalla basin.GEI Consultants, Inc. (GEI), prepared this data transmittal to present these additional estimates of natural recharge to the Chuckwalla groundwater basin. Attachment F contains estimates of natural recharge which concluded the natural recharge was about acre-feet per year 12,700 AFY.

A baseline water balance was developed to estimate the amount of recharge to the basin between 1948 and 2009. The water balance was calibrated based on changes in groundwater levels. Only two wells, well 7S/20E-28C1 and 5S/17E-33N1, in the valley had groundwater levels that spanned at least portions of the time period used for the water balance. These wells are located east of Desert Center and represent average groundwater conditions in the valley. However, the groundwater level trends are not consistent. Well 5S/17E-33N1, which is located about the center of the Chuckwalla valley, showed groundwater levels were 419 feet msl in April 1961 and 412 feet msl in August 2009, or a lowering of groundwater levels by about 7 feet. Well 7E/20S-28C1, which is located near the eastern end of the Chuckwalla Valley, had groundwater levels at 257 feet msl in 1982 and were 270 feet msl in 2009, or about 13 feet of rise in groundwater levels. Because of the long period of record, and that the record is after the intense pumping by Kaiser Mine and local farmers, any depletion of storage should have been distributed across the basin. The baseline water balance was developed and the average recharge was backed into based on these water level measurements. The recharge ranged from 7,000 AFY to 15,200 AFY. Tables 1 and 2 present the water balances calibrated to each well. The estimates are conservative, as well 5S/17E-33N1 is located in a portion of the valley where the aquifers are confined and therefore small changes in storage results in large changes in groundwater levels. The water balance also did not account for pumping by the Kaiser Mine in the Pinto Basin, near the outlet to the Chuckwalla valley, where 137,000 AF of water was pumped reducing recharge to the Chuckwalla valley.

GEI also obtained additional estimates of natural recharge provided in environmental impact reports published by solar energy firms developing projects in the Chuckwalla valley. Figure 1 shows the results of these studies and their referenced reports. These studies showed a range of 6,300 to 35,000 AFY.

The estimates of the natural recharge, based on all of the studies, has a wide range from 1,600 to 35,000 AFY, but there is some grouping of the results. The average of all of the studies is about 12,100 AFY. Throwing out the lowest and highest values the average is about 12,500 AFY. These estimates are still in line with our previous estimates, therefore we believe it is reasonable to continue to use a value of 12,700 AFY for recharge in water balance calculations.

References

Bureau of Land Management (2010), Environmental Impact Statement and California Desert Conservation Area Plan Amendment for the Proposed First Solar Desert Sunlight Solar Farm Project, Riverside County, August 2010.

Bureau of Land Management (2010), Plan Amendment/Final Environmental Impact Statement for the Genesis Solar Energy Project.

Bureau of Land Management (2010), Staff Assessment and Draft Environmental Impact Statement Palen Solar Power Project, Application For Certification (09-AFC-7), March 2010.

National Park Service (2010). Comment on the Draft Environmental Impact Report for the Eagle Crest Energy Pumped Storage Project (State Clearinghouse No. : 2009011010).

United States Geological Survey (2004). Evaluation of Geohydrologic Framework, Recharge Estimates, and Ground-Water Flow of the Joshua Tree Area, San Bernardino County, California.

