12 Appendix C – Technical Memorandum

12.9 Project Drainage Plan and Reservoir Spillway Designs

Memo

Eagle Mountain Pumped Storage Project - Project Drainage Plan and Reservoir Spillway Designs

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October 22, 2009

This Technical Memorandum (TM) was prepared in response to the Federal Energy Regulatory Commission's (FERC) letter referencing Schedule A: Deficiency of License Application, Project No. 13123-002---California Eagle Mountain Pumped Storage Project, Eagle Crest Energy Company (ECEC), specifically Item 5. *"Per section 4.41(g)(1), please provide detailed plan, section, and profile views of the spillway crest, spillway chute, energy dissipation structure and channel from the spillway to lower reservoir"*. Based on the FERC's request, additional information and drawings regarding the spillway, chute, energy dissipation structure and channel have been developed.

This TM also addresses the FERC's letter referencing Schedule B: Additional Information Request for License Application, Project No. 13123-002-California Eagle Mountain Pumped Storage Project, Eagle Crest Energy Company, specifically Item 14, which requests additional information regarding the Probable Maximum Flood and the use of Eagle Creek for conveyance of storm-water flows emanating from drainages associated with the Pumped Storage Project.

As a related issue this TM also addresses compatibility of the surface water conveyance system for the Pumped Storage Project with storm-water conveyance facilities planned for the proposed Eagle Mountain landfill on adjacent lands. In addition, this TM addresses the following comments received from FERC relative to surface water resources of the Project:

> *In Exhibit E, section 2.2.1, page 2-2, you state that the project would be located entirely off-stream and would not intercept a surface water course. However, in Exhibit E, section 3.3.4.1, page 3-76, you state that Eagle Creek is an intermittent surface water source and in Exhibit A, section 1.3, page 1-6, and in Exhibit E, section 2.2.1, page 2-6, you suggest that Eagle Creek would discharge into the lower reservoir by indicating that Eagle Creek would be used to convey spilled flows from the upper reservoir. Please clarify if Eagle Creek or any other surface water courses would be used by the proposed project.*

In the hydrology calculations for the Probable Maximum Precipitation and Flood and resulting runoff inflow calculations to the reservoirs contained in the Standard Design Report (Exhibit F, Appendix B.1), you report the individual drainage area to the upper reservoir as approximately 1.17 square miles and the lower reservoir as 2.85 square miles. The U.S. Geological Survey (USGS) gage no. 10253600, Eagle Creek at Eagle Mountain, which was active from October 1, 1960 to September 30, 1966, reports the drainage area as 7.71 square miles. As indicated in AIR 13, your description of the proposed project and your proposal to use the Eagle Creek channel to route spilled flows into the lower reservoir suggest that the Eagle Creek drainage area should be included in your calculations. We estimate that the total drainage area of the lower reservoir would be about 9 square miles, not including the drainage area of the upper reservoir. Therefore, please provide the following information:

a. a map clearly showing the location of the flow path from the upper reservoir spillway to the lower reservoir, including the location of Eagle Creek and the portion that would be used by the proposed project;
b. revised calculations for the Probable Maximum Precipitation and Flood if the drainage area calculations used in the license application were incorrect;
c. general descriptive information on Eagle Creek such as channel geomorphology, soil types, channel capacity, gradient, and other characteristics that could influence the ability of Eagle Creek to function as a conveyance channel for spilled flows; and
d. any hydrologic information on Eagle Creek (excluding the information available from USGS gage no. 10253600) that would help to explain the seasonality and quantity of flow in this creek.

Existing Site Drainage Features and Watershed Conditions

There are two main surface drainage features at the project site, Eagle Creek and Bald Eagle Creek, which are shown on **Figure DLA5-1**. Both are ephemeral streams, and both currently drain into the East Mine Pit where flows are contained. Eagle Creek is artificially blocked in two locations by embankments in the main channel placed to divert flood flows into the existing East Pit of the mine (future site of the Lower Reservoir) as a means to provide flood protection at the Eagle Mountain town site. With the development of the Pumped Storage Project, Bald Eagle Creek and Eagle Creek will continue to flow into the Lower Reservoir, as they have in the past. The Upper Reservoir of the Project will intercept a small tributary of Eagle Creek.

Eagle Creek is generally dry throughout the year, except during large storm events, which occur infrequently in this area of California. USGS gage (10253600) data for Eagle Creek was collected between 1960 and 1966. During this period only three events were recorded, all having daily mean discharges less than 20 cfs. Hourly flow data were not reported for the gage. Eagle Creek has a watershed area of approximately

7.3 square miles (excluding the Upper Reservoir drainage basin) upstream of the Eagle Mountain town site and varies considerably in width and gradient. The watershed area was measured by GEI using available USGS mapping and the estimate is slightly smaller than the 7.7 square miles reported for the abandoned gaging station. The channel morphology is typical of streams draining the Eagle Mountains; steep incised channels in the higher elevations leading to broader less-defined channels that essentially disappear into the broad alluvial fans that lie along the foot of the steeper slopes. Bare desert soils exposed to rainfall are subjected to physical and chemical processes that change the hydraulic properties of the soil near the surface. When dried, a hard layer is formed in the soil surface that is often called "desert crust," commonly enriched in calcite or silica. Desert crust decreases the infiltration rate of soils, thereby increasing runoff and soil erosion, reducing the availability of water to the root zone, and impeding seedling and plant growth (Water/Science and Issues, 2003, Noam Weisbrod, 2003, Gale Group).

Prior to mine development and its engineered diversion into the East Pit, Eagle Creek discharged into the broad alluvial fan at the Eagle Mountain town site with dispersal of flow to the south and east away from the mine feature and the town site. Flood flows from the steeper portions of the watershed would have spread over a very broad area and flow depths during large flooding events would have been shallow in the numerous dry washes draining the alluvial fan. This spreading alluvial fan feature is clearly shown on Figure DLA5-1.

The landfill Report of Waste Discharge (GeoSyntec, 1992) does not provide descriptions of the Eagle Creek and Bald Eagle Creek channels and only shows and describes the surficial soils east of the town site (the alluvial fan or debris flow). We expect that the channels in the steeper portions of the watershed are incised into bedrock over overburden and are relatively stable. As the creek channels transition to the alluvial fan, we anticipate the stream channels of the region, including Eagle Creek, are incised by water-caused erosion into alluvial deposits and are less stable and more prone to erosion.

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), engineered works that were completed many years ago during active mining operations to provide flood protection at the Eagle Mountain town site. This drainage pattern is proposed to be retained for development of the permitted first four phases of the landfill. The unpermitted fifth phase of the landfill involves using the East Pit for waste storage. When this would occur, according to previously published drainage plans (CM Engineering, 1991), the diversion of Eagle Creek to the East Pit would be eliminated and replaced with a new channel and detention basin constructed to manage storm-water runoff from the site. This system for the landfill project was intended to be designed for the 100-year rainfall event.

Proposed Pumped Storage Reservoirs

The proposed Pumped Storage Project will use the East Pit for water storage as part of a water cycling operation. Water will be pumped from the Lower Reservoir (East Pit) to the Upper Reservoir (Central Pit) during evening and weekend hours and subsequently released from the Upper Reservoir to generate energy in peak energy demand periods and as needed to support ancillary services for regional transmission grid operations. The volume of water that can normally be cycled between the two reservoirs is the "active" storage, which is 17,700 acre-feet. Because of the closed nature of the system, both reservoirs cannot be full at the same time. Minimum storage in the Upper Reservoir is 2,300 acre-feet and minimum storage in the Lower Reservoir is 4,200 acre-feet.

Upper Reservoir Hydrologic Design

The Upper Reservoir will be contained within the Central Pit of the Eagle Mountain Mine by the use of two dams. Each dam will have a 20-foot-wide crest at EL 2890, with a vertical upstream face and a 0.8H:1V downstream slope.

Design of the two dams that will form the Upper Reservoir will require conformance to stringent design standards to meet the regulatory requirements of the Federal Energy Regulatory Commission (FERC) and the State of California Division of Safety of Dams (DSOD). The hydrologic design standard for the Upper Reservoir dams is the Probable Maximum Flood (PMF). Based upon FERC and DSOD requirements, we have assumed that the Upper Reservoir is full to its maximum normal pool level (El. 2485) at the onset of the Probable Maximum Precipitation (PMP), which will produce the PMF design flood. Dam design is also based upon an assumption that the large hydraulic capacity of the conveyance system between the two Project reservoirs is not available for flood management.

Consistent with FERC and DSOD guidance, the PMF for the Upper Reservoir was estimated using rainfall depths published in Hydrometerological Report No. 59 (HMR 59), and the USACE HEC-1 rainfall-runoff computer model. The 72-hour general storm PMP for the Upper Reservoir basin was estimated to be approximately 18.6 inches. The Upper Reservoir has a drainage basin area of approximately 1.74 square miles, with a maximum elevation of 3,535 feet to a minimum elevation of 2,230 feet. The USBR Flood Hydrology Manual was used to develop the unit hydrograph for the drainage basin assuming an average Manning's (Kn)[1] value of 0.045 for the basin. Losses due to soil infiltration or depression storage were very conservatively assumed to be zero based on the high potential for desert crust formation that limits infiltration, as described earlier. This means that all of the rainfall on the basin was assumed to produce runoff rather than just that portion of rainfall not intercepted by depression storage and infiltration. The resulting PMF has a volume of 1,730 acre-feet and peak inflow of 4,640 cfs.

[1] Kn is a representation of "basin roughness", which affects the rate at which runoff collects and flows to the outlet of a defined drainage basin.

There are two options for accommodating the PMF to prevent uncontrolled over-topping of the Upper Reservoir dams – (1) providing a spillway to safely pass the PMF or (2) providing adequate freeboard on the dam to store the PMF inflow.

Another factor that must be considered in Upper Reservoir design is an inadvertent "over-pumping" event from the Lower Reservoir to the Upper Reservoir. In a closed hydraulic system, such as the Eagle Mountain Project, this factor is less critical than in a system where the project's lower reservoir has a source of water that is significantly larger than the Upper Reservoir (e.g. the situation at the Taum Sauk Project where an inadvertent over-pumping action resulted in overtopping and failure of the upper reservoir dam).

Over-pumping to the Upper Reservoir could occur if pumping were to continue when the Lower Reservoir is below El. 925 (minimum pool). The amount of storage below El. 925 in the Lower Reservoir is 4,200 acre-feet. The minimum pool level provides the amount of submergence over the Lower Reservoir intake structure required to avoid vortex formation and unwanted air entrainment during the pumping cycle. Should the air be entrained into the intake and tunnel, serious problems could result in the system. These may include cavitation of hydraulic equipment and unwanted pressure fluctuations. Operators will receive warnings from reservoir level sensors and alarms should the Lower Reservoir pool drop below El. 925 or the Upper Reservoir pool rise above El. 2485. If the alarms should fail, there remains a limit on how long over-pumping could occur because of fixed storage available in the closed system. Similar to the PMF design requirement, over-pumping to the Upper Reservoir could be accommodated by providing spillway capacity (there was no spillway at the Taum Sauk upper reservoir) or additional storage capacity.

Providing added storage capacity in the Upper Reservoir for both the PMF and over-pumping of the Lower Reservoir inactive storage would involve providing a maximum of 5,930 acre-feet of capacity above the normal maximum pool level. This would result in total storage capacity of 25,930 acre-feet below the nominal crest of the dam. Under this configuration, the two dam crests would be at El. 2511, and the normal freeboard between the normal maximum pool and the dam crest would be 26 feet at both dams.

Alternatively, a spillway could be provided to handle the PMF outflow or an over-pumping event. This is ECEC's currently preferred configuration. The Upper Reservoir spillway in this configuration is planned to be a 100-foot-wide ogee crest at El. 2486, one-foot above normal maximum reservoir pool (20,000 acre-feet) to reduce potentials for water losses due to wave action. The ogee crest will be constructed integrally with Upper Reservoir Dam No.1. The peak PMF inflow to the Upper Reservoir is estimated to be about 4,640 cubic feet per second (cfs), with a peak reservoir stage of 2489.0 feet, providing one-foot of residual freeboard below the dam crest. The peak PMF outflow through the spillway is estimated to be about 2,060 cfs.

The ogee spillway crest will have an approach depth of 10-feet, and 4-foot high vertical side walls. The ogee crest will transition to the stepped downstream face of the dam where considerable energy dissipation will occur. At the toe of the dam a USBR Type III Stilling Basin will be constructed to dissipate the remaining excess energy of the flood flows. The stilling basin will be 100-feet wide, approximately 30-feet long, and have 12.5-feet high basin side walls. The basin floor will be set approximately at El. 2380, and transition to the spillway channel. The dam spillway and stilling basin plan, profile and section are shown on **Figure DLA5-2**.

The Upper Reservoir spillway will be able to discharge 3,120 cfs prior to over-topping the dam during an extreme worst-case scenario over-pumping event. As noted previously, the potential to overtop the Upper Reservoir dams by over-pumping from the Lower Reservoir is limited by the volume of storage in the Lower Reservoir. Spillway design capacity is about 8% greater than the pumping capacity of one pump-turbine unit.

A final decision on the preferred Upper Reservoir dam configuration for managing the PMF and unlikely over-pumping will be made during final design. The option of constructing taller dams for added storage would increase the height of the Upper Reservoir Dam No. 1 from 120 to 141 feet and the height of Dam No. 2 from 60 to 81 feet.

Upper Reservoir Spillway Discharge Channel

The Upper Reservoir spillway will discharge to the spillway channel, which will convey the flows from the spillway to the ephemeral stream channel of Eagle Creek. The Upper Reservoir Spillway Channel will be about 4,230-feet long and descend from approximately El. 2380 to approximately El. 2200. The Upper Reservoir Spillway Channel was modeled using the USACE HEC-RAS computer program to estimate the required size and velocities within the channel. The Upper Reservoir Spillway Channel will transition from the 100-foot wide vertical side wall stilling basin at the dam toe to a 20-foot wide, 10-foot-high, 2H:1V side slope channel over a distance of approximately 500-feet. The first 500-feet will be concrete-lined channel, and the remaining portion of the channel will be provided with armoring to protect against high velocities, and/or with energy dissipation structures to reduce velocities and protect against scour and erosion. The Upper Spillway Channel will cross an existing road in two locations and then the spillway channel flows will be discharged into the Eagle Creek channel. The Upper Reservoir Spillway Channel plan, profile and sections are shown on **Figure DLA5-3**.

Aerial images indicate that downstream of the proposed channel and road crossings of the Upper Spillway Discharge Channel the natural Eagle Creek channel has been modified by mine road construction. Engineering surveys of the channel will verify dimensions and potential needs to increase its capacity. Releases from the Upper Reservoir will be smaller than the estimated 100-year flow from the 7.3 square mile Eagle Creek watershed, indicating that the natural channel should have adequate capacity.

Lower Reservoir Spillway and Drainage Considerations

Once flows from the Upper Reservoir are discharged to the Eagle Creek channel, they will join flows generated from the remainder of the Eagle Creek watershed (7.3 square miles). With the current measures implemented at the mine to divert Eagle Creek flows into the East Pit, any spill from the Upper Reservoir will reach the Lower Reservoir. For purposes of this analysis, we conservatively estimated the PMF and 100-year flows generated from the Eagle Creek watershed and the Bald Eagle Creek watershed, which also drains into the Lower Reservoir, as shown on **Figure DLA5-1**.

One challenge in assessing the potential impacts of the Pumped Storage Project on flood flows from these watersheds is selecting appropriate assumptions for the amount of water storage present in the Project reservoirs during the flood events. As noted in the previous section entitled Upper Reservoir Hydrologic Design, it is appropriate for dam and spillway design to assume that the Upper Reservoir is at El. 2485 at the onset of the PMP. Although it is an extreme worst-case scenario, it is also appropriate, for purposes of dam design only, to assume that the large hydraulic capacity of the conveyance system between the two Project reservoirs is not available for flood management. However, if the Upper Reservoir is full to its normal maximum pool, the Lower Reservoir will have 17,700 acre-feet of empty storage space above El. 925 to store runoff from Eagle Creek and Bald Eagle Creek. Depending on the timing of the PMP event, the empty storage space may be split between the two reservoirs. The total active reservoir volume for pumped storage (17,700 acre-feet) can be shifted between the two reservoirs in 18 hours, in comparison to the 72-hour duration of the general storm PMP. With monitoring of inflows, it will be possible to space available in either reservoir, as it is needed for runoff storage, by shifting water through the tunnel interconnecting the reservoirs.

