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.

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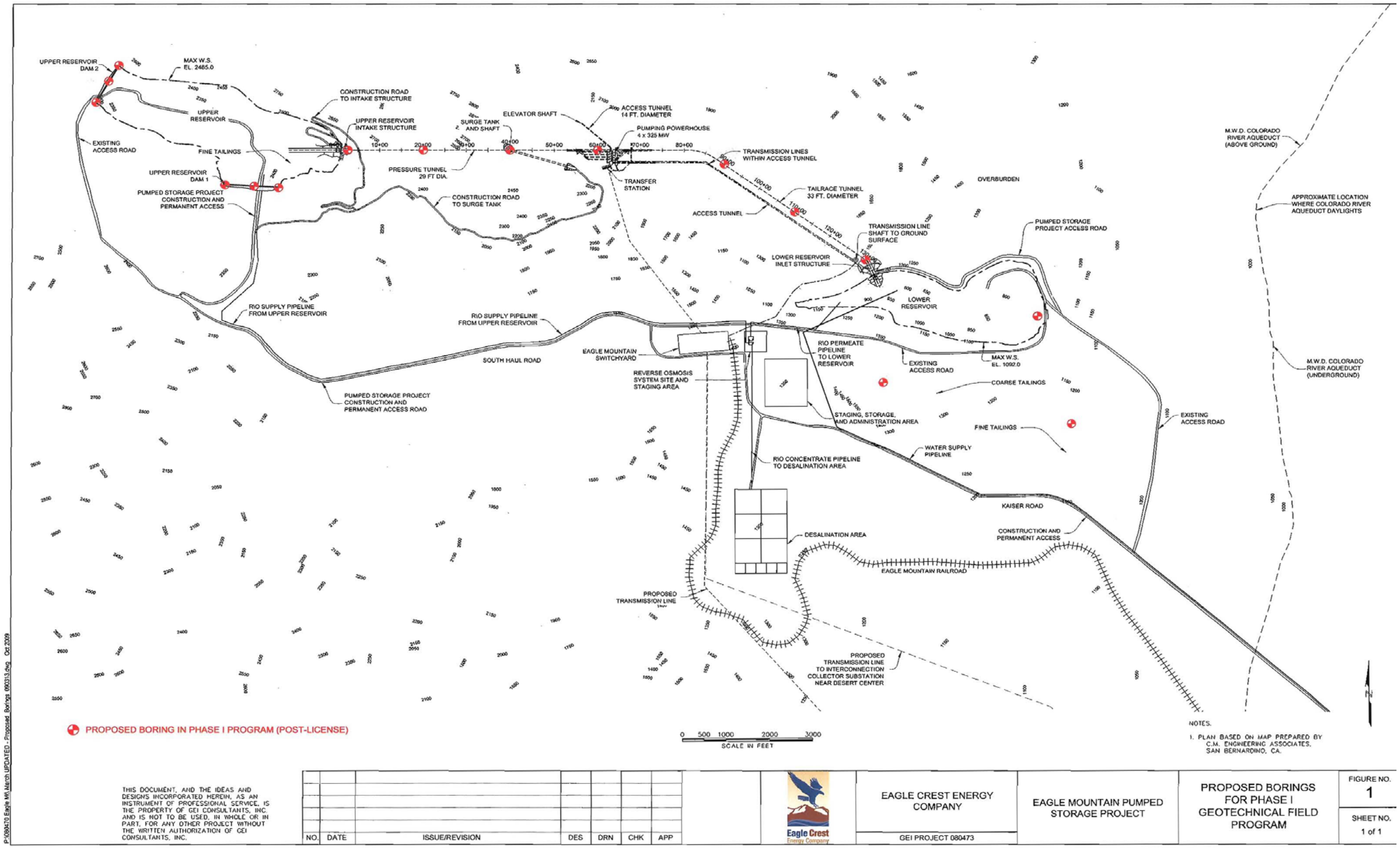
UPPER RESERVOIR DAM 2
MAX W.S. EL. 2485.0
CONSTRUCTION ROAD TO INTAKE STRUCTURE
UPPER RESERVOIR
UPPER RESERVOIR INTAKE STRUCTURE
SURGE TANK AND SHAFT
ELEVATOR SHAFT
ACCESS TUNNEL 14 FT. DIAMETER
PUMPING POWERHOUSE 4 x 325 MW
EXISTING ACCESS ROAD
FINE TAILINGS
PRESSURE TUNNEL 29 FT DIA.
TRANSMISSION LINES WITHIN ACCESS TUNNEL
UPPER RESERVOIR DAM 1
PUMPED STORAGE PROJECT CONSTRUCTION AND PERMANENT ACCESS
CONSTRUCTION ROAD TO SURGE TANK
TRANSFER STATION
TAILRACE TUNNEL 33 FT. DIAMETER
OVERBURDEN