Figure 1
Summary of Estimated Annual Recoverable Water Chuckwalla Valley

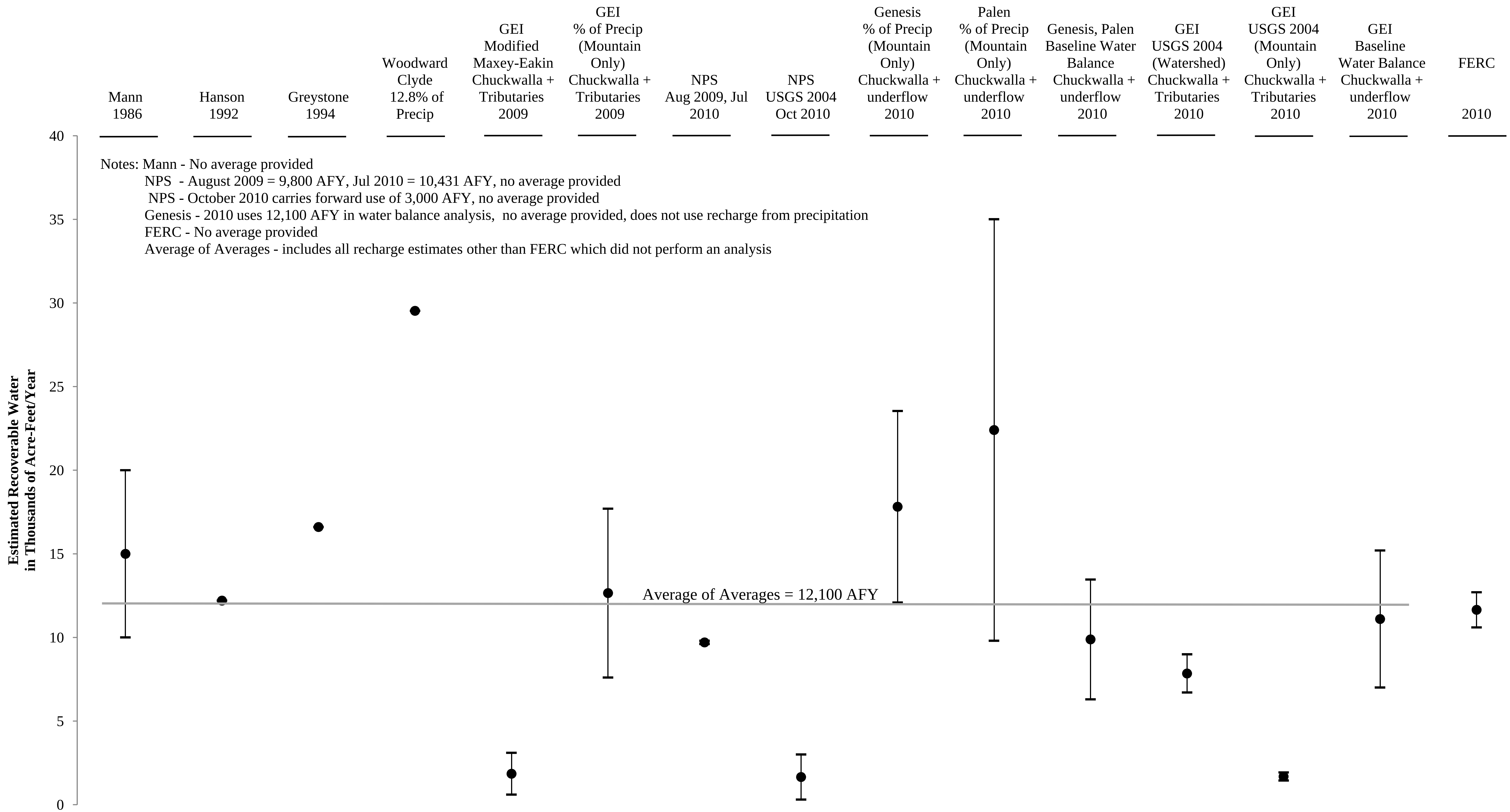


Table 1
Baseline Water Balance - Calibrate to Well 5S/17E-33N1 (in Acre-Feet)

Year	Eagle Mountain Mine (Pinto Basin)	Eagle Mountain Mine (Chuckwalla Basin)	Agricultural Pumping [3]	Aquaculture Pumping/Open Water Evap [4]	Desert Center Domestic [5]	So. Cal Gas [5]	Lake Tamarisk [6]	Chuckwalla/Ironwood State Prison [7]	Subsurface Outflow [8]	**Subtotal Outflow**	Lake Tamarisk Wastwater Return [8]	Infiltration at Chuckwalla/ Ironwood Prison Ponds	Average Recharge	**Subtotal Inflow**	**Inflow minus Outflow**	**Cumulative Change**	**Change in Groundwater level (feet)**
1948	60								400	460			7,000	7,000	6,540	6,540	0.4
1949	160								400	560			7,000	7,000	6,440	12,980	0.9
1950	188								400	588			7,000	7,000	6,412	19,392	1.3
1951	220								400	620			7,000	7,000	6,380	25,772	1.7
1952	260					1			400	661			7,000	7,000	6,339	32,111	2.1
1953	320					1			400	721			7,000	7,000	6,279	38,390	2.6
1954	540					1			400	941			7,000	7,000	6,059	44,449	3.0
1955	660					1			400	1,061			7,000	7,000	5,939	50,388	3.4
1956	836					1			400	1,237			7,000	7,000	5,763	56,151	3.7
1957	647					1			400	1,048			7,000	7,000	5,952	62,103	4.1
1958	1,681				50	1			400	2,132			7,000	7,000	4,868	66,971	4.5
1959	1,712				50	1			400	2,163			7,000	7,000	4,837	71,808	4.8
1960	3,494				50	1			400	3,945			7,000	7,000	3,055	74,863	5.0
1961	3,866				50	1			400	4,317			7,000	7,000	2,683	77,546	5.2
1962	4,600				50	1			400	5,051			7,000	7,000	1,949	79,495	5.3
1963	7,904				50	1			400	8,355			7,000	7,000	-1,355	78,140	5.2
1964	6,968				50	1			400	7,419			7,000	7,000	-419	77,721	5.2
1965	5,950	2,454			50	1			400	8,855			7,000	7,000	-1,855	75,866	5.1
1966	6,266	3,864			50	1			400	10,581			7,000	7,000	-3,581	72,285	4.8
1967	6,688	3,951			50	1			400	11,090			7,000	7,000	-4,090	68,195	4.5
1968	5,468	4,019			50	1			400	9,938			7,000	7,000	-2,938	65,257	4.4
1969	5,426	4,097			50	1			400	9,974			7,000	7,000	-2,974	62,283	4.2
1970	5,932	3,507			50	1			400	9,890			7,000	7,000	-2,890	59,393	4.0
1971	5,190	3,211			50	1	870		400	9,722	29		7,000	7,029	-2,693	56,700	3.8
1972	4,860	2,344			50	1	870		400	8,525	29		7,000	7,029	-1,496	55,204	3.7
1973	5,114	3,724			50	1	870		400	10,159	29		7,000	7,029	-3,130	52,074	3.5
1974	5,074	3,555			50	1	870		400	9,950	29		7,000	7,029	-2,921	49,153	3.3
1975	5,026	3,574			50	1	870		400	9,921	29		7,000	7,029	-2,892	46,261	3.1
1976	5,482	3,750			50	1	870		400	10,553	29		7,000	7,029	-3,524	42,737	2.8
1977	5,980	3,896			50	1	870		400	11,197	29		7,000	7,029	-4,168	38,569	2.6
1978	5,486	4,177			50	1	870		400	10,984	29		7,000	7,029	-3,955	34,614	2.3
1979	5,388	4,166			50	1	870		400	10,875	29		7,000	7,029	-3,846	30,768	2.1
1980	5,204	3,245			50	1	870		400	9,770	29		7,000	7,029	-2,741	28,027	1.9
1981	5,966	3,005	11,331	302	50	1	870		400	21,925	29		7,000	7,029	-14,896	13,131	0.9
1982	4,854	1,574	13,220	302	50	1	870		400	21,271	29		7,000	7,029	-14,242	-1,111	-0.1
1983	3,226	47	15,108	302	50	1	870		400	20,004	29		7,000	7,029	-12,975	-14,086	-0.9
1984	500	790	16,997	302	50	1	870		400	19,910	29		7,000	7,029	-12,881	-26,967	-1.8
1985		484	18,885	302	50	1	870		400	20,992	29		7,000	7,029	-13,963	-40,930	-2.7
1986			20,774	302	50	1	870		400	22,397	29		7,000	7,029	-15,368	-56,298	-3.8
1987			6,000	302	50	1	870		400	7,623	29		7,000	7,029	-594	-56,891	-3.8
1988			6,000	302	50	1	870	2,100	400	9,723	29	795	7,000	7,824	-1,899	-58,790	-3.9
1989			6,000	302	50	1	870	2,100	400	9,723	29	795	7,000	7,824	-1,899	-60,689	-4.0
1990			6,000	302	50	1	870	2,100	400	9,723	29	795	7,000	7,824	-1,899	-62,588	-4.2
1991			6,000	302	50	1	870	2,100	400	9,723	29	795	7,000	7,824	-1,899	-64,487	-4.3
1992			5,587	302	50	1	1,090	2,100	400	9,530	36	795	7,000	7,831	-1,699	-66,186	-4.4
1993			4,000	302	50	1	1,090	2,100	400	7,943	36	795	7,000	7,831	-112	-66,298	-4.4
1994			3,000	302	50	1	1,090	2,100	400	6,943	36	795	7,000	7,831	888	-65,410	-4.4
1995			2,000	302	50	1	1,090	2,100	400	5,943	36	795	7,000	7,831	1,888	-63,522	-4.2