The PMF runoff volume from the entire Eagle Creek watershed (1.74 and 7.30 square miles as shown on **Figure DLA5-1**) is 9,000 acre-feet, assuming no infiltration or initial losses (i.e., all rainfall is converted to runoff). Similarly, the PMF runoff volume from Black Eagle Creek watershed (2.85 square miles) is 2,520 acre-feet. The sum of these volumes (11,520 acre-feet) could be stored in the Lower Reservoir during the PMF event, as long as the volume of water in storage in the Lower Reservoir for Pumped Storage Project power operations and intake submergence is less than 10,380 acre-feet. If there is more water in storage in the Lower Reservoir than that amount and a large flooding event is occurring, up to 11,600 cfs of pumping capacity could be used to convey water to the Upper Reservoir for temporary storage thereby creating storage space in the Lower Reservoir to store runoff entering from Eagle Creek and Black Eagle Creek.

Full operation of the Pumped Storage Project requires that adequate storage space be available in the reservoir system to cycle the 17,700 acre-feet of active water volume used for energy storage and subsequent on-peak energy generation. Therefore, after a flood event, in which runoff has been stored in the Lower Reservoir (or transferred to the Upper Reservoir temporarily), a period of time must be provided to release excess stored water from the system through a structure at the Lower Reservoir. During this period, pumped-storage operations would be altered and limited. Release of storm water stored in the reservoir system would be made at a measured rate to prevent downstream flooding. If the 100-year, 24-hour storm event is considered, the storm-water runoff entering the reservoir system is estimated to be 2,630 acre-feet.

The release system from the Lower Reservoir is proposed to be an overflow spillway and a channel from the southeast rim of the Lower Reservoir across mine property and the Colorado River Aqueduct. This channel would terminate at the location shown on **Figure DLA5-1.** From that location flows would spread laterally at shallow depths over the alluvial fan as they naturally would have prior to channel modifications and diversions to the lower pit made during previous mining operations.

For Project planning, the Lower Reservoir spillway has been assumed to be 15 feet wide, with an ogee crest at EL. 1094. The ogee crest will have an approach depth of 5.6 feet, and varying height sloped side walls. With the reservoir at El.1098, the spillway will discharge a maximum of approximately 460 cfs.

The ogee crest will discharge to the spillway channel, which would convey the flows from the spillway to an area on the east side of the CRA. The layout of this channel is presented on **Figure DLA5-4**.The Lower Reservoir Spillway Channel will be about 6,670 feet long and descend from approximately El. 1088 to approximately El. 985. The Lower Reservoir Spillway Channel was modeled using the USACE HEC-RAS computer program to estimate the required size and velocities within the channel. The Lower Reservoir Spillway Channel will transition from the 15-foot wide ogee crest with vertical side walls to a 10-foot wide, minimum 5-foot-high, 2H:1V side slope channel over a distance of approximately 250 feet. The first 250 feet will be a concrete-lined channel, and the remaining portion of the channel will be lined with riprap. The Lower Reservoir Spillway Channel will terminate at the location shown on **Figure DLA5-6**.

If the PMF flood volume (11,520 acre-feet) is stored in addition to the water used for energy storage, it will be necessary to change the normal pumped-storage operating procedures to cause this excess water to be spilled. With the small Lower Reservoir spillway described above, the excess PMF volume could be released over a period of 305 hours (13 days). The excess storage from the 100-year storm (2,630 acre-feet) could be released over a period of 70 hours (3 days).

Landfill Compatibility

This Pumped Storage Project drainage plan was intentionally developed to be compatible with the proposed Eagle Mountain Landfill Drainage Plan, as shown on **Figure DLA5-5**. For the permitted landfill development, the East Pit (Lower Reservoir) is planned to be used for storage of storm-water runoff. With the Pumped Storage Project in operation, the East Pit will be used for water storage and its flood storage capacity will be reduced depending on the pumping and generating cycles. However, the ability to move large volumes of water between the two reservoirs when the Pumped Storage Project is completed and the fact that 17,700 acre-feet of storage will remain available, means that the flood management benefits of the mine pits will not be lost.

The dams creating additional storage at the Upper Reservoir are required to be designed to withstand all extreme loading conditions including the PMF and the maximum credible earthquake, and will pose no risk to the landfill,. Two regulatory agencies, FERC and DSOD, will assure that the Upper Reservoir dams meet very stringent design standards. The flood and earthquake design standards for all features of the Pumped Storage Project proposed by ECEC will meet or exceed those that govern final design of the landfill.

Because the Pumped Storage Project would be developed prior to the landfill, and drainage facilities constructed for the Pumped Storage Project will be designed with future landfill construction in mind, the cost of major portions of the drainage facilities at the site will therefore be borne by the Pumped Storage Project and not the landfill project.

References

CM Engineering Associates, Inc., 1991. Eagle Mountain Project -- Drainage Report. Prepared for: Mine Reclamation Corporation, Palm Springs, CA.

GeoSyntec Consultants, 1992. Report of Waste Discharge. Eagle Mountain Landfill and Recycling Center. Mine Reclamation Corporation, Palm Springs, CA.

Weisbrod, Naom. Water/Science and Issues, 2003, Gale Group. Discussion on Desert Soils.

Summary of Flood Estimates for the Eagle Mountain Project

10/22/2009

Basin	Area	Rainfall Depth 100-Yr 24-hr	Rainfall Depth PMP 72-hr	Runoff Volume 100-Yr	Runoff Volume PMP	Peak Inflow 100-Yr	Peak Inflow PMP
	mi^2	in.	in.	AF	AF	cfs	cfs
Above Upper Reservoir	1.74	4.15	18.59	385	1,725	2,789	4,640
Eagle Creek to Lower Reservoir	7.3	4.15	18.68	1,616	7,273	6,455	15,320
Bald Eagle Creek to Lower Reservoir	2.85	4.15	16.60	631	2,523	4,410	6,900

In compliance with 18 C.F.R. § 4.39(e), ECE is filing any maps and drawings "showing project location information and details of project structures" as CEII, not for public disclosure. Figures DLA 5-1 through DLA 5-6 have been file under separate cover as CEII.

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 *                                       *                                                     *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                                                     *    U.S. ARMY CORPS OF ENGINEERS     *
 *             JULY   1998               *                                                     *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1(L)              *                                                     *         609 SECOND STREET           *
 *                                       *                                                     *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   21AUG09  TIME  10:30:46   *                                                     *          (916) 756-1104             *
 *                                       *                                                     *                                     *
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                                                     X     X  X         X              X
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                                                     X     X  X         X              X
                                                     X     X  X         X     X        X
                                                     X     X  XXXXXXX   XXXXX         XXX



            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1L INPUT                                             PAGE  1

           LINE          ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

             1            ID   PROJECT: Eagle Mountain
             2            ID   CLIENT: Eagle Crest Engergy
             3            ID   FILE NAME: EMURPMF.HC1 [Eagle Mountain, Upper Res., PMF storm]
             4            ID   HISTORY: Created 8/19/09 by NDM
             5            ID   PURPOSE: Estimate PMF-Storm for Upper Reservoir
             6            ID
             7            ID   PRECIPITATION: HMR 59 PMP
             8            ID   TEMPORAL DISTRIBUTION: 2/3 end weighted
             9            ID   SUB-BASINS: none
            10            ID   LOSS RATE: zero
            11            ID
            12            ID   BASE FLOW: Zero
            13            ID   UH (OVERLAND): USBR Synthetic, Southwest Desert, Kn = 0.045, 1-min duration
            14            ID
            15            ID
            16            ID   ****************************************************************************
                          *
            17            IT       1               0    4500
            18            IO       1       2
                          *

            19            KK  Inflow --> OVERLAND INFLOW TO RESERVOIR (excludes direct rainfall on reservoir
                          * SUB-BASIN AREA (sq. mi)
            20            BA   1.736
                          *
            21            IN      60
                          * ALL-SEASON GENERAL STORM PMP - BASIN B1
                          * (1-hr incr.; Mid-End Wt, FERC/HMR 59 alt. 6-hr Blocks; EXCESS RAINFALL ONLY)
                          * Applied HSG loss rates(A,B,C,D   0.000   0.000   0.000   0.000(in/hr)
            22            PI   0.061   0.061   0.061   0.061   0.061   0.061   0.068   0.068   0.068   0.068
            23            PI   0.071   0.071   0.078   0.078   0.078   0.078   0.078   0.078   0.112   0.112
            24            PI   0.112   0.112   0.119   0.119   0.137   0.137   0.137   0.138   0.138   0.138
            25            PI   0.559   0.638   0.643   0.645   0.645   0.645   0.651   0.652   0.689   0.689
            26            PI   1.673   4.354   0.207   0.207   0.207   0.195   0.195   0.195   0.119   0.119
            27            PI   0.119   0.119   0.119   0.119   0.112   0.112   0.112   0.112   0.078   0.078
            28            PI   0.071   0.071   0.071   0.071   0.071   0.071   0.068   0.068   0.068   0.068
            29            PI   0.061   0.061   0.000
                          *
                          * BASEFLOW (SET TO ZERO)
            30            BF    00.0     0.0     1.0
                          *
                          * UNIFORM LOSS RATE, ZERO INIT. BUDGET (SAT'D). ZERO IMPERMIABLE.
            31            LU     0.0   0.000     0.0
                          *
            32            IN       1
                          *       Eagle Mountain Upper Reservoir, Kn = 0.045, 1-min UH
                          * USBR UH, Kn =    0.045, duration =   1min.
            33            UI      15      27      39      52      73     107     150     201     267     349
            34            UI     463     624     863    1189    1516    1833    2158    2443    2739    2984
            35            UI    3081    3015    2901    2750    2570    2357    2143    1923    1700    1547
            36            UI    1413    1285    1164    1079    1000     928     860     792     742     695
            37            UI     653     623     594     566     541     516     494     472     453     436
            38            UI     417     401     385     368     353     338     324     310     295     285
            39            UI     273     261     249     240     231     221     212     203     195     187
            40            UI     179     171     164     158     152     146     140     134     128     123
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          LINE          ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

            41           UI     118     113     108     104      99      95      91      88      84      81
            42           UI      78      74      71      69      66      63      60      58      55      53
            43           UI      51      49      47      44      43      41      40      38      36      35
            44           UI      34      31      30      29      28      27      26      25      24      23
            45           UI      22      21      21      20      19      18      17      17      16      16
            46           UI      15      13      13      13      12       6
                         *
                         *
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            47           KK  PMFout --> PMF OUTFLOW THROUGH SPILLWAY
            48           KP       1
            49           KO       0       2
                         *
                         * INITIAL RESERVOIR ELEVATION
            50           RS       1    ELEV    2485
                         *
                         * ELEV-CAP TABLE
            51           SV   20000   20220   20604   20991   21380   21771   22164   22559   22956
            52           SE    2485    2486    2488    2490    2492    2494    2496    2498    2500
                         *
                         * SPILLWAY CREST ELEVATION: EL, L, C, Exp
            53           SS    2486     100     3.9     1.5
                         *
                         * DAM OVERTOPPING SUMMARY: EL, L (w/o spillway), C, EXP
                         * ST  2490  1200     3.0     1.5
                         *
                         *DIAGRAM
                         *
            54           ZZ
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    19      Inflow
                 V
                 V
    47      PMFout


   31 LU         UNIFORM LOSS RATE
                       STRTL        0.00  INITIAL LOSS
                       CNSTL        0.00  UNIFORM LOSS RATE
                       RTIMP        0.00  PERCENT IMPERVIOUS AREA

   33 UI         INPUT UNITGRAPH, 136 ORDINATES,  VOLUME = 1.00
                      15.0      27.0      39.0      52.0      73.0     107.0     150.0     201.0     267.0     349.0
                     463.0     624.0     863.0    1189.0    1516.0    1833.0    2158.0    2443.0    2739.0    2984.0
                    3081.0    3015.0    2901.0    2750.0    2570.0    2357.0    2143.0    1923.0    1700.0    1547.0
                    1413.0    1285.0    1164.0    1079.0    1000.0     928.0     860.0     792.0     742.0     695.0
                     653.0     623.0     594.0     566.0     541.0     516.0     494.0     472.0     453.0     436.0
                     417.0     401.0     385.0     368.0     353.0     338.0     324.0     310.0     295.0     285.0
                     273.0     261.0     249.0     240.0     231.0     221.0     212.0     203.0     195.0     187.0
                     179.0     171.0     164.0     158.0     152.0     146.0     140.0     134.0     128.0     123.0
                     118.0     113.0     108.0     104.0      99.0      95.0      91.0      88.0      84.0      81.0
                      78.0      74.0      71.0      69.0      66.0      63.0      60.0      58.0      55.0      53.0
                      51.0      49.0      47.0      44.0      43.0      41.0      40.0      38.0      36.0      35.0
                      34.0      31.0      30.0      29.0      28.0      27.0      26.0      25.0      24.0      23.0
                      22.0      21.0      21.0      20.0      19.0      18.0      17.0      17.0      16.0      16.0
                      15.0      13.0      13.0      13.0      12.0       6.0

                                                              ***



                                                                 RUNOFF SUMMARY
                                                         FLOW IN CUBIC FEET PER SECOND
                                                      TIME IN HOURS,  AREA IN SQUARE MILES

                                            PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD       BASIN     MAXIMUM     TIME OF
          OPERATION       STATION           FLOW      PEAK                                             AREA       STAGE    MAX STAGE
+                                                               6-HOUR     24-HOUR      72-HOUR

          HYDROGRAPH AT
+                          Inflow          4636.    42.10        1563.        677.         289.        1.74

          ROUTED TO
+                          PMFout          2059.    42.47        1263.        630.         243.        1.74
+                                                                                                                2489.02       42.47


 *** NORMAL END OF HEC-1 ***
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1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                                                   *   U.S. ARMY CORPS OF ENGINEERS      *
 *            JULY   1998                *                                                   *   HYDROLOGIC ENGINEERING CENTER     *
 *          VERSION 4.1(L)               *                                                   *         609 SECOND STREET           *
 *                                       *                                                   *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   22OCT09  TIME  11:08:20   *                                                   *          (916) 756-1104             *
 *                                       *                                                   *                                     *
*****************************************                                                   ***************************************



                                                  X     X  XXXXXXX   XXXXX          X
                                                  X     X  X        X     X        XX
                                                  X     X  X        X               X
                                                  XXXXXXX  XXXX     X       XXXXX   X
                                                  X     X  X        X               X
                                                  X     X  X        X     X         X
                                                  X     X  XXXXXXX   XXXXX         XXX



            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                           HEC-1L INPUT                                              PAGE  1

           LINE      ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

              1       ID   PROJECT: Eagle Mountain
              2       ID   CLIENT: Eagle Crest Engergy
              3       ID   FILE NAME: EMUR100YR.HC1 [Eagle Mountain, Upper Res., 100-YR storm]
              4       ID   HISTORY: Created 8/19/09 by NDM  Revised 9/25/2009 by NJN
              5       ID   PURPOSE: Estimate 100 YR-Storm for Upper Reservoir
              6       ID
              7       ID   PRECIPITATION: 100 YR
              8       ID   TEMPORAL DISTRIBUTION: Center weighted
              9       ID   SUB-BASINS: none
             10       ID   LOSS RATE: zero
             11       ID
             12       ID   BASE FLOW: Zero
             13       ID   UH (OVERLAND): USBR Synthetic, Southwest Desert, Kn = 0.045, 1-min duration
             14       ID
             15       ID
             16       ID   ***************************************************************************
                      *
             17       IT       1               0    4500
             18       IO       1       2
                      *