M.W.D. COLORADO RIVER AQUEDUCT (ABOVE GROUND)
APPROXIMATE LOCATION WHERE COLORADO RIVER AQUEDUCT DAYLIGHTS
ACCESS TUNNEL
TRANSMISSION LINE SHAFT TO GROUND SURFACE
PUMPED STORAGE PROJECT ACCESS ROAD
LOWER RESERVOIR INLET STRUCTURE
LOWER RESERVOIR
RIO SUPPLY PIPELINE FROM UPPER RESERVOIR
RIO SUPPLY PIPELINE FROM UPPER RESERVOIR
EAGLE MOUNTAIN SWITCHYARD
SOUTH HAUL ROAD
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.
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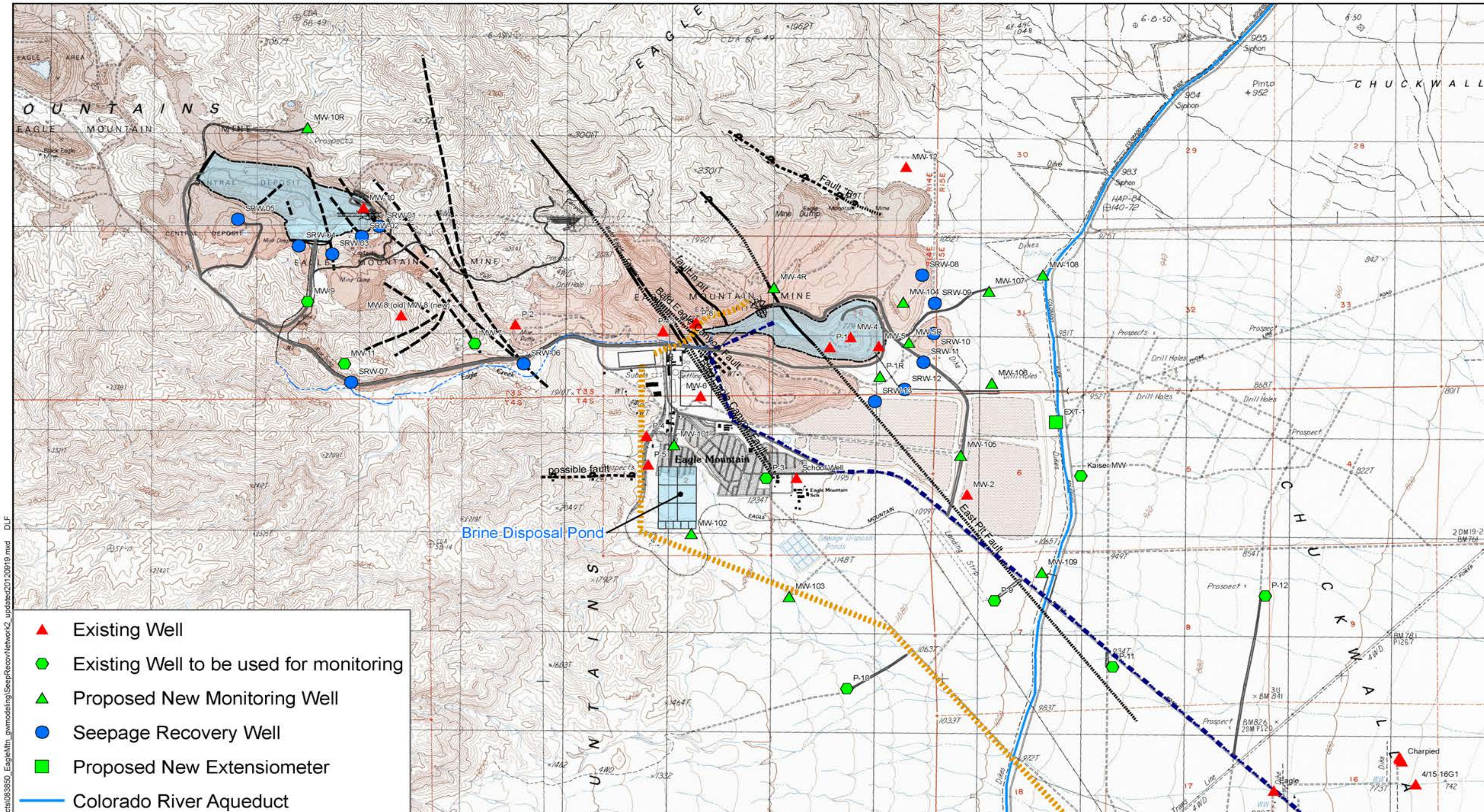
EAGLE CREST ENERGY COMPANY
GEI PROJECT 080473
EAGLE MOUNTAIN PUMPED STORAGE PROJECT
PROPOSED BORINGS FOR PHASE I GEOTECHNICAL FIELD PROGRAM
FIGURE NO. 1
SHEET NO. 1 of 1