Table 1
Baseline Water Balance - Calibrate to Well 5S/17E-33N1 (in Acre-Feet)

Year	Eagle Mountain Mine (Pinto Basin)	Eagle Mountain Mine (Chuckwalla Basin)	Agricultural Pumping [3]	Aquaculture Pumping/Open Water Evap [4]	Desert Center Domestic [5]	So. Cal Gas [5]	Lake Tamarisk [6]	Chuckwalla/Ironwood State Prison [7]	Subsurface Outflow [8]	**Subtotal Outflow**	Lake Tamarisk Wastwater Return [8]	Infiltration at Chuckwalla/ Ironwood Prison Ponds	Average Recharge	**Subtotal Inflow**	**Inflow minus Outflow**	**Cumulative Change**	**Change in Groundwater level (feet)**
1996			1,525	302	50	1	1,090	2,100	400	5,468	36	795	7,000	7,831	2,363	-61,159	-4.1
1997			1,600	300	50	1	1,090	2,100	400	5,541	36	795	7,000	7,831	2,290	-58,869	-3.9
1998			1,600	300	50	1	1,090	2,100	400	5,541	36	795	7,000	7,831	2,290	-56,579	-3.8
1999			1,600	300	50	1	1,090	2,100	400	5,541	36	795	7,000	7,831	2,290	-54,289	-3.6
2000			1,600	275	50	1	1,090	2,100	400	5,516	36	795	7,000	7,831	2,315	-51,974	-3.5
2001			1,600	275	50	1	1,090	2,100	400	5,516	36	795	7,000	7,831	2,315	-49,659	-3.3
2002			1,700	275	50	1	1,090	2,100	400	5,616	36	795	7,000	7,831	2,215	-47,444	-3.2
2003			1,700	250	50	1	1,090	2,100	400	5,591	36	795	7,000	7,831	2,240	-45,204	-3.0
2004			1,700	250	50	1	1,090	2,100	400	5,591	36	795	7,000	7,831	2,240	-42,964	-2.9
2005			1,758	215	50	1	1,090	2,100	400	5,614	36	795	7,000	7,831	2,217	-40,747	-2.7
2006			1,775	215	50	1	1,090	2,100	400	5,631	36	795	7,000	7,831	2,200	-38,547	-2.6
2007			1,800	215	50	1	1,090	2,100	400	5,656	36	795	7,000	7,831	2,175	-36,372	-2.4
2008			1,800	215	50	1	1,090	2,100	400	5,656	36	795	7,000	7,831	2,175	-34,197	-2.3
2009			1,800	215	50	1	1,090	2,100	400	5,656	36	795	7,000	7,831	2,175	-32,022	-2.1
Subtotal										484,769							

Notes:

[1] EMEC 1994

[2] CH2MHill 1996. Doesn't include prison population.

[3] Value based on 2007 agricultural usage estimates (Table 3.3.3-2).

[4] Pumping required to account for evaporation from open water bodies associated with fish ponds. Based on 2005 aerial photos and evaporation rate of 86 in/yr (USGS 1968).

[5] Greystone 1994

[6] Based on annual average water use pumping recordation data filed with the State water Resources Control Board for 2003 through 2009.

[7] Personal communication with DPH

[8] Based on 2000 census population of 200 people and assuming conservative value of 150 gal/person/day

Table 2
Baseline Water Balance - Calibrate to Well 7S/20E-28C1 (in Acre-Feet)

Year	Eagle Mountain Mine (Pinto Basin)	Eagle Mountain Mine (Chuckwalla Basin)	Agricultural Pumping [3]	Aquaculture Pumping/Open Water Evap [4]	Desert Center Domestic [5]	So. Cal Gas [5]	Lake Tamarisk [6]	Chuckwalla/Ironwood State Prison [7]	Subsurface Outflow [8]	**Subtotal Outflow**	Lake Tamarisk Wastwater Return [8]	Infiltration at Chuckwalla/ Ironwood Prison Ponds	Average Recharge	**Subtotal Inflow**	**Inflow minus Outflow**	**Cumulative Change**	**Change in Groundwater level (feet)**
1948	60								400	460			15,200	15,200	14,740	14,740	1.0
1949	160								400	560			15,200	15,200	14,640	29,380	2.0
1950	188								400	588			15,200	15,200	14,612	43,992	2.9
1951	220								400	620			15,200	15,200	14,580	58,572	3.9
1952	260					1			400	661			15,200	15,200	14,539	73,111	4.9
1953	320					1			400	721			15,200	15,200	14,479	87,590	5.8
1954	540					1			400	941			15,200	15,200	14,259	101,849	6.8
1955	660					1			400	1,061			15,200	15,200	14,139	115,988	7.7
1956	836					1			400	1,237			15,200	15,200	13,963	129,951	8.7
1957	647					1			400	1,048			15,200	15,200	14,152	144,103	9.6
1958	1,681				50	1			400	2,132			15,200	15,200	13,068	157,171	10.5
1959	1,712				50	1			400	2,163			15,200	15,200	13,037	170,208	11.3
1960	3,494				50	1			400	3,945			15,200	15,200	11,255	181,463	12.1
1961	3,866				50	1			400	4,317			15,200	15,200	10,883	192,346	12.8
1962	4,600				50	1			400	5,051			15,200	15,200	10,149	202,495	13.5
1963	7,904				50	1			400	8,355			15,200	15,200	6,845	209,340	14.0
1964	6,968				50	1			400	7,419			15,200	15,200	7,781	217,121	14.5
1965	5,950	2,454			50	1			400	8,855			15,200	15,200	6,345	223,466	14.9
1966	6,266	3,864			50	1			400	10,581			15,200	15,200	4,619	228,085	15.2
1967	6,688	3,951			50	1			400	11,090			15,200	15,200	4,110	232,195	15.5
1968	5,468	4,019			50	1			400	9,938			15,200	15,200	5,262	237,457	15.8
1969	5,426	4,097			50	1			400	9,974			15,200	15,200	5,226	242,683	16.2
1970	5,932	3,507			50	1			400	9,890			15,200	15,200	5,310	247,993	16.5
1971	5,190	3,211			50	1	870		400	9,722	29		15,200	15,229	5,507	253,500	16.9
1972	4,860	2,344			50	1	870		400	8,525	29		15,200	15,229	6,704	260,204	17.3
1973	5,114	3,724			50	1	870		400	10,159	29		15,200	15,229	5,070	265,274	17.7
1974	5,074	3,555			50	1	870		400	9,950	29		15,200	15,229	5,279	270,553	18.0
1975	5,026	3,574			50	1	870		400	9,921	29		15,200	15,229	5,308	275,861	18.4
1976	5,482	3,750			50	1	870		400	10,553	29		15,200	15,229	4,676	280,537	18.7
1977	5,980	3,896			50	1	870		400	11,197	29		15,200	15,229	4,032	284,569	19.0
1978	5,486	4,177			50	1	870		400	10,984	29		15,200	15,229	4,245	288,814	19.3
1979	5,388	4,166			50	1	870		400	10,875	29		15,200	15,229	4,354	293,168	19.5
1980	5,204	3,245			50	1	870		400	9,770	29		15,200	15,229	5,459	298,627	19.9
1981	5,966	3,005	11,331	302	50	1	870		400	21,925	29		15,200	15,229	-6,696	291,931	19.5
1982	4,854	1,574	13,220	302	50	1	870		400	21,271	29		15,200	15,229	-6,042	285,889	19.1
1983	3,226	47	15,108	302	50	1	870		400	20,004	29		15,200	15,229	-4,775	281,114	18.7
1984	500	790	16,997	302	50	1	870		400	19,910	29		15,200	15,229	-4,681	276,433	18.4
1985		484	18,885	302	50	1	870		400	20,992	29		15,200	15,229	-5,763	270,670	18.0
1986			20,774	302	50	1	870		400	22,397	29		15,200	15,229	-7,168	263,502	17.6
1987			6,000	302	50	1	870		400	7,623	29		15,200	15,229	7,606	271,109	18.1
1988			6,000	302	50	1	870	2,100	400	9,723	29	795	15,200	16,024	6,301	277,410	18.5
1989			6,000	302	50	1	870	2,100	400	9,723	29	795	15,200	16,024	6,301	283,711	18.9