             19       KK  Inflow --> OVERLAND INFLOW TO RESERVOIR (excludes direct rainfall on reservoir
                      * SUB-BASIN AREA (sq. mi)
             20       BA   1.736
                      *
                      * 100-YR STORM, (CENTER-WEIGHTED, SEO GUIDELINES, IT or IN time step)
             21       PH             0.01   0.490    0.90    1.56    1.86    2.08    2.55    3.35    4.15
                      *
                      * BASEFLOW (SET TO ZERO)
             22       BF    00.0     0.0     1.0
                      *
                      * UNIFORM LOSS RATE, ZERO INIT. BUDGET (SAT'D). ZERO IMPERMIABLE.
             23       LU     0.0   0.000     0.0
                      *
             24       IN       1
                      *       Eagle Mountain Upper Reservoir, Kn = 0.045, 1-min UH
                      * USBR UH, Kn =    0.045, duration =    1min.
             25       UI      15      27      39      52      73     107     150     201     267     349
             26       UI     463     624     863    1189    1516    1833    2158    2443    2739    2984
             27       UI    3081    3015    2901    2750    2570    2357    2143    1923    1700    1547
             28       UI    1413    1285    1164    1079    1000     928     860     792     742     695
             29       UI     653     623     594     566     541     516     494     472     453     436
             30       UI     417     401     385     368     353     338     324     310     295     285
             31       UI     273     261     249     240     231     221     212     203     195     187
             32       UI     179     171     164     158     152     146     140     134     128     123
             33       UI     118     113     108     104      99      95      91      88      84      81
             34       UI      78      74      71      69      66      63      60      58      55      53
             35       UI      51      49      47      44      43      41      40      38      36      35
             36       UI      34      31      30      29      28      27      26      25      24      23
             37       UI      22      21      21      20      19      18      17      17      16      16
             38       UI      15      13      13      13      12       6
                      *
                      *
                      *
                      *
1                                           HEC-1L INPUT                                              PAGE  2

           LINE      ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10


             39       KK  PMFout --> PMF OUTFLOW THROUGH SPILLWAY
             40       KP       1
             41       KO       0       2
                      *
                      * INITIAL RESERVOIR ELEVATION
             42       RS       1    ELEV    2485
                      *
```

```
                    * ELEV-CAP TABLE
           43       SV   20000   20220   20604   20991   21380   21771   22164   22559   22956
           44       SE    2485    2486    2488    2490    2492    2494    2496    2498    2500
                    *
                    * SPILLWAY CREST ELEVATION: EL, L, C, Exp
           45       SS    2486     100     3.9     1.5
                    *
                    * DAM OVERTOPPING SUMMARY: EL, L (w/o spillway), C, EXP
                    * ST  2490  1200     3.0     1.5
                    *
                    *DIAGRAM
                    *
           46       ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    19      Inflow
                 V
                 V
    39      PMFout

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
                 PRECIPITATION DATA

   21 PH                             DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......    ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  0.49    0.90    1.56    1.86    2.08    2.55    3.35    4.15    0.00    0.00    0.00    0.00

                                          STORM AREA =    0.01

   23 LU         UNIFORM LOSS RATE
                       STRTL        0.00  INITIAL LOSS
                       CNSTL        0.00  UNIFORM LOSS RATE
                       RTIMP        0.00  PERCENT IMPERVIOUS AREA

   25 UI         INPUT UNITGRAPH, 136 ORDINATES,  VOLUME = 1.00
                      15.0      27.0      39.0      52.0      73.0     107.0     150.0     201.0     267.0     349.0
                     463.0     624.0     863.0    1189.0    1516.0    1833.0    2158.0    2443.0    2739.0    2984.0
                    3081.0    3015.0    2901.0    2750.0    2570.0    2357.0    2143.0    1923.0    1700.0    1547.0
                    1413.0    1285.0    1164.0    1079.0    1000.0     928.0     860.0     792.0     742.0     695.0
                     653.0     623.0     594.0     566.0     541.0     516.0     494.0     472.0     453.0     436.0
                     417.0     401.0     385.0     368.0     353.0     338.0     324.0     310.0     295.0     285.0
                     273.0     261.0     249.0     240.0     231.0     221.0     212.0     203.0     195.0     187.0
                     179.0     171.0     164.0     158.0     152.0     146.0     140.0     134.0     128.0     123.0
                     118.0     113.0     108.0     104.0      99.0      95.0      91.0      88.0      84.0      81.0
                      78.0      74.0      71.0      69.0      66.0      63.0      60.0      58.0      55.0      53.0
                      51.0      49.0      47.0      44.0      43.0      41.0      40.0      38.0      36.0      35.0
                      34.0      31.0      30.0      29.0      28.0      27.0      26.0      25.0      24.0      23.0
                      22.0      21.0      21.0      20.0      19.0      18.0      17.0      17.0      16.0      16.0
                      15.0      13.0      13.0      13.0      12.0       6.0

                                                                           ***



                                                                     RUNOFF SUMMARY
                                                             FLOW IN CUBIC FEET PER SECOND
                                                          TIME IN HOURS,  AREA IN SQUARE MILES

                                              PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD       BASIN     MAXIMUM     TIME OF
          OPERATION       STATION             FLOW     PEAK                                               AREA      STAGE     MAX STAGE
+                                                                  6-HOUR      24-HOUR      72-HOUR

          HYDROGRAPH AT
+                          Inflow            2789.   12.37          478.         193.          65.        1.74

          ROUTED TO
+                          PMFout             116.   18.37          109.          70.          27.        1.74
+                                                                                                                 2486.44       18.28


 *** NORMAL END OF HEC-1L ***
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```
1****************************************                                                               ***************************************
 *                                       *                                                              *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                                                              *    U.S. ARMY CORPS OF ENGINEERS     *
 *             JULY   1998               *                                                              *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1(L)              *                                                              *          609 SECOND STREET          *
 *                                       *                                                              *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   24AUG09  TIME  14:03:08   *                                                              *            (916) 756-1104           *
 *                                       *                                                              *                                     *
 ****************************************                                                               ***************************************


                                                       X     X  XXXXXXX   XXXXX          X
                                                       X     X  X        X     X        XX
                                                       X     X  X        X               X
                                                       XXXXXXX  XXXX     X       XXXXX   X
                                                       X     X  X        X               X
                                                       X     X  X        X     X         X
                                                       X     X  XXXXXXX   XXXXX         XXX


           THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

           THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
           THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
           NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
           DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
           KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                              HEC-1L INPUT                                          PAGE  1

          LINE          ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

            1            ID   PROJECT: Eagle Mountain
            2            ID   CLIENT: Eagle Crest Engergy
            3            ID   FILE NAME: EMLRPMF.HC1 [Eagle Mountain, Lower Res., PMF storm]
            4            ID   HISTORY: Created 8/19/09 by NDM
            5            ID   PURPOSE: Estimate PMF-Storm for Lower Reservoir
            6            ID
            7            ID   PRECIPITATION: HMR 59 PMP
            8            ID   TEMPORAL DISTRIBUTION: 2/3 end weighted
            9            ID   SUB-BASINS: none
           10            ID   LOSS RATE: zero
           11            ID
           12            ID   BASE FLOW: Zero
           13            ID   UH (OVERLAND): USBR Synthetic, Southwest Desert, Kn = 0.045, 1-min duration
           14            ID
           15            ID
           16            ID   ****************************************************************************
                         *
           17            IT       1             0    4500
           18            IO       1       2
                         *

           19            KK  Inflow --> OVERLAND INFLOW TO RESERVOIR (excludes direct rainfall on reservoir
                         * SUB-BASIN AREA (sq. mi)
           20            BA   2.850
                         *
           21            IN      60
                         * ALL-SEASON GENERAL STORM PMP - BASIN B1
                         * (1-hr incr.; Mid-End Wt, FERC/HMR 59 alt. 6-hr Blocks; EXCESS RAINFALL ONLY)
                         * Applied HSG loss rates(A,B,C,D   0.000   0.000   0.000   0.000(in/hr)
           22            PI   0.046   0.046   0.046   0.046   0.046   0.046   0.061   0.061   0.061   0.061
           23            PI   0.076   0.076   0.080   0.080   0.080   0.080   0.080   0.080   0.091   0.091
           24            PI   0.091   0.091   0.113   0.113   0.116   0.116   0.116   0.159   0.159   0.159
           25            PI   0.529   0.545   0.577   0.587   0.613   0.620   0.657   0.660   0.665   0.735
           26            PI   1.288   4.005   0.180   0.180   0.180   0.168   0.168   0.168   0.113   0.113
           27            PI   0.113   0.113   0.113   0.113   0.091   0.091   0.091   0.091   0.080   0.080
           28            PI   0.076   0.076   0.076   0.076   0.076   0.076   0.061   0.061   0.061   0.061
           29            PI   0.046   0.046   0.000
                         *
                         * BASEFLOW (SET TO ZERO)
           30            BF    00.0     0.0     1.0
                         *
                         * UNIFORM LOSS RATE, ZERO INIT. BUDGET (SAT'D). ZERO IMPERMIABLE.
           31            LU     0.0   0.000     0.0
                         *
           32            IN       1
                         *       Eagle Mountain Lower Reservoir, Kn = 0.045, 1-min UH
                         * USBR UH, Kn =    0.045, duration =   1min.
           33            UI      22      40      56      74     102     142     196     265     350     449
           34            UI     571     758    1012    1354    1833    2303    2756    3222    3642    4057
           35            UI    4497    4660    4727    4571    4374    4137    3867    3561    3255    2938
           36            UI    2615    2395    2199    2016    1833    1702    1585    1475    1377    1279
           37            UI    1188    1121    1054     996     953     911     872     835     799     767
           38            UI     736     706     681     655     629     607     583     560     538     517
           39            UI     496     476     455     440     424     406     389     375     362     348
           40            UI     335     322     309     297     286     274     264     253     243     235
1                                              HEC-1L INPUT                                          PAGE  2
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 LINE          ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

   41           UI     227     218     209     201     193     186     178     171     164     159
   42           UI     152     145     140     135     130     126     121     115     111     107
   43           UI     104      99      95      92      88      85      81      78      75      72
   44           UI      69      67      64      62      60      57      55      54      51      48
   45           UI      46      45      43      42      40      38      37      36      35      34
   46           UI      32      31      30      29      28      27      25      25      25      23
   47           UI      21      20      20      19      16       3
                *
                *
                *

   48           KK  PMFout --> PMF OUTFLOW THROUGH SPILLWAY
   49           KP       1
   50           KO       0       2
                *
                * INITIAL RESERVOIR ELEVATION
   51           RS       1    ELEV    1094
                *
                * ELEV-CAP TABLE
   52           SV    4200    5891   10400   10400   15917   19438   21900   23244   25210
   53           SE     925     950    1000    1025    1050    1076    1092    1100    1110
                *
                * SPILLWAY CREST ELEVATION: EL, L, C, Exp
   54           SS    1094     100     2.9     1.5
                *
                *
                *DIAGRAM
                *
   55           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    19      Inflow
                 V
                 V
    48      PMFout

   31 LU          UNIFORM LOSS RATE
                        STRTL        0.00  INITIAL LOSS
                        CNSTL        0.00  UNIFORM LOSS RATE
                        RTIMP        0.00  PERCENT IMPERVIOUS AREA

   33 UI          INPUT UNITGRAPH, 146 ORDINATES,  VOLUME = 1.00
                       22.0      40.0      56.0      74.0     102.0     142.0     196.0     265.0     350.0     449.0
                      571.0     758.0    1012.0    1354.0    1833.0    2303.0    2756.0    3222.0    3642.0    4057.0
                     4497.0    4660.0    4727.0    4571.0    4374.0    4137.0    3867.0    3561.0    3255.0    2938.0
                     2615.0    2395.0    2199.0    2016.0    1833.0    1702.0    1585.0    1475.0    1377.0    1279.0
                     1188.0    1121.0    1054.0     996.0     953.0     911.0     872.0     835.0     799.0     767.0
                      736.0     706.0     681.0     655.0     629.0     607.0     583.0     560.0     538.0     517.0
                      496.0     476.0     455.0     440.0     424.0     406.0     389.0     375.0     362.0     348.0
                      335.0     322.0     309.0     297.0     286.0     274.0     264.0     253.0     243.0     235.0
                      227.0     218.0     209.0     201.0     193.0     186.0     178.0     171.0     164.0     159.0
                      152.0     145.0     140.0     135.0     130.0     126.0     121.0     115.0     111.0     107.0
                      104.0      99.0      95.0      92.0      88.0      85.0      81.0      78.0      75.0      72.0
                       69.0      67.0      64.0      62.0      60.0      57.0      55.0      54.0      51.0      48.0
                       46.0      45.0      43.0      42.0      40.0      38.0      37.0      36.0      35.0      34.0
                       32.0      31.0      30.0      29.0      28.0      27.0      25.0      25.0      25.0      23.0
                       21.0      20.0      20.0      19.0      16.0       3.0

                                                            ***


                                                              RUNOFF SUMMARY
                                                      FLOW IN CUBIC FEET PER SECOND
                                                   TIME IN HOURS,  AREA IN SQUARE MILES

                                          PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD       BASIN     MAXIMUM     TIME OF
          OPERATION       STATION        FLOW      PEAK                                              AREA      STAGE     MAX STAGE
+                                                               6-HOUR     24-HOUR     72-HOUR

          HYDROGRAPH AT
+                          Inflow       6902.    42.13         2345.       1022.        436.        2.85

          ROUTED TO
+                          PMFout       3185.    42.50         1930.        995.        424.        2.85
+                                                                                                              1098.94      42.50


 *** NORMAL END OF HEC-1 ***
```

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1****************************************                                                  ***************************************
 *                                      *                                                  *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                                                  *   U.S. ARMY CORPS OF ENGINEERS      *
 *            JULY   1998               *                                                  *   HYDROLOGIC ENGINEERING CENTER     *
 *          VERSION 4.1(L)              *                                                  *         609 SECOND STREET           *
 *                                      *                                                  *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   22OCT09  TIME  11:04:16  *                                                  *          (916) 756-1104             *
 *                                      *                                                  *                                     *
 ****************************************                                                  ***************************************
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```
                    X     X  XXXXXXX   XXXXX          X
                    X     X  X        X     X        XX
                    X     X  X        X               X
                    XXXXXXX  XXXX     X       XXXXX   X
                    X     X  X        X               X
                    X     X  X        X     X         X
                    X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


```
  LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

    1           ID   PROJECT: Eagle Mountain
    2           ID   CLIENT: Eagle Crest Engergy
    3           ID   FILE NAME: EMLR100YR.HC1 [Eagle Mountain, Lower Res., 100 YR storm]
    4           ID   HISTORY: Created 8/19/09 by NDM Revised 9/25/2009 by NJN
    5           ID   PURPOSE: Estimate 100 YR-Storm for Lower Reservoir
    6           ID
    7           ID   PRECIPITATION: 100 YR
    8           ID   TEMPORAL DISTRIBUTION: Center weighted
    9           ID   SUB-BASINS: none
   10           ID   LOSS RATE: zero
   11           ID
   12           ID   BASE FLOW: Zero
   13           ID   UH (OVERLAND): USBR Synthetic, Southwest Desert, Kn = 0.045, 1-min duration
   14           ID
   15           ID
   16           ID   ***************************************************************************
                *
   17           IT       1               0    4500
   18           IO       1       2
                *

   19           KK  Inflow --> OVERLAND INFLOW TO RESERVOIR (excludes direct rainfall on reservoir
                * SUB-BASIN AREA (sq. mi)
   20           BA   2.850
                *
                * 100-YR STORM, (CENTER-WEIGHTED, SEO GUIDELINES, IT or IN time step)
   21           PH            0.01   0.490   0.90    1.56    1.86    2.08     2.55    3.35    4.15
                *
                * BASEFLOW (SET TO ZERO)
   22           BF    00.0     0.0     1.0
                *
                * UNIFORM LOSS RATE, ZERO INIT. BUDGET (SAT'D). ZERO IMPERMIABLE.
   23           LU     0.0   0.000     0.0
                *
   24           IN       1
                *       Eagle Mountain Lower Reservoir, Kn = 0.045, 1-min UH
                * USBR UH, Kn =    0.045, duration =   1min.
   25           UI      22      40      56      74     102     142     196     265     350     449
   26           UI     571     758    1012    1354    1833    2303    2756    3222    3642    4057
   27           UI    4497    4660    4727    4571    4374    4137    3867    3561    3255    2938
   28           UI    2615    2395    2199    2016    1833    1702    1585    1475    1377    1279
   29           UI    1188    1121    1054     996     953     911     872     835     799     767
   30           UI     736     706     681     655     629     607     583     560     538     517
   31           UI     496     476     455     440     424     406     389     375     362     348
   32           UI     335     322     309     297     286     274     264     253     243     235
   33           UI     227     218     209     201     193     186     178     171     164     159
   34           UI     152     145     140     135     130     126     121     115     111     107
   35           UI     104      99      95      92      88      85      81      78      75      72
   36           UI      69      67      64      62      60      57      55      54      51      48
   37           UI      46      45      43      42      40      38      37      36      35      34
   38           UI      32      31      30      29      28      27      25      25      25      23
   39           UI      21      20      20      19      16       3
                *
                *
                *
```