Pumped Storage Project
Eagle Mountain, California

Eagle Crest Energy Company

MITIGATION AND MONITORING NETWORK

JANUARY 2010 FIGURE 2

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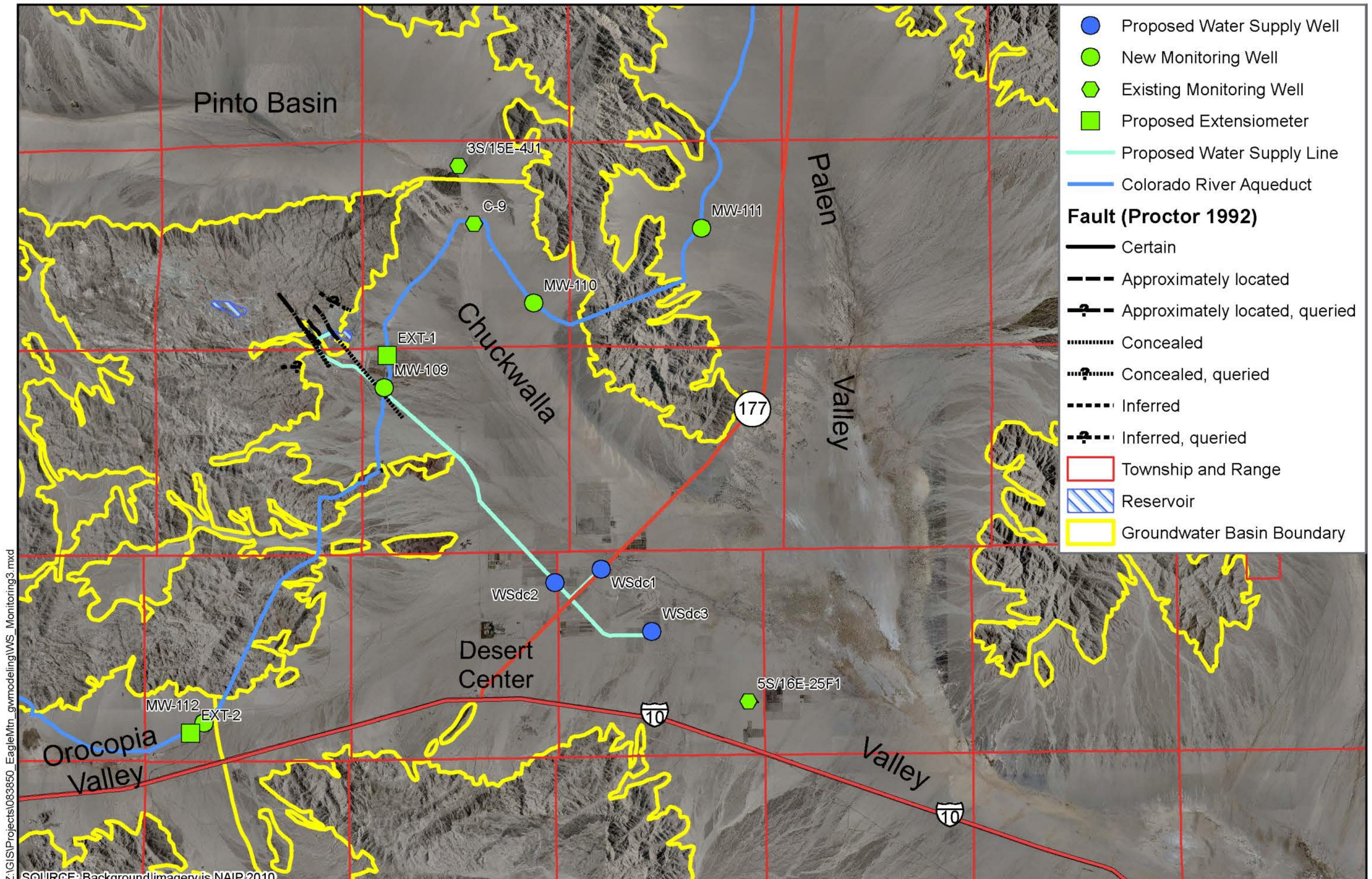

Pumped Storage Project Eagle Mountain, California	Water Boards	WATER SUPPLY MONITORING NETWORK	
Eagle Crest Energy Company		OCTOBER 2012	FIGURE 3