Table 2
Baseline Water Balance - Calibrate to Well 7S/20E-28C1 (in Acre-Feet)

Year	Eagle Mountain Mine (Pinto Basin)	Eagle Mountain Mine (Chuckwalla Basin)	Agricultural Pumping [3]	Aquaculture Pumping/Open Water Evap [4]	Desert Center Domestic [5]	So. Cal Gas [5]	Lake Tamarisk [6]	Chuckwalla/Ironwood State Prison [7]	Subsurface Outflow [8]	**Subtotal Outflow**	Lake Tamarisk Wastwater Return [8]	Infiltration at Chuckwalla/ Ironwood Prison Ponds	Average Recharge	**Subtotal Inflow**	**Inflow minus Outflow**	**Cumulative Change**	**Change in Groundwater level (feet)**
1990			6,000	302	50	1	870	2,100	400	9,723	29	795	15,200	16,024	6,301	290,012	19.3
1991			6,000	302	50	1	870	2,100	400	9,723	29	795	15,200	16,024	6,301	296,313	19.8
1992			5,587	302	50	1	1,090	2,100	400	9,530	36	795	15,200	16,031	6,501	302,814	20.2
1993			4,000	302	50	1	1,090	2,100	400	7,943	36	795	15,200	16,031	8,088	310,902	20.7
1994			3,000	302	50	1	1,090	2,100	400	6,943	36	795	15,200	16,031	9,088	319,990	21.3
1995			2,000	302	50	1	1,090	2,100	400	5,943	36	795	15,200	16,031	10,088	330,078	22.0
1996			1,525	302	50	1	1,090	2,100	400	5,468	36	795	15,200	16,031	10,563	340,641	22.7
1997			1,600	300	50	1	1,090	2,100	400	5,541	36	795	15,200	16,031	10,490	351,131	23.4
1998			1,600	300	50	1	1,090	2,100	400	5,541	36	795	15,200	16,031	10,490	361,621	24.1
1999			1,600	300	50	1	1,090	2,100	400	5,541	36	795	15,200	16,031	10,490	372,111	24.8
2000			1,600	275	50	1	1,090	2,100	400	5,516	36	795	15,200	16,031	10,515	382,626	25.5
2001			1,600	275	50	1	1,090	2,100	400	5,516	36	795	15,200	16,031	10,515	393,141	26.2
2002			1,700	275	50	1	1,090	2,100	400	5,616	36	795	15,200	16,031	10,415	403,556	26.9
2003			1,700	250	50	1	1,090	2,100	400	5,591	36	795	15,200	16,031	10,440	413,996	27.6
2004			1,700	250	50	1	1,090	2,100	400	5,591	36	795	15,200	16,031	10,440	424,436	28.3
2005			1,758	215	50	1	1,090	2,100	400	5,614	36	795	15,200	16,031	10,417	434,853	29.0
2006			1,775	215	50	1	1,090	2,100	400	5,631	36	795	15,200	16,031	10,400	445,253	29.7
2007			1,800	215	50	1	1,090	2,100	400	5,656	36	795	15,200	16,031	10,375	455,628	30.4
2008			1,800	215	50	1	1,090	2,100	400	5,656	36	795	15,200	16,031	10,375	466,003	31.1
2009			1,800	215	50	1	1,090	2,100	400	5,656	36	795	15,200	16,031	10,375	476,378	31.8

Notes:

[1] EMEC 1994

[2] CH2MHill 1996. Doesn't include prison population.

[3] Value based on 2007 agricultural usage estimates (Table 3.3.3-2).

[4] Pumping required to account for evaporation from open water bodies associated with fish ponds. Based on 2005 aerial photos and evaporation rate of 86 in/yr (USGS 1968).

[5] Greystone 1994

[6] Based on annual average water use pumping recordation data filed with the State water Resources Control Board for 2003 through 2009.

[7] Personal communication with DPH

[8] Based on 2000 census population of 200 people and assuming conservative value of 150 gal/person/day

Attachment H

Eagle Mountain Pumped Storage Project – Groundwater Levels

Prepared by: Richard Shatz [C.E.G. 1514], GEI Consultants, Inc.