```
  LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10


   40           KK  PMFout --> PMF OUTFLOW THROUGH SPILLWAY
   41           KP       1
   42           KO       0       2
                *
                * INITIAL RESERVOIR ELEVATION
   43           RS       1    ELEV    1094
```

```
                    *
                    * ELEV-CAP TABLE
      44            SV    4200    5891   10400   10400   15917   19438   21900   23244   25210
      45            SE     925     950    1000    1025    1050    1076    1092    1100    1110
                    *
                    * SPILLWAY CREST ELEVATION: EL, L, C, Exp
      46            SS    1094     100     2.9     1.5
                    *
                    *
                    *DIAGRAM
                    *
      47            ZZ
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    19      Inflow
                V
                V
    40      PMFout

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION



                PRECIPITATION DATA

   21 PH                           DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                 0.49    0.90    1.56    1.86    2.08    2.55    3.35    4.15    0.00    0.00    0.00    0.00

                                           STORM AREA =     0.01

   23 LU        UNIFORM LOSS RATE
                      STRTL        0.00  INITIAL LOSS
                      CNSTL        0.00  UNIFORM LOSS RATE
                      RTIMP        0.00  PERCENT IMPERVIOUS AREA

   25 UI        INPUT UNITGRAPH, 146 ORDINATES,  VOLUME = 1.00
                     22.0      40.0      56.0      74.0     102.0     142.0     196.0     265.0     350.0     449.0
                    571.0     758.0    1012.0    1354.0    1833.0    2303.0    2756.0    3222.0    3642.0    4057.0
                   4497.0    4660.0    4727.0    4571.0    4374.0    4137.0    3867.0    3561.0    3255.0    2938.0
                   2615.0    2395.0    2199.0    2016.0    1833.0    1702.0    1585.0    1475.0    1377.0    1279.0
                   1188.0    1121.0    1054.0     996.0     953.0     911.0     872.0     835.0     799.0     767.0
                    736.0     706.0     681.0     655.0     629.0     607.0     583.0     560.0     538.0     517.0
                    496.0     476.0     455.0     440.0     424.0     406.0     389.0     375.0     362.0     348.0
                    335.0     322.0     309.0     297.0     286.0     274.0     264.0     253.0     243.0     235.0
                    227.0     218.0     209.0     201.0     193.0     186.0     178.0     171.0     164.0     159.0
                    152.0     145.0     140.0     135.0     130.0     126.0     121.0     115.0     111.0     107.0
                    104.0      99.0      95.0      92.0      88.0      85.0      81.0      78.0      75.0      72.0
                     69.0      67.0      64.0      62.0      60.0      57.0      55.0      54.0      51.0      48.0
                     46.0      45.0      43.0      42.0      40.0      38.0      37.0      36.0      35.0      34.0
                     32.0      31.0      30.0      29.0      28.0      27.0      25.0      25.0      25.0      23.0
                     21.0      20.0      20.0      19.0      16.0       3.0

                                                                         ***



                                                               RUNOFF SUMMARY
                                                       FLOW IN CUBIC FEET PER SECOND
                                                    TIME IN HOURS,  AREA IN SQUARE MILES

                                               PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD       BASIN     MAXIMUM     TIME OF
          OPERATION       STATION              FLOW     PEAK                                               AREA      STAGE     MAX STAGE
+                                                                   6-HOUR     24-HOUR      72-HOUR

          HYDROGRAPH AT
+                          Inflow     4410.    12.38         786.         317.         106.        2.85

          ROUTED TO
+                          PMFout      749.    13.42         581.         279.         105.        2.85
+                                                                                                           1095.88       13.40


 *** NORMAL END OF HEC-1 ***
```

```
1*****************************************                                                        ***************************************
 *                                       *                                                        *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                                                        *   U.S. ARMY CORPS OF ENGINEERS      *
 *            JULY   1998                *                                                        *   HYDROLOGIC ENGINEERING CENTER     *
 *          VERSION 4.1(L)               *                                                        *         609 SECOND STREET           *
 *                                       *                                                        *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   25SEP09  TIME  16:45:03   *                                                        *          (916) 756-1104             *
 *                                       *                                                        *                                     *
 *****************************************                                                        ***************************************



                              X     X  XXXXXXX   XXXXX           X
                              X     X  X        X     X         XX
                              X     X  X        X                X
                              XXXXXXX  XXXX     X        XXXXX   X
                              X     X  X        X                X
                              X     X  X        X     X          X
                              X     X  XXXXXXX   XXXXX          XXX



          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                        HEC-1L INPUT                                                PAGE  1

         LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

           1           ID   PROJECT: Eagle Mountain
           2           ID   CLIENT: Eagle Crest Engergy
           3           ID   FILE NAME: EMECPMF.HC1 [Eagle Mountain, Eagle Creek, PMF storm]
           4           ID   HISTORY: Created 8/19/09 by NDM Revised 9/24/09 by NJN
           5           ID   PURPOSE: Estimate PMF-Storm for Eagle Creek Watershed w/o project
           6           ID
           7           ID   PRECIPITATION: HMR 59 PMP
           8           ID   TEMPORAL DISTRIBUTION: 2/3 end weighted
           9           ID   SUB-BASINS: none
          10           ID   LOSS RATE: zero
          11           ID
          12           ID   BASE FLOW: Zero
          13           ID   UH (OVERLAND): USBR Synthetic, Southwest Desert, Kn = 0.045, 1-min duration
          14           ID
          15           ID
          16           ID   ***************************************************************************
                       *
          17           IT       5               0     900
          18           IO       1       2
                       *

          19           KK  Inflow --> OVERLAND INFLOW TO RESERVOIR (excludes direct rainfall on reservoir
                       * SUB-BASIN AREA (sq. mi)
          20           BA   7.07
                       *
          21           IN      60
                       * ALL-SEASON GENERAL STORM PMP - BASIN B1
                       * (1-hr incr.; Mid-End Wt, FERC/HMR 59 alt. 6-hr Blocks; EXCESS RAINFALL ONLY)
                       * Applied HSG loss rates(A,B,C,D   0.000   0.000   0.000   0.000(in/hr)
          22           PI   0.048   0.048   0.048   0.048   0.048   0.048   0.068   0.068   0.068   0.068
          23           PI   0.085   0.085   0.090   0.090   0.090   0.090   0.090   0.090   0.109   0.109
          24           PI   0.109   0.109   0.111   0.111   0.149   0.149   0.149   0.165   0.165   0.165
          25           PI   0.597   0.625   0.638   0.640   0.644   0.650   0.663   0.697   0.699   0.704
          26           PI   1.614   4.377   0.197   0.197   0.197   0.170   0.170   0.170   0.111   0.111
          27           PI   0.111   0.111   0.111   0.111   0.109   0.109   0.109   0.109   0.090   0.090
          28           PI   0.085   0.085   0.085   0.085   0.085   0.085   0.068   0.068   0.068   0.068
          29           PI   0.048   0.048   0.000
                       *
                       * BASEFLOW (SET TO ZERO)
          30           BF    00.0     0.0     1.0
                       *
                       * UNIFORM LOSS RATE, ZERO INIT. BUDGET (SAT'D). ZERO IMPERMEABLE.
          31           LU     0.0   0.000     0.0
                       *
          32           IN       5
                       *       Eagle Mountain Eagle Creek Reservoir, Kn = 0.045, 1-min UH
                       * USBR UH, Kn =    0.045, duration =   5min.
          33           UI      42      79     156     291     503     863    1615    2611    3572    4463
          34           UI    4848    4525    4006    3357    2680    2241    1854    1602    1385    1195
          35           UI    1052     957     874     799     734     679     627     577     531     488
          36           UI     450     413     381     353     325     300     276     254     236     217
          37           UI     200     184     169     156     143     133     123     113     105      96
          38           UI      89      82      76      69      64      59      56      49      46      43
          39           UI      39      37      34      32      29      27      25      22      20      19
                       *
                       *
                       *
                       *
                       *
                       *DIAGRAM
                       *
1                                                        HEC-1 INPUT                                                 PAGE  2
1
```

33 UI INPUT UNITGRAPH, 70 ORDINATES, VOLUME = 1.00

42.0	79.0	156.0	291.0	503.0	863.0	1615.0	2611.0	3572.0	4463.0
4848.0	4525.0	4006.0	3357.0	2680.0	2241.0	1854.0	1602.0	1385.0	1195.0
1052.0	957.0	874.0	799.0	734.0	679.0	627.0	577.0	531.0	488.0
450.0	413.0	381.0	353.0	325.0	300.0	276.0	254.0	236.0	217.0
200.0	184.0	169.0	156.0	143.0	133.0	123.0	113.0	105.0	96.0
89.0	82.0	76.0	69.0	64.0	59.0	56.0	49.0	46.0	43.0
39.0	37.0	34.0	32.0	29.0	27.0	25.0	22.0	20.0	19.0

***

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	Inflow	15319.	42.50	6046.	2768.	1182.	7.07		

*** NORMAL END OF HEC-1 ***

```
1****************************************                                                     ***************************************
 *                                       *                                                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                                                    *   U.S. ARMY CORPS OF ENGINEERS     *
 *            JULY   1998                *                                                    *   HYDROLOGIC ENGINEERING CENTER    *
 *          VERSION 4.1(L)               *                                                    *         609 SECOND STREET          *
 *                                       *                                                    *      DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   22OCT09  TIME  11:12:09   *                                                    *          (916) 756-1104            *
 *                                       *                                                    *                                     *
 ****************************************                                                     ***************************************


                                                          X     X  XXXXXXX   XXXXX          X
                                                          X     X  X        X     X        XX
                                                          X     X  X        X               X
                                                          XXXXXXX  XXXX     X       XXXXX   X
                                                          X     X  X        X               X
                                                          X     X  X        X     X         X
                                                          X     X  XXXXXXX   XXXXX         XXX


           THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

           THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
           THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
           NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
           DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
           KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```



```
          LINE          ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

            1            ID   PROJECT: Eagle Mountain
            2            ID   CLIENT: Eagle Crest Engergy
            3            ID   FILE NAME: EMEC100YR.HC1 [Eagle Mountain, Eagle Creek, 100 YR storm]
            4            ID   HISTORY: Created 8/19/09 by NDM Revised 9/24/09 by NJN
            5            ID   PURPOSE: Estimate 100 YR-Storm for Eagle Creek Watershed w/o project
            6            ID
            7            ID   PRECIPITATION: 100-YR
            8            ID   TEMPORAL DISTRIBUTION: 2/3 end weighted
            9            ID   SUB-BASINS: none
           10            ID   LOSS RATE: zero
           11            ID
           12            ID   BASE FLOW: Zero
           13            ID   UH (OVERLAND): USBR Synthetic, Southwest Desert, Kn = 0.045, 1-min duration
           14            ID
           15            ID
           16            ID   ******************************************************************************
                         *
           17            IT       5              0     900
           18            IO       1       2
                         *

           19            KK  Inflow --> OVERLAND INFLOW TO RESERVOIR (excludes direct rainfall on reservoir
                         * SUB-BASIN AREA (sq. mi)
           20            BA   7.07
                         *
                         * 100-YR STORM, (CENTER-WEIGHTED, SEO GUIDELINES, IT or IN time step)
           21            PH           0.01  0.490   0.90   1.56   1.86   2.08   2.55   3.35   4.15
                         *
                         * BASEFLOW (SET TO ZERO)
           22            BF    00.0    0.0    1.0
                         *
                         * UNIFORM LOSS RATE, ZERO INIT. BUDGET (SAT'D). ZERO IMPERMEABLE.
           23            LU     0.0  0.000    0.0
                         *
           24            IN       5
                         *       Eagle Mountain Eagle Creek Reservoir, Kn = 0.045, 1-min UH
                         * USBR UH, Kn =    0.045, duration =   5min.
           25            UI      42     79    156    291    503    863   1615   2611   3572   4463
           26            UI    4848   4525   4006   3357   2680   2241   1854   1602   1385   1195
           27            UI    1052    957    874    799    734    679    627    577    531    488
           28            UI     450    413    381    353    325    300    276    254    236    217
           29            UI     200    184    169    156    143    133    123    113    105     96
           30            UI      89     82     76     69     64     59     56     49     46     43
           31            UI      39     37     34     32     29     27     25     22     20     19
                         *
                         *
                         *
                         *
                         *
                         *DIAGRAM
                         *
           32            ZZ
```

PRECIPITATION DATA

21 PH DEPTHS FOR 0-PERCENT HYPOTHETICAL STORM

..... HYDRO-35			.... TP-40					.... TP-49			
5-MIN	15-MIN	60-MIN	2-HR	3-HR	6-HR	12-HR	24-HR	2-DAY	4-DAY	7-DAY	10-DAY
0.49	0.90	1.56	1.86	2.08	2.55	3.35	4.15	0.00	0.00	0.00	0.00

STORM AREA = 0.01

25 UI INPUT UNITGRAPH, 70 ORDINATES, VOLUME = 1.00

42.0	79.0	156.0	291.0	503.0	863.0	1615.0	2611.0	3572.0	4463.0
4848.0	4525.0	4006.0	3357.0	2680.0	2241.0	1854.0	1602.0	1385.0	1195.0
1052.0	957.0	874.0	799.0	734.0	679.0	627.0	577.0	531.0	488.0
450.0	413.0	381.0	353.0	325.0	300.0	276.0	254.0	236.0	217.0
200.0	184.0	169.0	156.0	143.0	133.0	123.0	113.0	105.0	96.0
89.0	82.0	76.0	69.0	64.0	59.0	56.0	49.0	46.0	43.0
39.0	37.0	34.0	32.0	29.0	27.0	25.0	22.0	20.0	19.0

***

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+					6-HOUR	24-HOUR	72-HOUR			
	HYDROGRAPH AT									
+		Inflow	6455.	12.92	1935.	783.	263.	7.07		

*** NORMAL END OF HEC-1 ***

Dimensionless Unit Hydrograph (select from menu) = **Southwest Desert, Great Basin, Colorado Plateau** 27-Aug-09

Eagle Mountain Upper Reservoir, Kn = 0.045, 1-min UH

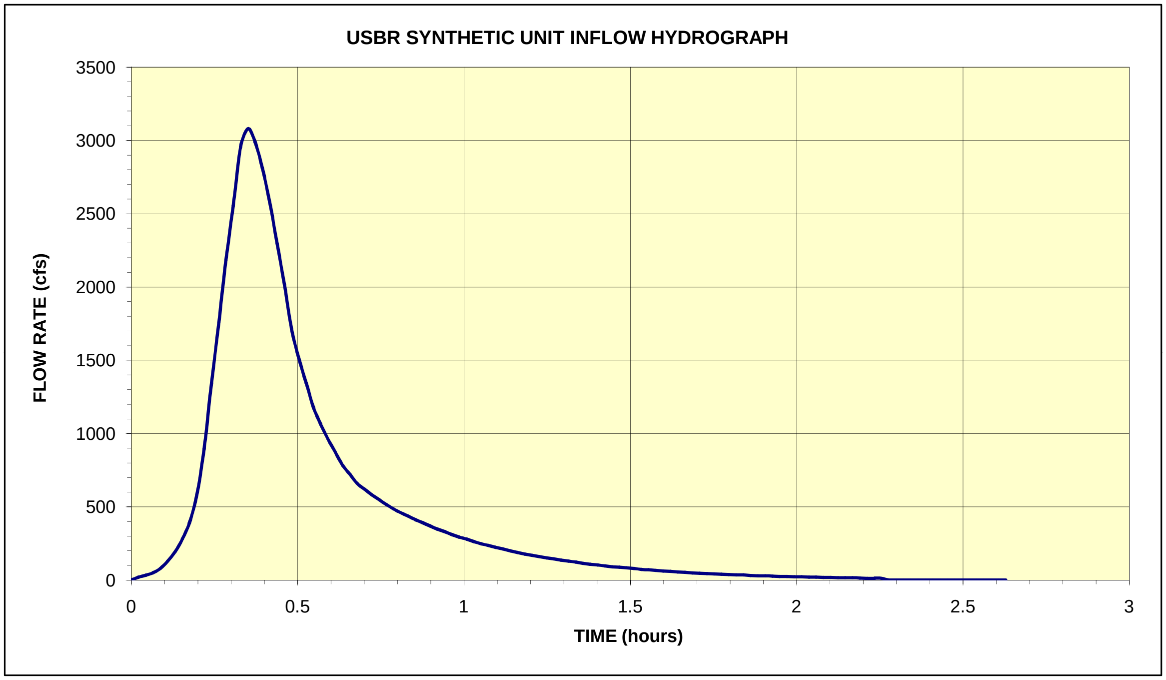
Lag Reduction to Peak UH (%) =	0%				
Drainage Area, **A** =	1.74	sq. miles	**Lg+D/2** =	0.44	Hours
Basin Slope, **S** =	430.2	ft/mile	Basin Factor =	0.05	**(L*Lca/S^0.5)**
Length of Watercourse, **L** =	2.22	miles	(Vol. 1" rain, ft^3)*(days/sec), **V'** =	46.68	cfs*day
Length to Centroid, **Lca** =	0.45	miles	Quotient X for X*q = Q_s; X =	106.6	**V'/(Lg+D/2)**
Kn =	0.045	***** avg. Manning's "n" (weighted by stream length for principle watercourses)			

Estimated: Lag Time, **Lg** = 0.43 Hours

*Lg = 26*Kn*(L*Lca/S^0.5)^0.33*

Duration of Unit Rainfall to define peak, D = 5 minutes
Minimum Timestep (D) for < 120 UH increments***** = 1 minutes
Minimum Timestep (D) for < 200 UH increments***** = 1 minutes

For UH: Duration of Unit Rainfall, **D** = **1** minutes, round down to nearest: 5, 10, 15, 30, 60, 120, 180, 360
D must equal time step used for converting precipitation to runoff.