December 10, 2010

GEI Consultants, Inc. (GEI) prepared this data transmittal to document wells with available water level measurements in the Chuckwalla Valley groundwater basin. This transmittal contains a map showing the locations of the wells, a hydrograph for each well, and a table of groundwater level measurements. The hydrographs were plotted with similar scales (200 feet) to allow a direct comparison of groundwater elevations and time periods.

Most wells show little change in water levels other than for a few wells near Desert Center. Well 5S/16E-7P1 shows that pumping in the early 1980s caused groundwater levels to decline. There are only a few wells in the Upper Chuckwalla groundwater basin with groundwater level measurements but most of those measurements were only obtained for a relatively short period of time during 1990. A few wells have recent measurements that were collected by solar generator applicants or the state prison.

Data available for these wells, distributed throughout the valley, indicate that drawdown effects of the concentrated pumping for agricultural uses in the 1980s produced a strong localized effect, but did not result in measurable effects to groundwater levels throughout the Chuckwalla Basin.

The 1980s agricultural pumping exceeded 100,000 AF in total, approximately equal to that proposed for the pumped storage project over its 50 year life. Therefore, we conclude that proposed project pumping would produce similar basin-wide effects as occurred during the 1980s agricultural intensive use period.

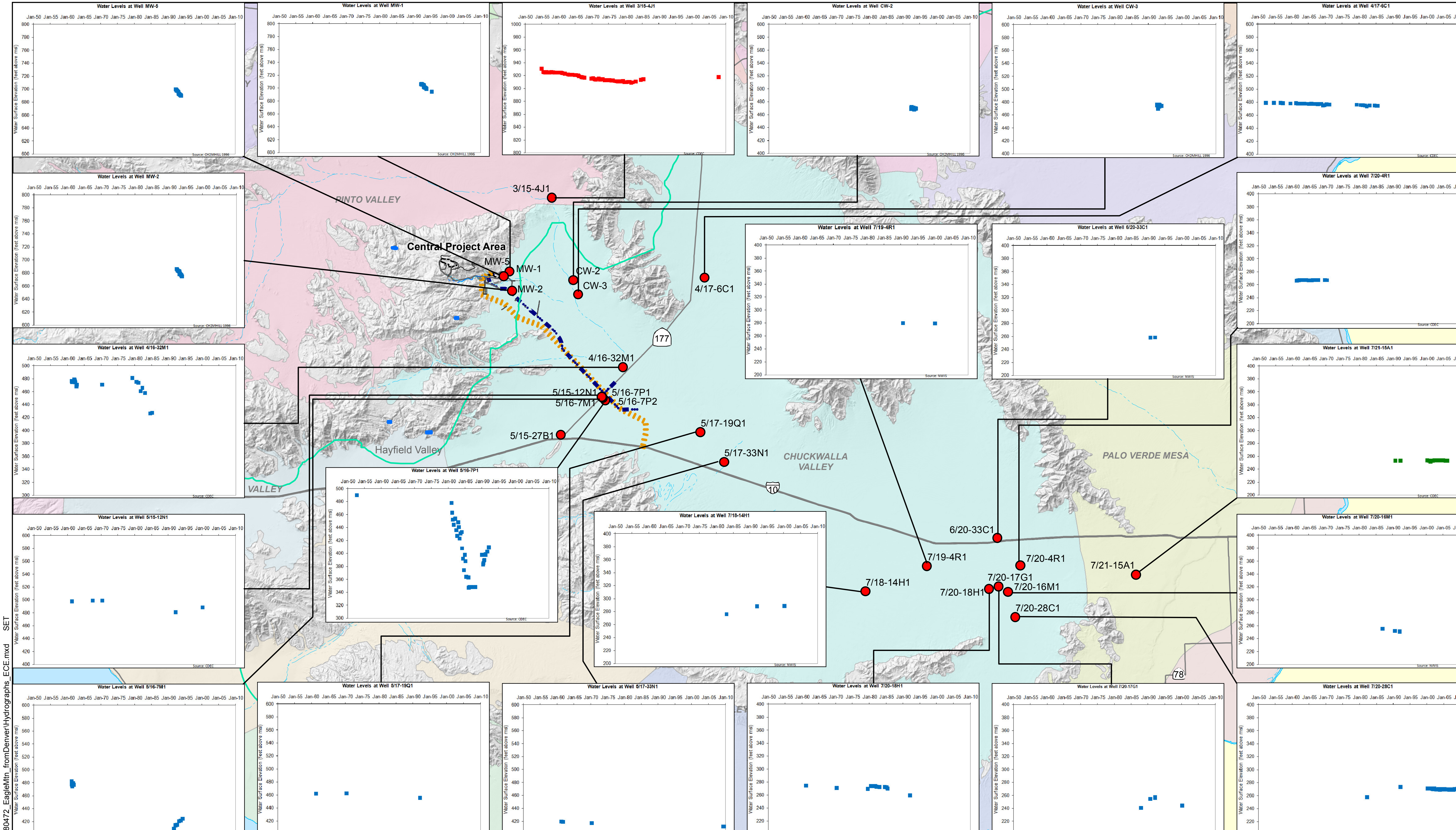
References:

Final EIS for the Genesis Solar Energy Project, August 2010

Palen Solar Power Project, March 2010

http://waterdata.usgs.gov/ca/nwis/si

http://www.water.ca.gov/waterdatalibrary/



N
0 6 12 Miles

- Well With Hydrograph
- Spring
- Creek, Stream, etc.
- Colorado River Aqueduct
- Water Supply Pipeline (buried)
- FERC Staff Recommended Transmission Route

Pumped Storage Project
Eagle Mountain, CA

Eagle Crest Energy

Eagle Crest Energy Company

WELLS WITH HYDROGRAPHS

December 2010 Figure 1

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Table 1
Supplemental Groundwater Level Measurement Table

Well Name	Ground Surface Elevation (feet)	Well Depth (feet bgs)	Date	Static Water Level (feet bgs)	Static Water Level (feet amsl)	Status	Difference from Original Measurement (feet)	Data Source
Groundwater Basin - Chuckwalla Valley								
4S/17E-6C1	500	501	1/15/1932	22.5	477.5			CDEC
			5/21/1952	21	479		1.5	
			9/17/1954	21.2	478.8		1.3	
			10/16/1956	21.4	478.6		1.1	
			5/16/1957	21.6	478.4		0.9	
			9/11/1959	21.9	478.1		0.6	
			4/10/1961	21.82	478.18		0.68	
			11/9/1961	22.4	477.6		0.1	
			1/9/1962	22.2	477.8		0.3	
			3/8/1962	22.14	477.86		0.36	
			11/1/1962	22.41	477.59		0.09	
			3/14/1963	22.22	477.78		0.28	
			10/31/1963	22.31	477.69		0.19	
			3/19/1964	22.41	477.59		0.09	
			11/25/1964	22.4	477.6		0.1	
			3/18/1965	22.51	477.49		-0.01	
			11/18/1965	22.3	477.7		0.2	
			3/2/1966	22.5	477.5		0	
			10/28/1966	22.74	477.26		-0.24	
			3/16/1967	22.55	477.45		-0.05	
			10/26/1967	22.95	477.05		-0.45	
			4/8/1968	22.8	477.2		-0.3	
			11/7/1968	22.71	477.29		-0.21	
			4/23/1969	25.02	474.98		-2.52	
			10/23/1969	24.72	475.28		-2.22	
			4/29/1970	23.15	476.85		-0.65	
			10/27/1970	23.55	476.45		-1.05	
			3/31/1971	23.57	476.43		-1.07	
			4/25/1979	23.88	476.12		-1.38	
			7/24/1980	24.4	475.6		-1.9	
			1/23/1981	24.52	475.48		-2.02	
			10/1/1981	25.23	474.77		-2.73	
			4/15/1982	26.69	473.31		-4.19	
			1/27/1983	25.01	474.99		-2.51	
			7/31/1984	25.31	474.69		-2.81	
			2/27/1985	25.42	474.58		-2.92	
			6/12/1985	25.65	474.35		-3.15	
5S/15E-12N1	671	746	4/28/1961	173.07	497.81			CDEC
			6/20/1967	171.8	499.08		1.27	
			5/1/1970	171.82	499.06		1.25	
			3/24/1992			P		
			3/26/1992	189.9	480.98		-16.83	
			3/31/2000	182.51	488.37		-9.44	
5S/15E-27B1	900	644	5/10/1958	394.6	505.4			CDEC
			3/28/1961	395.3	504.7		-0.7	
			6/10/1961	395.14	504.86		-0.54	
			3/8/1962			O		
5S/16E-7M1	603.7	648	4/9/1961	121.14	482.56			NWIS
			4/20/1961	125.61	478.09	R	-4.47	
			6/10/1961	125.11	478.59		-3.97	
			6/11/1961	126.84	476.86		-5.7	
			6/13/1961	127.2	476.5		-6.06	
			6/14/1961	125.52	478.18		-4.38	
			6/15/1961	128.09	475.61		-6.95	
			6/19/1961	129.19	474.51		-8.05	
			8/6/1961	126.93	476.77		-5.79	
			10/7/1961	124.14	479.56		-3	
			10/8/1961	124.1	479.6		-2.96	
			10/9/1961	124.9	478.8		-3.76	
			10/9/1961	124.93	478.77		-3.79	

Table 1
Supplemental Groundwater Level Measurement Table

Well Name	Ground Surface Elevation (feet)	Well Depth (feet bgs)	Date	Static Water Level (feet bgs)	Static Water Level (feet amsl)	Status	Difference from Original Measurement (feet)	Data Source
			11/8/1961	126.7	477		-5.56	
			8/24/1962			P		
			11/1/1962	139.7		P	-18.56	
			4/29/1970	128.13		V	-6.99	
			10/3/1991	194.37	409.33		-73.23	
			2/18/1992	189.1	414.6		-67.96	
			3/18/1992	189.85	413.85		-68.71	
			9/23/1992	188.42	415.28		-67.28	
			4/21/1993	183	420.7		-61.86	
			9/16/1993	182.34	421.36		-61.2	
			4/20/1994	179.16	424.54		-58.02	
			9/18/2001			O		
5S/16E-7P1	598	347	9/19/1952	108	490			NWIS
			6/26/1990	212.86	385.14		-104.86	
			10/23/1990	207.83	390.17		-99.83	
			3/14/1991	199.29	398.71		-91.29	
			10/3/1991			O		
			10/4/1991			N		
			2/18/1992	188.38	409.62		-80.38	
5S/16E - 7P1		347	1/1/1981	120	478			So. Ca. Gas Co.
So Ca. Gas Co. Well			3/1/1981	135	463		-15	Greystone
			6/1/1981	146	452		-26	
			9/1/1981	154	444		-34	
			1/1/1982	145	453		-25	
			3/1/1982	144	454		-24	
			6/1/1982	162	436		-42	
			9/1/1982	171	427		-51	
			1/1/1983	150	448		-30	
			3/1/1983	157	441		-37	
			6/1/1983	175	423		-55	
			9/1/1983	167	431		-47	
			1/1/1984	165	433		-45	
			3/1/1984	190	408		-70	
			6/1/1984	206	392		-86	
			9/1/1984	224	374		-104	
			1/1/1985	200	398		-80	
			3/1/1985	210	388		-90	
			6/1/1985	234	364		-114	
			1/1/1986	235	363		-115	
			3/1/1986	251	347		-131	
			6/1/1986	250	348		-130	
			9/1/1986	250	348		-130	
			1/1/1987	250	348		-130	
			3/1/1988	250	348		-130	
			1/1/1990	200	398		-80	
			6/1/1990	215	383		-95	
			9/1/1990	209	389		-89	
			3/1/1991	200	398		-80	
			9/1/1991	195	403		-75	
			3/1/1992	189	409		-69	
5S/16E-7P2		767	4/10/1961	71.41	476.59			So. Ca. Gas Co.
			4/21/1961	71.61	476.39		-0.2	Greystone
			6/10/1961	71.43	476.57		-0.02	
			6/14/1961	73.46	474.54	R	-2.05	
			2/7/1962	69.32	478.68		2.09	
			3/8/1962	70.29	477.71		1.12	
			4/9/1962	72.45	475.55		-1.04	
			5/7/1962	73.82	474.18		-2.41	