HEC-1 UI RECORDS 1 -min Duration Unit Rainfall Peak UI (cfs) = 3081
ITERATE PEAK TO TARGET 1.000 --------> Unit Runoff (inch) = 0.99987 Absolute Peak (cfs) = 3081

UI	15	27	39	52	73	107	150	201	267	349
UI	463	624	863	1189	1516	1833	2158	2443	2739	2984
UI	3081	3015	2901	2750	2570	2357	2143	1923	1700	1547
UI	1413	1285	1164	1079	1000	928	860	792	742	695
UI	653	623	594	566	541	516	494	472	453	436
UI	417	401	385	368	353	338	324	310	295	285
UI	273	261	249	240	231	221	212	203	195	187
UI	179	171	164	158	152	146	140	134	128	123
UI	118	113	108	104	99	95	91	88	84	81
UI	78	74	71	69	66	63	60	58	55	53
UI	51	49	47	44	43	41	40	38	36	35
UI	34	31	30	29	28	27	26	25	24	23
UI	22	21	21	20	19	18	17	17	16	16
UI	15	13	13	13	12	6				

Dimensionless Unit Hydrograph (select from menu) = **Southwest Desert, Great Basin, Colorado Plateau** 27-Aug-09

Eagle Mountain Lower Reservoir, Kn = 0.045, 1-min UH

Lag Reduction to Peak UH (%) =	0%				
Drainage Area, **A** =	2.85	sq. miles	**Lg+D/2** =	0.47	Hours
Basin Slope, **S** =	912.7	ft/mile	Basin Factor =	0.06	**(L*Lca/S^0.5)**
Length of Watercourse, **L** =	2.46	miles	(Vol. 1" rain, ft^3)*(days/sec), **V'** =	76.64	cfs*day
Length to Centroid, **Lca** =	0.73	miles	Quotient X for X*q = Q_s; X =	163.5	**V'/(Lg+D/2)**
Kn =	0.045	* avg. Manning's "n" (weighted by stream length for principle watercourses)			

Estimated: Lag Time, **Lg** = 0.46 Hours

*Lg = 26*Kn*(L*Lca/S^0.5)^0.33*

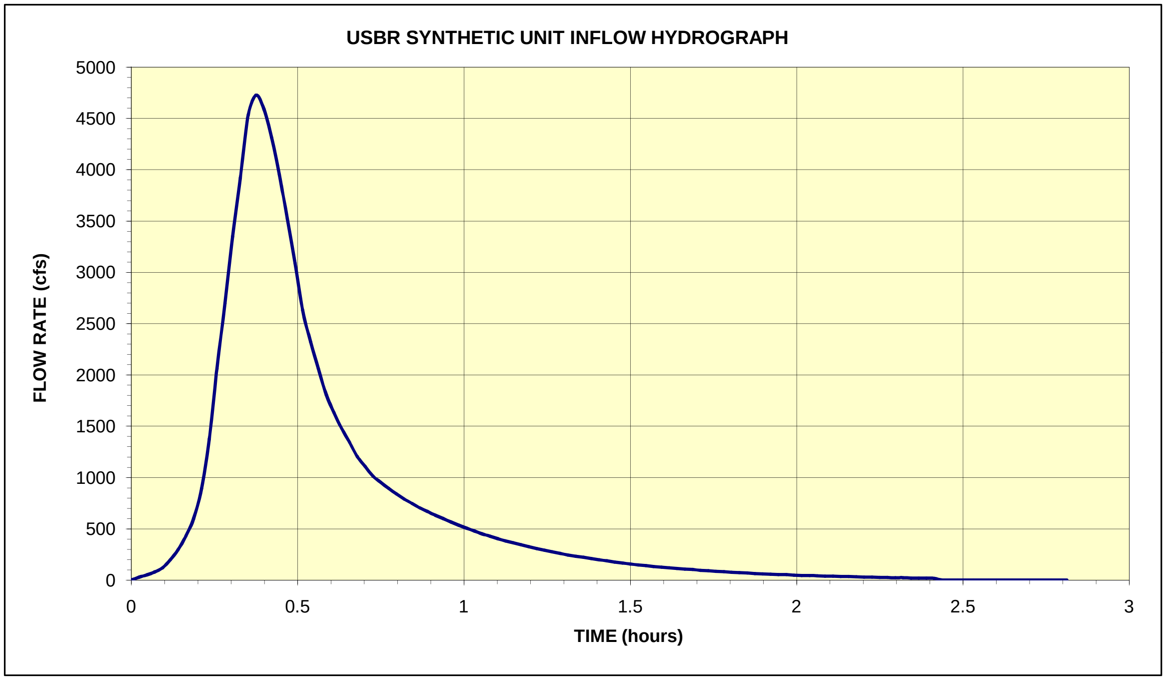
Duration of Unit Rainfall to define peak, D = 5 minutes

Minimum Timestep (D) for < 120 UH increments* = 1 minutes

Minimum Timestep (D) for < 200 UH increments* = 1 minutes

For UH: Duration of Unit Rainfall, **D** = **1** minutes, round down to nearest: 5, 10, 15, 30, 60, 120, 180, 360

D must equal time step used for converting precipitation to runoff.



HEC-1 UI RECORDS 1 -min Duration Unit Rainfall Peak UI (cfs) = 4727

ITERATE PEAK TO TARGET 1.000 --------> Unit Runoff (inch) = 1.00020 Absolute Peak (cfs) = 4727

UI	22	40	56	74	102	142	196	265	350	449
UI	571	758	1012	1354	1833	2303	2756	3222	3642	4057
UI	4497	4660	4727	4571	4374	4137	3867	3561	3255	2938
UI	2615	2395	2199	2016	1833	1702	1585	1475	1377	1279
UI	1188	1121	1054	996	953	911	872	835	799	767
UI	736	706	681	655	629	607	583	560	538	517
UI	496	476	455	440	424	406	389	375	362	348
UI	335	322	309	297	286	274	264	253	243	235
UI	227	218	209	201	193	186	178	171	164	159
UI	152	145	140	135	130	126	121	115	111	107
UI	104	99	95	92	88	85	81	78	75	72
UI	69	67	64	62	60	57	55	54	51	48
UI	46	45	43	42	40	38	37	36	35	34
UI	32	31	30	29	28	27	25	25	25	23
UI	21	20	20	19	16	3				

Dimensionless Unit Hydrograph (select from menu) = **Southwest Desert, Great Basin, Colorado Plateau** 22-Oct-09

Eagle Mountain Eagle Creek Reservoir, Kn = 0.045, 1-min UH

Lag Reduction to Peak UH (%) =	0%				
Drainage Area, **A** =	7.07	sq. miles	**Lg+D/2** =	1.13	Hours
Basin Slope, **S** =	313.9	ft/mile	Basin Factor =	0.81	**(L*Lca/S^0.5)**
Length of Watercourse, **L** =	5.51	miles	(Vol. 1" rain, ft^3)*(days/sec), **V'** =	190.11	cfs*day
Length to Centroid, **Lca** =	2.61	miles	Quotient X for X*q = Q_s; X =	167.7	**V'/(Lg+D/2)**
Kn =	0.045	***** avg. Manning's "n" (weighted by stream length for principle watercourses)			

Estimated: Lag Time, **Lg** = 1.09 Hours

*Lg = 26*Kn*(L*Lca/S^0.5)^0.33*

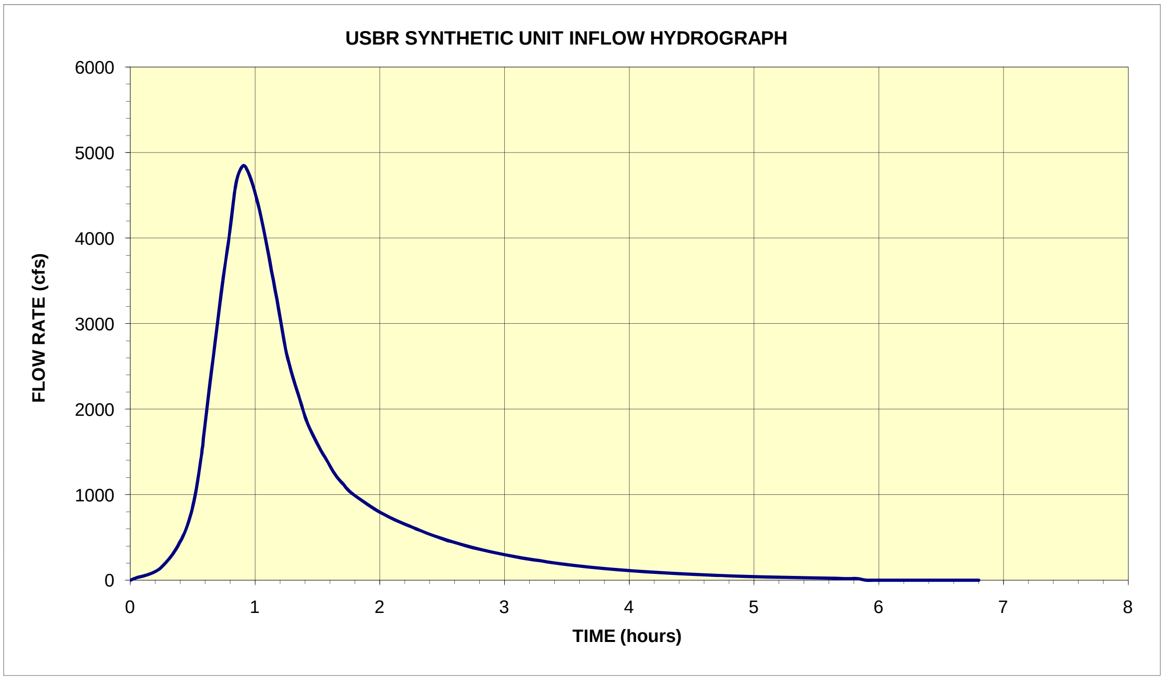
Duration of Unit Rainfall to define peak, D = 12 minutes

Minimum Timestep (D) for < 120 UH increments***** = 3 minutes

Minimum Timestep (D) for < 200 UH increments***** = 2 minutes

For UH: Duration of Unit Rainfall, **D** = **5** minutes, round down to nearest: 5, 10, 15, 30, 60, 120, 180, 360

D must equal time step used for converting precipitation to runoff.



HEC-1 UI RECORDS 5 -min Duration Unit Rainfall Peak UI (cfs) = 4848

ITERATE PEAK TO TARGET 1.000 --------> Unit Runoff (inch) = 1.00001 Absolute Peak (cfs) = 4848

UI	42	79	156	291	503	863	1615	2611	3572	4463
UI	4848	4525	4006	3357	2680	2241	1854	1602	1385	1195
UI	1052	957	874	799	734	679	627	577	531	488
UI	450	413	381	353	325	300	276	254	236	217
UI	200	184	169	156	143	133	123	113	105	96
UI	89	82	76	69	64	59	56	49	46	43
UI	39	37	34	32	29	27	25	22	20	19

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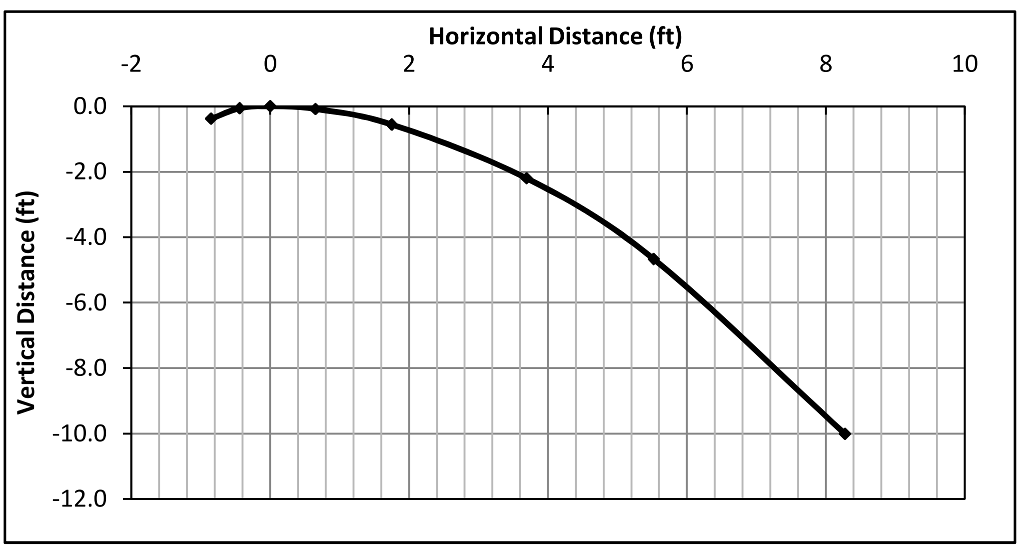
UPPER RESERVOIR OGEE CREST GEOMETRY

Design Head, Ho:	3	ft
Approach Depth, P:	10	ft
Is P > 0.5Ho:	YES	
Use USBR Fig. 9.22:	YES	

X Points			Y Points		
-X2 =	-0.852	ft	-Y2 =	-0.381	ft
-X1 =	-0.441	ft	-Y1 =	-0.063	ft
X Origin =	0	ft	Y Origin =	0	ft
X1 =	0.651	ft	Y1 =	-0.087	ft
X2 =	1.749	ft	Y2 =	-0.561	ft
X3 =	3.69	ft	Y3 =	-2.202	ft
X4 =	5.52	ft	Y4 =	-4.668	ft
X5 =	8.274	ft	Y5 =	-10.008	ft

RADIUS LENGTHS			RADIUS CENTER POINT					
R1 =	0.705	ft	X1 =	-0.246	ft	Y1 =	-0.741	ft
R2 =	1.59	ft	X2 =	0	ft	Y2 =	-1.59	ft
R3 =	2.475	ft	X3 =	0	ft	Y3 =	-2.475	ft
R4 =	4.23	ft	X4 =	-0.462	ft	Y4 =	-4.167	ft
R5 =	8.4	ft	X5 =	-2.64	ft	Y5 =	-7.725	ft
R6 =	19.5	ft	X6 =	-11.004	ft	Y6 =	-15.021	ft
R7 =	36	ft	X7 =	-24.987	ft	Y7 =	-23.781	ft



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UPPER RESERVOIR OGEE CREST GEOMETRY

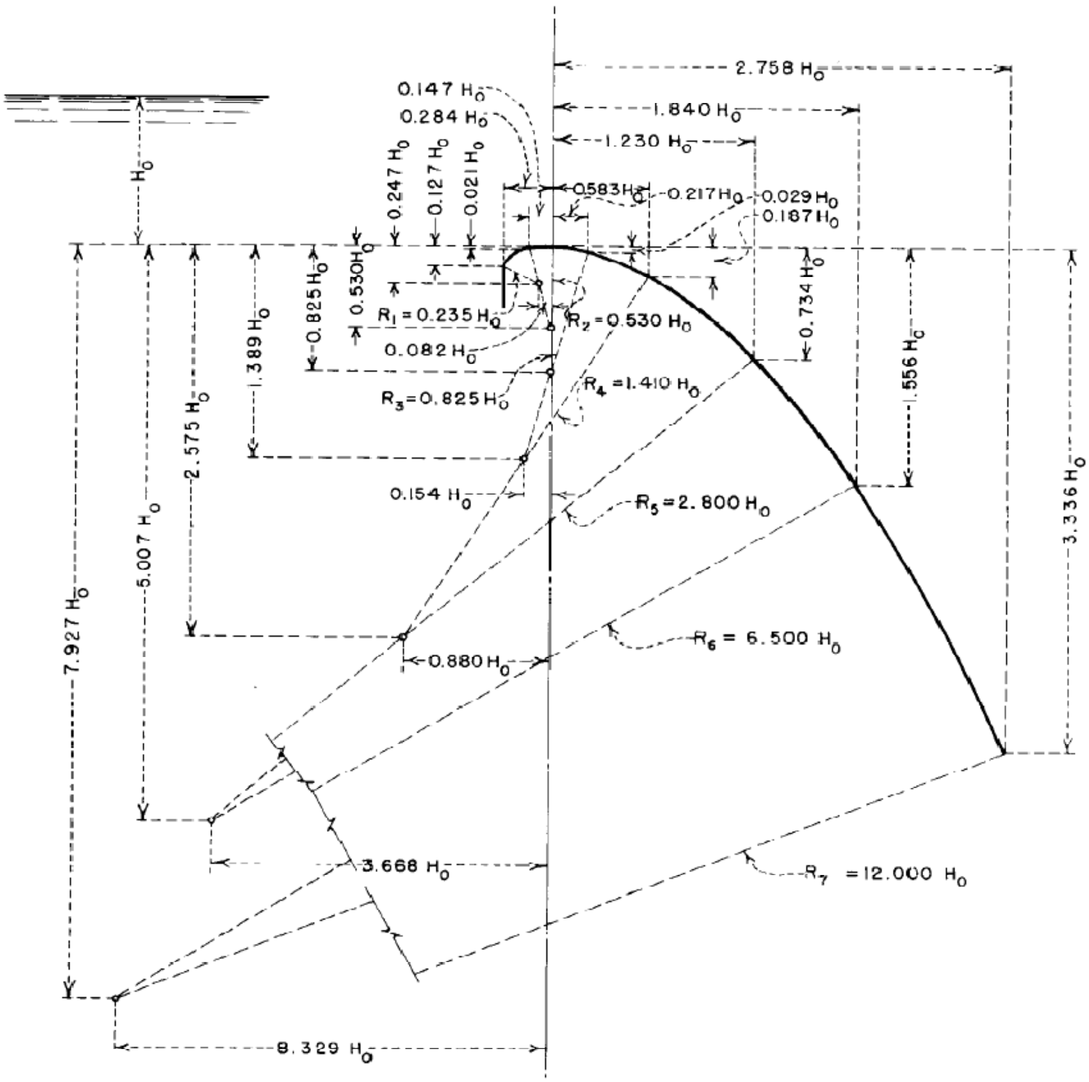


Figure 9-22.—Ogee crest shape defined by compound curves. 288–D–2408.

GEI Consultants

CLIENT:	Eagle Crest Energy Company		
PROJECT:	Eagle Mountain Pumped Storage Project	Project: 80474	Pages: 2
SUBJECT:	Stilling Basin Design	Date: 8/24/2009	By: NDM
		Checked:	By:
		Approved:	By:

Purpose: Estimate minimum dimensions for the chute and Type III stilling basin structure required at Eagle Mountain Upper Reservoir.

Procedure: Follow design steps presented in *Design of Small Canals - Ch. II Conveyance Structures - F. Chutes*.

References: USBR (1978). Design of Small Canal Structures.
USBR (1984). Engineering Monograph No. 25, Hydraulic Design of Stilling Basins and Energy Dissipators.

Input Variables:

Start El.:	2490.0	ft
Initial Basin Floor El.:	2380.0	ft
Difference:	110.0	ft
Chute Slope:	0.8	H:1V
Chute Width, B:	100.00	ft

Assume 50% of energy is dissipated on chute slope

Head at toe:	55	ft
Assumed Depth:	0.53	ft
Velocity at Toe:	59.2	ft/sec

TYPE III STILLING BASIN

Step 1: Inflow Variables.

Discharge, Q (cfs)	Upstream Depth, D1 (ft)	Upstream Velocity, V1 (ft/sec)	Upstream Froude #, F1	Unit Discharge, q (cfs/ft)	Downstream Depth, D2 (ft)	Velocity Downstream, V2 (ft/sec)
3120	0.53	59.2	14.3	31.20	10.48	2.98

Step 2: Determine Basin Length, L.

Maximum Froude #, Fr1:	14.3	
Maximum D2:	10.48	ft
Ratio L/D2:	**2.8**	(from chart)
Calculated Basin Length:	29.4	ft
Use Basin Length:	**30.0**	**ft**

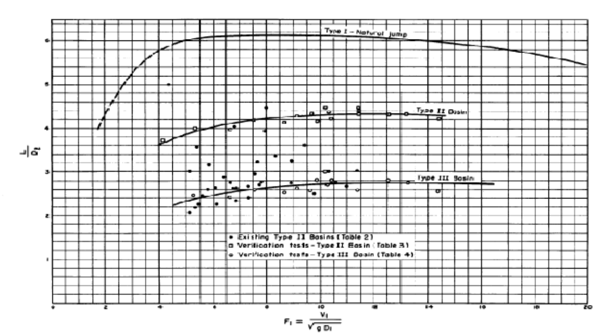


FIGURE 12—Length of jump on horizontal floor (Basins I, II, and III).

Step 3: Determine Chute Blocks and Baffle Pier Dimensions.

Chute Blocks:

Height:	**8.0**	**inches**	=D1 at max. flow, Min. = 8"
Width:	**8.0**	**inches**	=D1 at max. flow, Min. = 8"
Spacing:	**8.0**	**inches**	=D1 at max. flow, Min. = 8"
# of Full Blocks:	75.0		
Partial Blocks:	0.0		

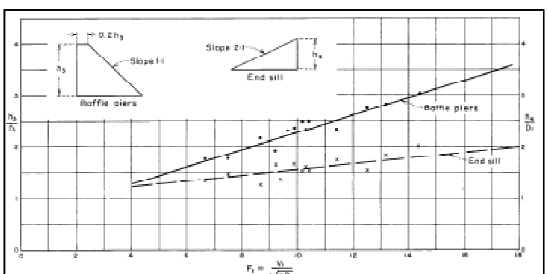


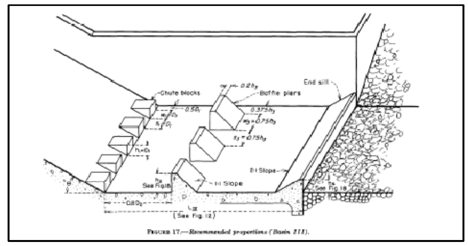
FIGURE 18.—Height of baffle piers and end sill (Basin III).

Baffle Piers:

Maximum Froude #, Fr1:	14.3		
Maximum D1:	0.53	ft	
Ratio H3/D1:	**3.0**	(from chart)	
Baffle Piers Height, H3:	19.1	inches	
Use Baffle Peir Height, H3:	**20.0**	**inches**	
Baffle Peir Width, Pw:	**15.0**	**inches**	=0.75(H3)
Top Width:	**4.0**	**inches**	=0.20(H3)
Spacing, Ps:	**15.0**	**inches**	=0.75(H3)
# of Blocks:	40.0		
Distance to Baffle Face:	**8.39**	**ft**	=0.8(D2)

CLIENT:	Eagle Crest Energy Company		
PROJECT:	Eagle Mountain Pumped Storage Project	Project: 80474	Pages: 2
SUBJECT:	Stilling Basin Design	Date: 8/24/2009	By: NDM
		Checked:	By:
		Approved:	By:

Step 4: Determine End Sill Dimensions.



Maximum Froude #, Fr1:	14.3		
Maximum D1:	0.53	ft	
Ratio H4/D1:	1.8	(from chart)	
End Sill Minimum Height, H4:	11.4	inches	
Top Width:	12.0	inches	
US Slope of Sill:	**2.0**	H:1V	
Use End Sill Height,H4:	**1.0**	**ft**	
Drop to DS Channel:	**1.0**	**ft**	
Final Basin Floor El.:	**2380.00**	ft	=(Int El.)-H4+Drop

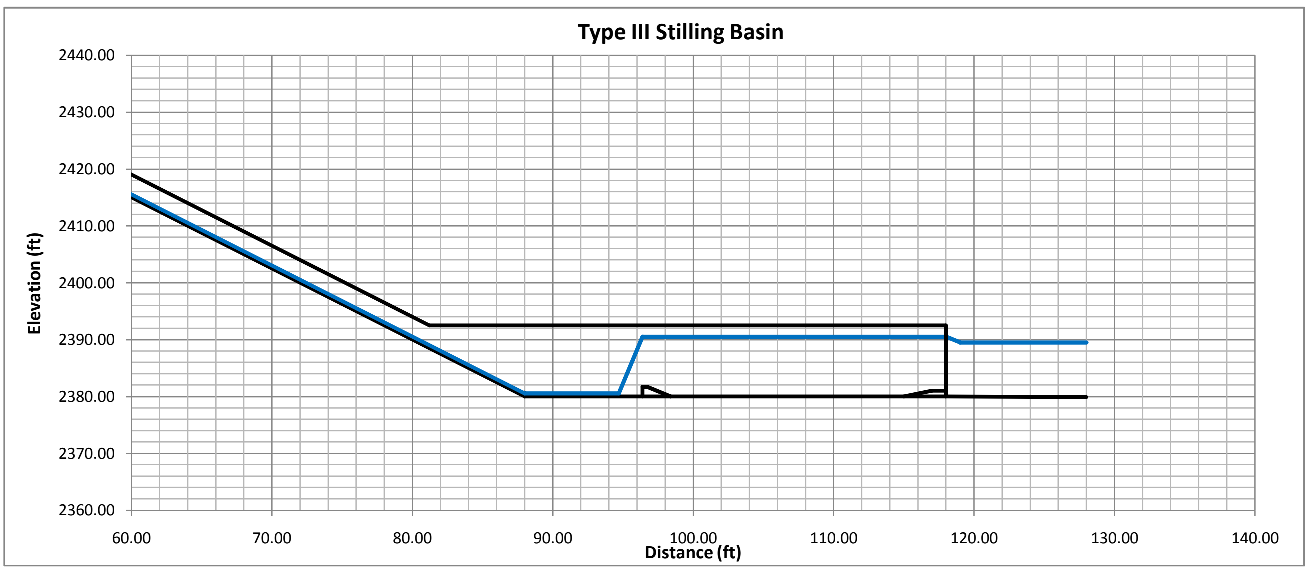
Step 5: Wall Heights

Inlet Structure Wall Height:	4	ft	
Chute Wall Height:	**4**	**ft**	
Basin Freeboard:	**2.0**	**ft**	
Basin Wall Height:	**12.5**	**ft**	
Wing Wall Length:	**9.0**	**ft**	=0.75*(basin wall height)
Wall Thickness:	**1.0**	**ft**	
Floor Thickness:	**1.5**	ft	

Concrete Volume

Structure Volume: 1019 CY

Type III Basin Plots



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Schedule A: Deficiency of License Application
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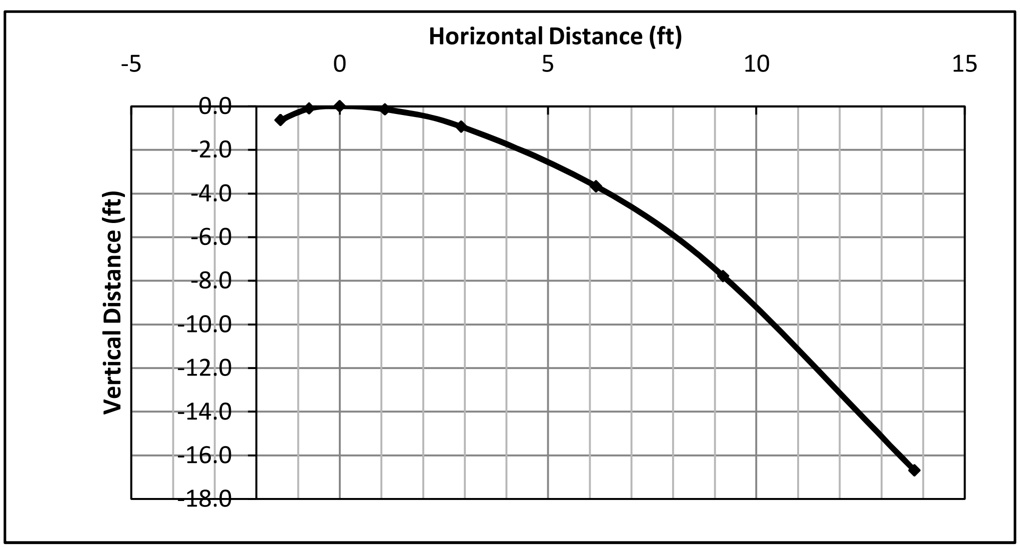
LOWER RESERVOIR OGEE CREST GEOMETRY

Design Head, Ho:	5	ft
Approach Depth, P:	5	ft
Is P > 0.5Ho:	YES	
Use USBR Fig. 9.22:	YES	

X Points			Y Points		
-X2 =	-1.42	ft	-Y2 =	-0.635	ft
-X1 =	-0.735	ft	-Y1 =	-0.105	ft
X Origin =	0	ft	Y Origin =	0	ft
X1 =	1.085	ft	Y1 =	-0.145	ft
X2 =	2.915	ft	Y2 =	-0.935	ft
X3 =	6.15	ft	Y3 =	-3.67	ft
X4 =	9.2	ft	Y4 =	-7.78	ft
X5 =	13.79	ft	Y5 =	-16.680	ft

RADIUS LENGTHS			RADIUS CENTER POINT					
R1 =	1.175	ft	X1 =	-0.41	ft	Y1 =	-1.235	ft
R2 =	2.65	ft	X2 =	0	ft	Y2 =	-2.65	ft
R3 =	4.125	ft	X3 =	0	ft	Y3 =	-4.125	ft
R4 =	7.05	ft	X4 =	-0.77	ft	Y4 =	-6.945	ft
R5 =	14	ft	X5 =	-4.4	ft	Y5 =	-12.875	ft
R6 =	32.5	ft	X6 =	-18.34	ft	Y6 =	-25.035	ft
R7 =	60	ft	X7 =	-41.645	ft	Y7 =	-39.635	ft



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Schedule A: Deficiency of License Application
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LOWER RESERVOIR OGEE CREST GEOMETRY