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Well Name	Ground Surface Elevation (feet)	Well Depth (feet bgs)	Date	Static Water Level (feet bgs)	Static Water Level (feet amsl)	Status	Difference from Original Measurement (feet)	Data Source
			8/24/1962	79.95	468.05		-8.54	
			9/27/1962	79.57	468.43		-8.16	
			11/1/1962	77.17	470.83		-5.76	
			5/1/1970	77.25	470.75		-5.84	
			4/19/1979	66.95	481.05		4.46	
			7/24/1980	72.87	475.13		-1.46	
			1/23/1981	74.16	473.84		-2.75	
			10/1/1981	86.9	461.1		-15.49	
			4/15/1982	82.01	465.99		-10.6	
			1/27/1983	90.29	457.71		-18.88	
			7/31/1984	121.88	426.12		-50.47	
			2/27/1985	120.8	427.2		-49.39	
5S/16E-7P2	598.4	767	10/18/2000	136.82	461.58			NWIS
5S/17E-19Q1	538	760	4/6/1961	76.18	683.82			NWIS
			4/20/1961	76.17	683.83		0.01	
			5/1/1970	75.3	684.7		0.88	
			2/12/1992	82.3	677.7		-6.12	
5S/17E-33N1	592	758	4/7/1961	172.69	419.31			CDEC
			4/20/1961	172.59	419.41		0.1	
			10/11/1961	172.78	419.22		-0.09	
			4/30/1970	174.7	417.3		-2.01	
			4/29/2009	180	412		-7.31	
			8/24/2009	180	412		-7.31	
6S/20E-33C1	392.10	400	9/26/1990	134.1	258			NWIS
			2/10/1992	134.8	258.3		-0.7	
7S/18E-14H1	545.90	985	1/16/1983	270	275.9			NWIS
			2/13/1992	257.61	288.29		12.39	
			3/15/2000	257.22	288.68		12.78	
7S/19E-4R1	423.89	242	9/16/1990	144.25	279.64			NWIS
			3/29/2000	144.41	279.48		-0.16	
7S/20E-4R1	418	316	6/12/1961	151.83	266.17			CDEC
			10/10/1961	151.09	266.91		0.74	
			11/8/1961	151.03	266.97		0.8	
			1/10/1962	151.04	266.96		0.79	
			3/8/1962	150.89	267.11		0.94	
			4/9/1962	150.73	267.27		1.1	
			5/7/1962	150.83	267.17		1	
			10/31/1962	150.9	267.1		0.93	
			3/13/1963	150.84	267.16		0.99	
			10/31/1963	150.91	267.09		0.92	
			3/19/1964	150.77	267.23		1.06	
			11/25/1964	151.13	266.87		0.7	
			3/18/1965	151.21	266.79		0.62	
			11/18/1965	151.4	266.6		0.43	
			3/2/1966	150.66	267.34		1.17	
			10/27/1966	150.89	267.11		0.94	
			3/16/1967	150.92	267.08		0.91	
			10/25/1967	150.86	267.14		0.97	
			10/23/1969	150.89	267.11		0.94	
			4/30/1970	150.95	267.05		0.88	
7S/20E-16M1	457.50	1,200	1/1/1987	202.25	255.25			NWIS
			9/17/1990	205.62	251.88		-3.37	
			2/10/1992	206.7	250.8		-4.45	
			2/11/1992	206.27	251.23		-4.02	
7S/20E-17G1	443.50	1,200	12/1/1987	203	240.5			NWIS
			9/17/1990	189.05	254.45		13.95	
			2/10/1992	187.7	255.8		15.3	
			2/10/1992	186.2	257.3		16.8	
			3/16/2000	199.24	244.26		3.76	

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Well Name	Ground Surface Elevation (feet)	Well Depth (feet bgs)	Date	Static Water Level (feet bgs)	Static Water Level (feet amsl)	Status	Difference from Original Measurement (feet)	Data Source
7S/20E-18H1	442.94	1,139	4/5/1961	168.37	274.57			NWIS
			4/30/1970	171.81	271.13	V	-3.44	
			7/31/1979	173.48	269.46		-5.11	
			7/24/1980	169.06	273.88		-0.69	
			1/23/1981	169.22	273.72		-0.85	
			9/23/1981	169.23	273.71		-0.86	
			3/3/1982	170.26	272.68		-1.89	
			1/28/1983	170.54	272.4		-2.17	
			7/31/1984	170.65	272.29		-2.28	
			2/27/1985	171.1	271.84		-2.73	
			6/12/1985	172.9	270.04		-4.53	
			2/9/1992	183.46	259.48	V	-15.09	
7S/20E-28C1	505.6	830	3/15/1982	248	257.6			CDEC
			2/13/1992	232.35	273.25		15.65	
			3/29/2000	234.5	271.1		13.5	
			10/5/2000	234.84	270.76		13.16	
			1/10/2001	234.89	270.71		13.11	
			2/23/2001	234.45	271.15		13.55	
			4/16/2001	234.82	270.78		13.18	
			4/16/2001	234.82	270.78		13.18	
			7/10/2001	235.4	270.2		12.6	
			11/7/2001	235.66	269.94		12.34	
			11/7/2001	235.69	269.91		12.31	
			4/3/2002	234.69	270.91		13.31	
			4/3/2002	234.69	270.91		13.31	
			10/2/2002	236.16	269.44		11.84	
			10/2/2002	236.04	269.56		11.96	
			6/3/2003	235.59	270.01		12.41	
			6/3/2003	235.61	269.99		12.39	
			11/5/2003	236.46	269.14		11.54	
			11/5/2003	236.45	269.15		11.55	
			3/2/2004	235.63	269.97		12.37	
			3/2/2004	235.65	269.95		12.35	
			8/4/2004	236.18	269.42		11.82	
			12/8/2004	236.11	269.49		11.89	
			4/15/2005	235.61	269.99		12.39	
			8/31/2005	236.17	269.43		11.83	
			2/14/2006	236.12	269.48		11.88	
			5/5/2006	236.38	269.22		11.62	Dept of Corrections
			8/10/2006	236.66	268.94		11.34	
			12/8/2006	236.57	269.03		11.43	
			2/7/2007	236.16	269.44		11.84	
			5/17/2007	236.55	269.05		11.45	
			9/5/2007	236.91	268.69		11.09	
			12/13/2007	236.55	269.05		11.45	
			3/19/2008	235.65	269.95		12.35	
			6/25/2008	235.62	269.98		12.38	
			9/24/2008	235.73	269.87		12.27	
			1/14/2009	235.25	270.35		12.75	
			4/16/2009	235.28	270.32		12.72	

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Well Name	Ground Surface Elevation (feet)	Well Depth (feet bgs)	Date	Static Water Level (feet bgs)	Static Water Level (feet amsl)	Status	Difference from Original Measurement (feet)	Data Source
Groundwater Basin - Pinto Valley								
3S/15E-4J1			12/4/1954	150	930.6			CDEC
			6/22/1955	154.94	925.66		-4.94	
			9/22/1955	155.2	925.4		-5.2	
			12/22/1955	155.6	925		-5.6	
			2/9/1956	155.2	925.4		-5.2	
			2/11/1956	155.1	925.5		-5.1	
			2/12/1956	155	925.6		-5	
			3/23/1956	155	925.6		-5	
			5/27/1956	154.88	925.72		-4.88	
			7/27/1956	155.3	925.3		-5.3	
			8/18/1956	155.3	925.3		-5.3	
			9/19/1956	155.7	924.9		-5.7	
			5/18/1957	155.21	925.39		-5.21	
			5/19/1957	155.65	924.95		-5.65	
			6/26/1957	155.48	925.12		-5.48	
			8/21/1957	155.49	925.11		-5.49	
			9/18/1957	155.37	925.23		-5.37	
			11/30/1957	155	925.6		-5	
			3/2/1958	155.1	925.5		-5.1	
			5/30/1958	155.4	925.2		-5.4	
			9/15/1958	155.6	925		-5.6	
			1/7/1959	155.7	924.9		-5.7	
			3/12/1959	155.6	925		-5.6	
			6/11/1959	155.8	924.8		-5.8	
			9/8/1959	155.71	924.89		-5.71	
			12/10/1959	155.74	924.86		-5.74	
			3/1/1960	155.6	925		-5.6	
			6/12/1960	155.9	924.7		-5.9	
			10/13/1960	155.93	924.67		-5.93	
			1/1/1961	156.14	924.46		-6.14	
			3/28/1961	156.81	923.79		-6.81	
			11/9/1961	157.49	923.11		-7.49	
			11/16/1961	157.77	922.83		-7.77	
			11/1/1962	158.79	921.81		-8.79	
			3/14/1963	159.28	921.32		-9.28	
			10/31/1963	159.34	921.26		-9.34	
			3/19/1964	159.49	921.11		-9.49	
			11/25/1964	159.53	921.07		-9.53	
			3/16/1965	159.81	920.79		-9.81	
			11/18/1965	160.21	920.39		-10.21	
			3/2/1966	161.95	918.65	S	-11.95	
			10/27/1966	162.94	917.66	S	-12.94	
			3/17/1967	163.38	917.22	S	-13.38	
			10/26/1967	163.78	916.82	S	-13.78	
			10/23/1969	165.06	915.54		-15.06	
			5/2/1970	164.86	915.74	S	-14.86	
			10/28/1970	166.17	914.43	S	-16.17	
			3/31/1971	166.54	914.06	S	-16.54	
			1/27/1972	165.04	915.56	S	-15.04	
			6/15/1972	166.67	913.93	S	-16.67	

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Supplemental Groundwater Level Measurement Table

Well Name	Ground Surface Elevation (feet)	Well Depth (feet bgs)	Date	Static Water Level (feet bgs)	Static Water Level (feet amsl)	Status	Difference from Original Measurement (feet)	Data Source
			3/17/1973	166.31	914.29	S	-16.31	
			9/24/1973	167.72	912.88	S	-17.72	
			2/25/1974	167.72	912.88		-17.72	
			10/17/1974	167.48	913.12		-17.48	
			4/7/1975	167.88	912.72	S	-17.88	
			11/12/1975	168	912.6	S	-18	
			3/25/1976	168.25	912.35	S	-18.25	
			11/4/1976	168.91	911.69	S	-18.91	
			4/19/1977	169	911.6	S	-19	
			10/5/1977	169.43	911.17	S	-19.43	
			5/14/1978	169.08	911.52	S	-19.08	
			10/11/1978	169.75	910.85	S	-19.75	
			4/9/1979	168.65	911.95	S	-18.65	
			10/4/1979	170.49	910.11	S	-20.49	
			4/25/1980	170.55	910.05	S	-20.55	
			10/20/1980	170.2	910.4	S	-20.2	
			4/8/1981	170.03	910.57	S	-20.03	
			10/1/1981	171.49	909.11	S	-21.49	
			4/15/1982	170.89	909.71	S	-20.89	
			1/27/1983	169.73	910.87	S	-19.73	
			8/22/1984	167.24	913.36		-17.24	
			2/27/1985	166.44	914.16		-16.44	
			6/12/1985	166.27	914.33		-16.27	
			12/4/2007	162.63	917.97		-12.63	GEI
Groundwater Basin - Palo Verde Mesa								
7S/21E-15A1			9/23/1990	137.81	252.99			CDEC
			3/23/1992	137.73	253.07		0.08	
			3/29/2000	137.4	253.4		0.41	
			10/4/2000	137.46	253.34		0.35	
			12/14/2000	137.6	253.2		0.21	
			2/25/2001	139.27	251.53		-1.46	
			4/17/2001	137.5	253.3		0.31	
			7/11/2001	137.53	253.27		0.28	
			7/11/2001	137.53	253.27		0.28	
			11/7/2001	137.63	253.17		0.18	
			11/7/2001	137.63	253.17		0.18	
			4/3/2002	137.39	253.41		0.42	
			4/3/2002	137.39	253.41		0.42	
			10/2/2002	137.32	253.48		0.49	
			10/2/2002	137.33	253.47		0.48	
			6/3/2003	137.28	253.52		0.53	
			6/3/2003	137.27	253.53		0.54	
			11/5/2003	137.25	253.55		0.56	
			11/5/2003	137.25	253.55		0.56	
			3/2/2004	137.4	253.4		0.41	
			3/2/2004	137.41	253.39		0.4	
			8/4/2004	137.32	253.48		0.49	
			12/8/2004	137.36	253.44		0.45	
			4/15/2005	137.42	253.38		0.39	
			8/31/2005	137.55	253.25		0.26	
			1/27/2006	137.6	253.2		0.21	
			3/30/2006	137.63	253.17		0.18	
			3/31/2006	137.63	253.17		0.18	

Notes: Other wells may be present in the area that have only one measurement and therefore were not included in the record