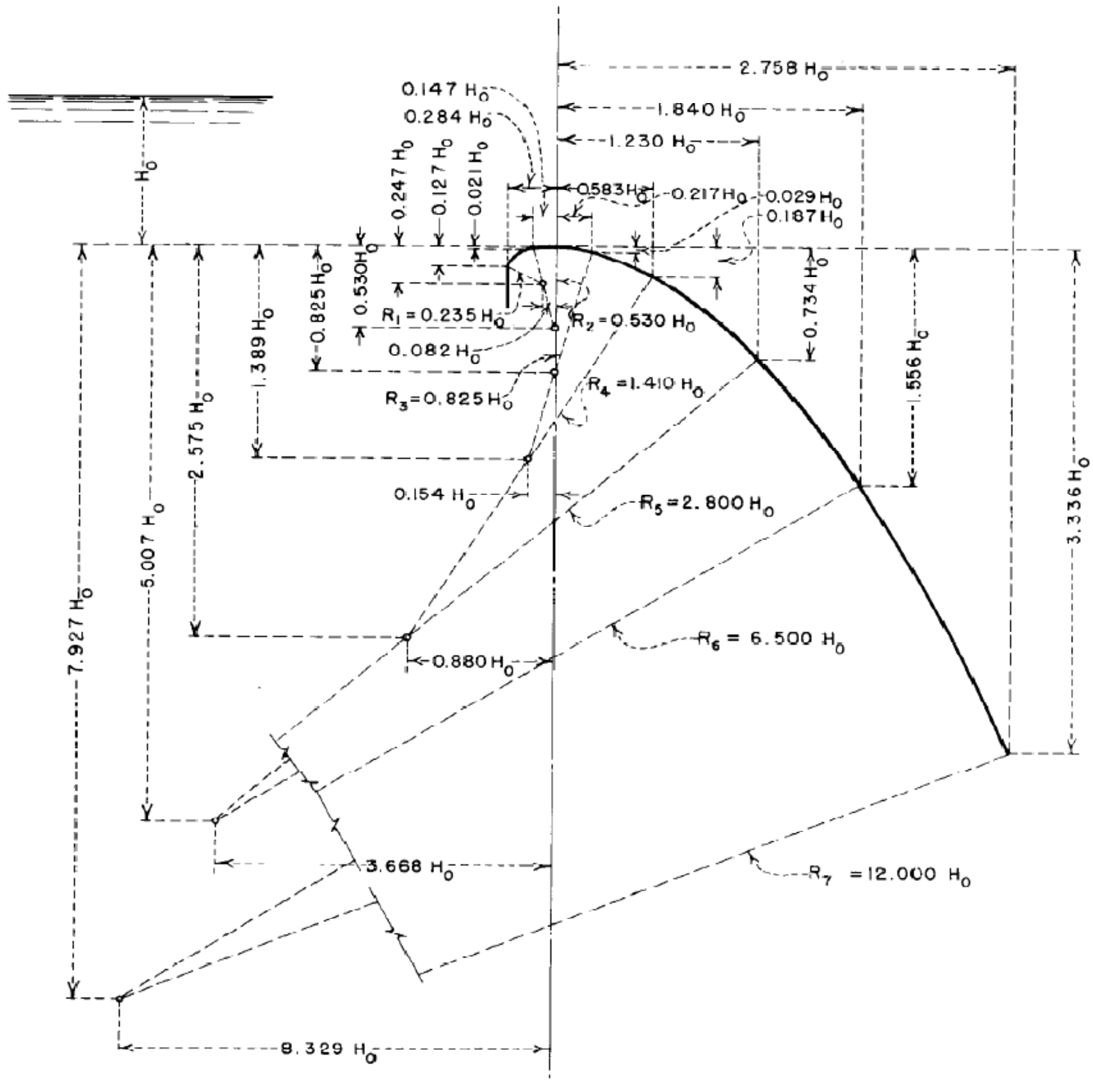
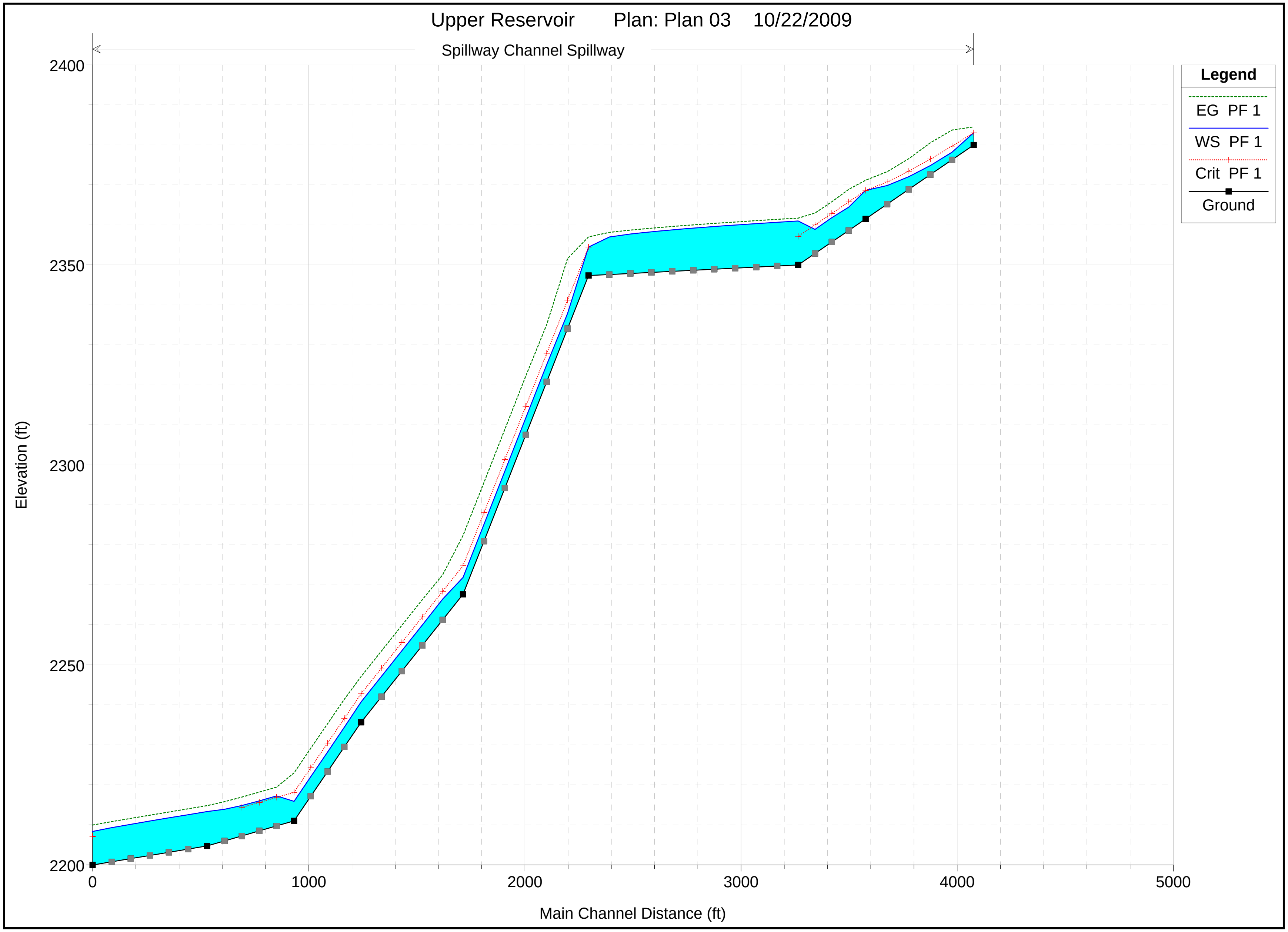
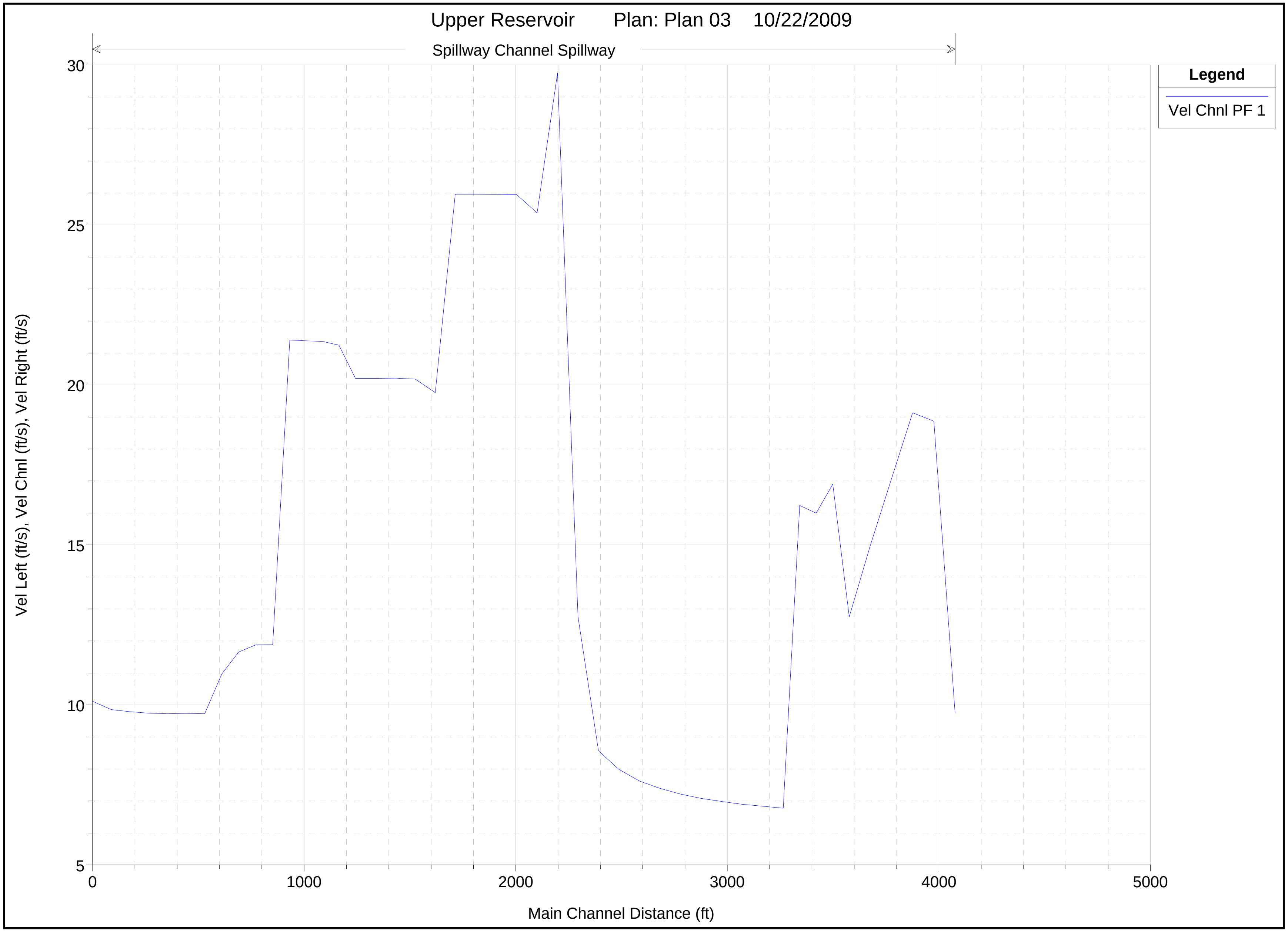


Figure 9-22.—Ogee crest shape defined by compound curves. 288-D-2408.

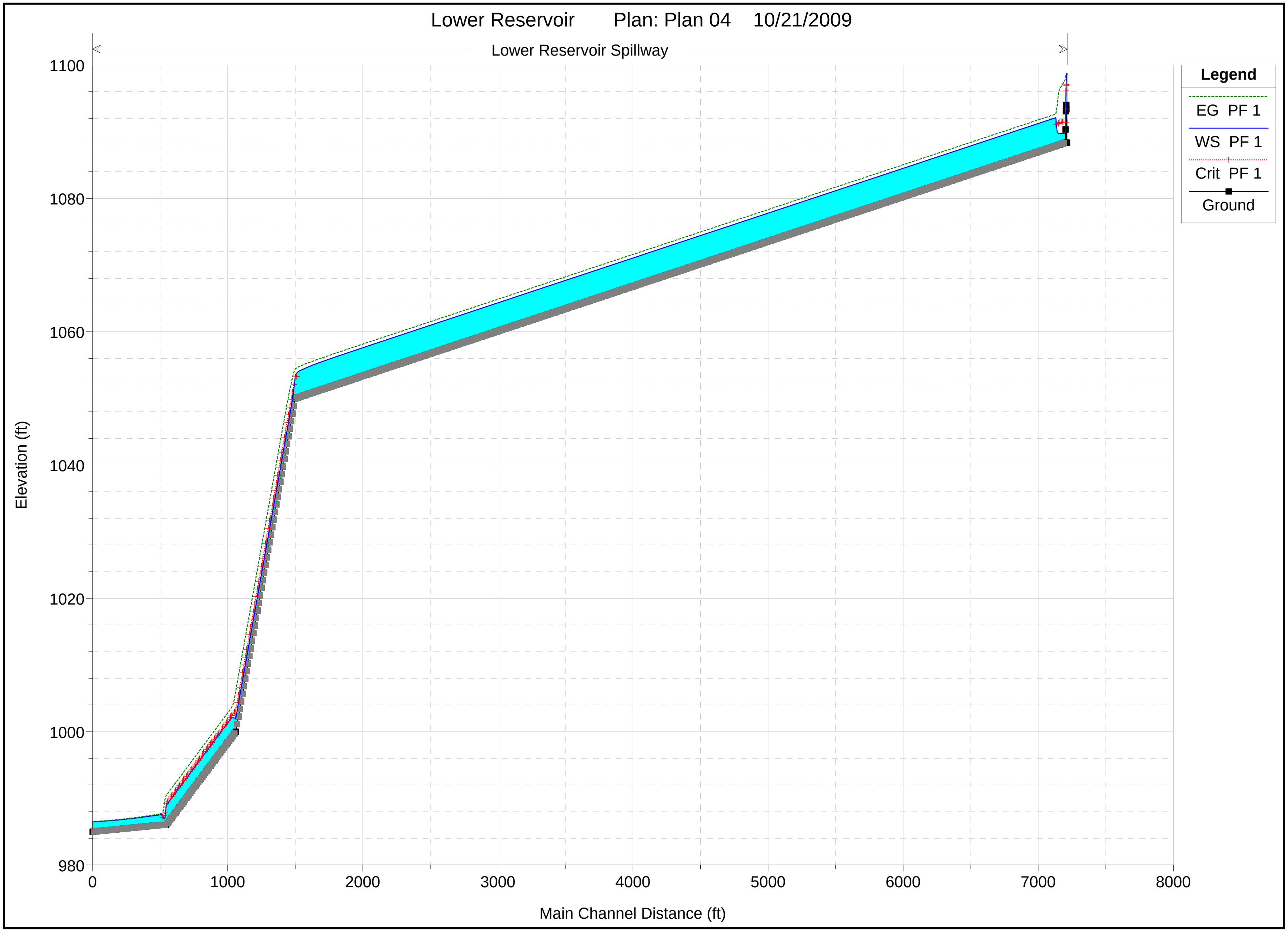

Upper Reservoir Plan: Plan 03 10/22/2009
Spillway Channel Spillway
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
2400
2350
2300
2250
2200
0
1000
2000
3000
4000
5000
Main Channel Distance (ft)



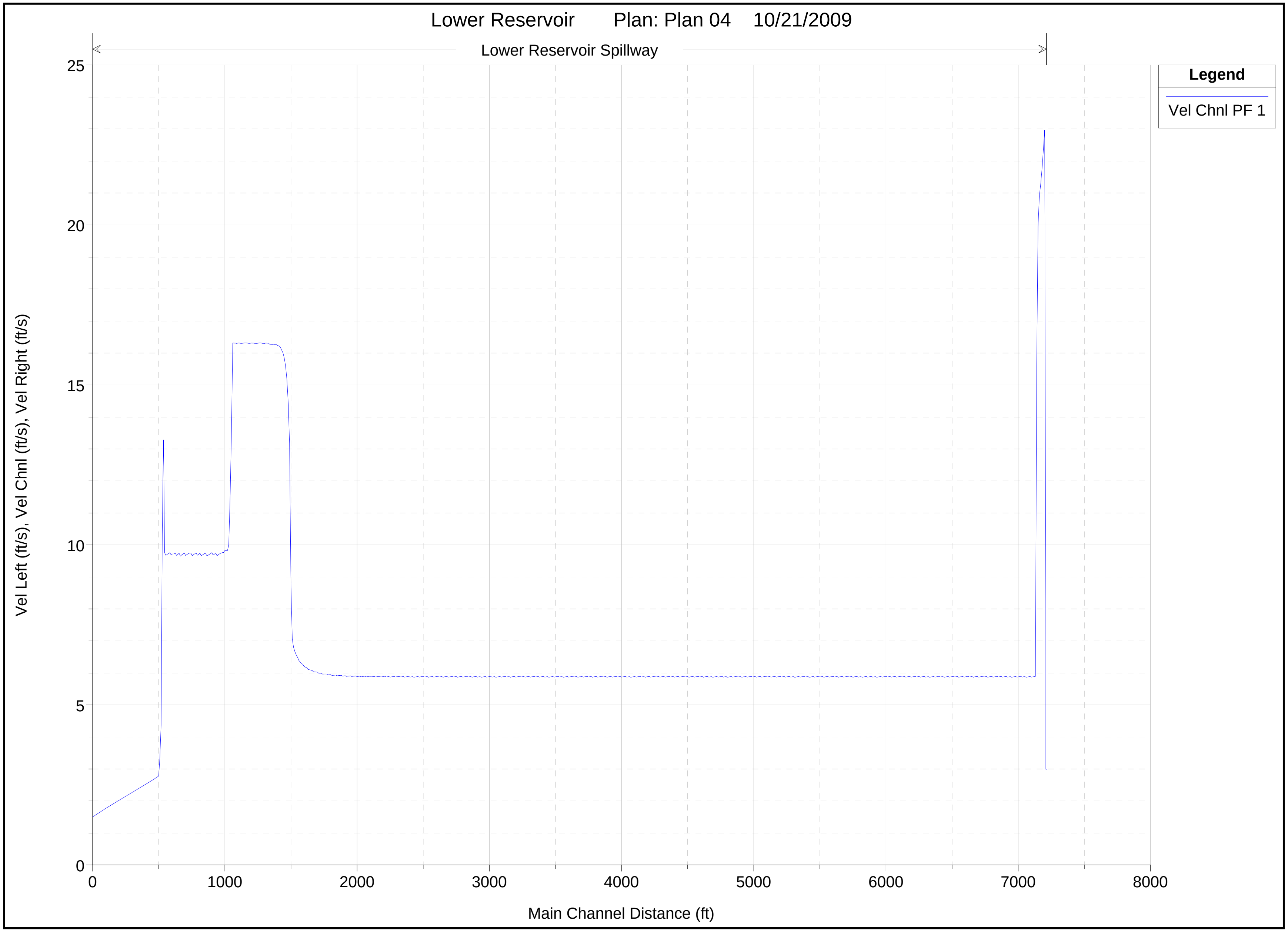
Upper Reservoir Plan: Plan 03 10/22/2009
Spillway Channel Spillway
Legend
Vel Chnl PF 1
Vel Left (ft/s), Vel Chnl (ft/s), Vel Right (ft/s)
30
25
20
15
10
5
0
1000
2000
3000
4000
5000
Main Channel Distance (ft)

HEC-RAS Plan: Plan 03   River: Spillway Channel   Reach: Spillway   Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Power Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/ft s)
Spillway	0	PF 1	3120.00	2380.00	2383.05	3.05	2383.05	2384.53	0.001518	9.75	320.13	109.77	1.01	2.65
Spillway	-500	PF 1	3120.00	2361.52	2368.66	7.14	2368.66	2371.18	0.018903	12.76	244.55	48.54	1.00	70.93
Spillway	-812	PF 1	3120.00	2350.00	2361.01	11.01	2357.14	2361.72	0.003205	6.78	460.50	60.00	0.43	9.35
Spillway	-1782	PF 1	3120.00	2347.36	2354.50	7.14	2354.50	2357.02	0.018903	12.76	244.55	48.54	1.00	70.93
Spillway	-2362	PF 1	3120.00	2267.68	2271.90	4.22	2274.82	2282.37	0.137373	25.96	120.17	36.90	2.54	688.02
Spillway	-2834	PF 1	3120.00	2235.68	2240.79	5.11	2242.82	2247.13	0.067782	20.21	154.41	40.44	1.82	308.11
Spillway	-3144	PF 1	3120.00	2211.02	2215.91	4.89	2218.16	2223.03	0.079672	21.40	145.76	39.57	1.97	370.51
Spillway	-3545	PF 1	3120.00	2204.76	2213.38	8.62		2214.85	0.008977	9.73	320.80	54.46	0.71	29.87
Spillway	-4075	PF 1	3120.00	2200.00	2208.39	8.39	2207.13	2209.98	0.010001	10.12	308.38	53.54	0.74	33.88



Lower Reservoir Plan: Plan 04 10/21/2009
Lower Reservoir Spillway
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
1100
1080
1060
1040
1020
1000
980
0
1000
2000
3000
4000
5000
6000
7000
8000
Main Channel Distance (ft)



Lower Reservoir Plan: Plan 04 10/21/2009
Lower Reservoir Spillway
Legend
Vel Chnl PF 1
Vel Left (ft/s), Vel Chnl (ft/s), Vel Right (ft/s)
0
5
10
15
20
25
0
1000
2000
3000
4000
5000
6000
7000
8000
Main Channel Distance (ft)

HEC-RAS Plan: Plan 04 River: Lower Reservoir Reach: Spillway Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Power Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/ft s)
Spillway	0	PF 1	460.00	1088.36	1098.62	10.26	1091.43	1098.76	0.000082	2.99	153.95	15.00	0.16	0.07
Spillway	-5	PF 1	460.00	1088.36	1098.62	10.26		1098.76	0.000082	2.99	153.95	15.00	0.16	0.07
Spillway	-5.1	PF 1	460.00	1093.36	1098.04	4.68		1098.71	0.000682	6.55	70.25	15.00	0.53	0.80
Spillway	-5.7	PF 1	460.00	1093.47	1097.99	4.52		1098.70	0.000754	6.79	67.77	15.00	0.56	0.90
Spillway	-6.43	PF 1	460.00	1094.00	1097.07	3.07	1097.07	1098.62	0.002305	9.99	46.05	15.00	1.00	3.13
Spillway	-7.51	PF 1	460.00	1093.85	1096.53	2.68	1096.92	1098.57	0.003460	11.46	40.15	15.00	1.23	4.88
Spillway	-9.34	PF 1	460.00	1093.06	1095.18	2.12	1096.13	1098.43	0.007002	14.48	31.77	15.00	1.75	10.45
Spillway	-12.58	PF 1	460.00	1090.33	1091.86	1.53	1093.40	1098.10	0.019020	20.04	22.96	15.00	2.85	30.24
Spillway	-14.18	PF 1	460.00	1088.33	1089.67	1.34	1091.40	1097.85	0.029096	22.96	20.03	15.00	3.50	47.29
Spillway	-65	PF 1	460.00	1088.00	1089.72	1.72	1091.22	1095.89	0.202178	19.94	23.06	16.87	3.01	328.43
Spillway	-2700	PF 1	460.00	1050.00	1053.22	3.22	1053.22	1054.39	0.019483	8.69	52.94	22.88	1.01	22.93
Spillway	-3140	PF 1	460.00	1000.00	1002.01	2.01	1003.22	1006.14	0.113915	16.32	28.19	18.04	2.30	172.25
Spillway	-3655	PF 1	460.00	986.00	988.96	2.96	989.22	990.44	0.026844	9.75	47.16	21.85	1.17	33.16
Spillway	-3700	PF 1	460.00	986.00	987.56	1.56		987.68	0.003373	2.78	165.29	112.45	0.40	0.86
Spillway	-3800	PF 1	460.00	985.00	986.49	1.49	985.54	986.52	0.001000	1.50	306.50	211.91	0.22	0.14

12 Appendix C – Technical Memorandum

12.10 Appendix to Air Quality Analysis – Construction Related Data

12.10 Appendix to Air Quality Analysis – Construction Related Data

Construction-related emissions are primarily associated the exhaust from heavy equipment (i.e., backhoes, bulldozers, graders, etc.), delivery trucks (i.e., cement trucks, dump trucks, etc.) and construction worker vehicles getting to and from the site; dust from site preparation, land clearing, material handling, equipment movement on unpaved areas, blasting, and demolition activities; and fugitive emissions from the storage/transfer of raw materials. These emissions are temporary in nature and generally confined to the construction site and the access/egress roadways.

Emissions from construction activities were estimated based on the projected construction activity schedule, the number of vehicles/pieces of equipment, the types of equipment/type of fuel used, vehicle/equipment utilization rates, and the year construction occurs. This information was derived directly from the *Estimated Schedule, Manpower and Equipment Utilization during Construction of the Eagle Mountain Pumped-Storage Project* developed by GEI Consultants, which is provided in Section 12.7.

Data regarding the number of pieces and types of construction equipment to be used on the project, the deployment schedule of equipment (monthly and annually), and the approximate daily operating time (including activity level or usage factor)[1] were estimated for each individual construction project based on the previously referenced schedule of construction activity. A construction workday of ten hours was used. However, construction equipment is assumed to operate between two and ten hours per day, based on available usage factors. Construction is expected to occur between 2012 and 2015.

Table 12.10-1 provides a list of construction equipment, along with their horsepower, load factor[2], fuel type, Source Classification Code (SCC) designation and usage factor expected to be used. Load factor and usage factor are presented in greater detail further in this appendix.

The emission inventories for off-road (non-highway) equipment were calculated using emission factors obtained from the California Air Resources Board (CARB)'s OFFROAD emissions model (Version 2007)[3]. Emission factors for on-road (highway) pickup, dump trucks, concrete trucks, employee vehicles, and other on-road regulated vehicles were obtained from the CARB EMFAC[4] motor vehicle emission model. Refer to Tables 12.10-2 through 12.10-6 for a summary of the emission factors developed for this analysis.

[1] Activity level (or usage factor) are defined as the hours of operation for a piece of equipment over a given time.

[2] Load factor (or throttle setting) are the engine performance demands, as a percent of maximum power.

[3] CARB EMFAC2007 Emissions Model, http://www.arb.ca.gov/msei/onroad/latest_version.htm

[4] CARB OFFROAD2007 Emissions Model http://www.arb.ca.gov/msei/offroad/offroad.htm

Emission factors for each equipment type were applied to the anticipated equipment work output (horsepower-hours of expected equipment use). Operating times for the equipment were based on a five-day workweek and a ten-hour workday during which the equipment may be operating.

A usage factor accounting for the percentage of daily operation and a load factor accounting for the average throttle setting relative to capacity were used. That is, a usage factor of 0.75 equates to six hours of operation and a load factor of 0.62 equates to 62 percent of throttle capacity during operation. For the off-road equipment sulfur dioxide and particulate matter emission factors, a diesel sulfur content of 15 parts per million (ultra low sulfur diesel fuel) was assumed, based on EPA mandated regulations effective June 2010.

Table 12.10-1
Construction Equipment

Equipment	Size (hp)	Load Factor	SCC	Usage Factor	Fuel Type
AIR COMPRESSOR	5	0.56	2265006015	0.41	4-Stroke Gasoline
BACKHOE / FRONT END LOADER	87	0.54	2270002060	0.26	Diesel
BACKHOE, TRACKED	75	0.55	2270002066	0.26	Diesel
CHIPPER, WOOD	18	0.78	2265004065	0.00	4-Stroke Gasoline
COMPACTOR	84	0.56	2270002015	0.40	Diesel
COMPACTOR	84	0.56	2270002015	0.55	Diesel
CONCRETE / GROUT PUMP	8	0.69	2265006010	0.42	4-Stroke Gasoline
CRANE, 40 TON	149	0.43	2270002045	0.72	Diesel
CRANE, 70 TON	208	0.43	2270002045	0.47	Diesel
DOZER, D5	175	0.59	2270002063	0.61	Diesel
DOZER, D6	248	0.59	2270002063	0.26	Diesel
DOZER, D8	358	0.59	2270002063	0.38	Diesel
DOZER, D10	539	0.59	2270002063	0.00	Diesel
DRILL, TRACKED	18	0.79	2265002033	0.38	4-Stroke Gasoline
DUMP TRUCK, 15 TON	233	0.57	2270002051	0.47	Diesel
DUMP TRUCK, 34 TON	381	0.57	2270002051	0.48	Diesel
DUMP TRUCK, SEMI TRAILER	618	0.57	2270002051	0.00	Diesel
EXCAVATOR	157	0.57	2270002036	0.41	Diesel
FORKLIFT, ROUGH TERRAIN	83	0.6	2270002057	0.52	Diesel
FRONT END LOADER, TRACKED	37	0.55	2270002072	0.00	Diesel

FRONT END LOADER, WHEELED	87	0.54	2270002060	0.44	Diesel
FUEL / SUPPORT TRUCK	381	0.57	2270002051	0.44	Diesel
GENERATOR, DIESEL	84	0.74	2270006005	0.42	Diesel
HYDROSEED SPRAYER, TRUCK MOUNTED	4	0.5	2265005035	0.00	4-Stroke Gasoline
MOTOR GRADER	1662	0.61	2270002048	0.32	Diesel
PILE DRIVER	85	0.78	2270002054	0.00	Diesel
PUMP TRUCK – CONCRETE	381	0.57	2270002051	0.39	Diesel
POWDER TRUCK	381	0.57	2270002051	0.00	Diesel
SCRAPER, 21 CY, SELF-PROPELLED	356	0.72	2270002018	0.00	Diesel
TRUCK, FLATBED	381	0.57	2270002051	0.36	Diesel
TUNNEL RIG	18	0.79	2265002033	0.49	4-Stroke Gasoline
WATER PUMP, DIESEL	84	0.74	2270006010	0.50	Diesel
WATER TRUCK	381	0.57	2270002051	0.41	Diesel
WELDER AND GENERATOR SET	84	0.74	2270006005	0.54	Diesel
EMPLOYEE VEHICLES				--	
CONCRETE MIXER TRUCK – 8CY		ON-ROAD VEHICLES		0.40	Composite
SEMI TRAILER TRUCK				0.44	

Source: CARB OFFROAD2007

Table 12.10-2
Construction Equipment Emissions Factors (g/hp-hr) for 2012

		Exhaust								Evaporative
Equipment	**hp**	**ROG**	**CO**	**NOX**	**CO2**	**SO2**	**PM10**	**N2O**	**CH4**	**ROG**
AIR COMPRESSOR	5	11.373	134.347	5.163	429.438	0.015	0.140	0.635	0.649	0.942
BACKHOE / FRONT END	87	1.009	4.040	6.180	568.297	0.007	0.556	0.000	0.091	--
BACKHOE, TRACKED	75	0.837	3.909	5.398	568.297	0.007	0.475	0.000	0.075	--
CHIPPER, WOOD	18	6.628	288.600	3.151	429.438	0.011	3.262	0.230	0.381	6.495
COMPACTOR	84	1.017	3.949	6.379	568.297	0.007	0.554	0.000	0.092	--
CONCRETE / GROUT PUMP	8	6.972	253.287	4.942	429.438	0.012	3.600	0.451	0.399	1.638
CRANE, 40 TON	149	0.771	3.422	5.845	568.297	0.006	0.339	0.000	0.070	--
CRANE, 70 TON	208	0.559	1.571	5.430	568.297	0.006	0.197	0.000	0.050	--
DOZER, D5	175	0.970	3.743	7.158	568.297	0.006	0.415	0.000	0.088	--
DOZER, D6	248	0.788	2.204	6.810	568.297	0.006	0.292	0.000	0.071	--
DOZER, D8	358	0.717	3.261	6.182	568.297	0.006	0.259	0.000	0.065	--
DOZER, D10	539	0.718	3.246	6.286	568.297	0.006	0.261	0.000	0.065	--
DRILL, TRACKED	18	6.854	266.795	4.297	429.438	0.011	3.600	0.269	0.393	1.109
DUMP TRUCK, 15 TON	233	0.501	1.346	4.614	568.297	0.006	0.157	0.000	0.045	--
DUMP TRUCK, 34 TON	381	0.472	1.390	4.063	568.297	0.006	0.147	0.000	0.043	--
DUMP TRUCK, SEMI TRAILER	618	0.475	1.388	4.199	568.297	0.006	0.150	0.000	0.043	--
EXCAVATOR	157	0.653	3.382	4.872	568.297	0.006	0.288	0.000	0.059	--
FORKLIFT, ROUGH TERRAIN	83	0.946	3.972	5.849	568.297	0.007	0.533	0.000	0.085	--
FRONT END LOADER, TRACKED	37	1.330	5.196	5.350	568.296	0.007	0.402	0.000	0.120	--
GENERATOR, DIESEL	84	0.856	3.596	5.808	568.297	0.007	0.457	0.000	0.077	--
HYDROSEED SPRAYER, TRUCK	4	10.108	165.825	4.627	429.438	0.015	0.140	0.698	0.580	--
MOTOR GRADER	162	0.713	3.377	5.476	568.297	0.006	0.316	0.000	0.064	--
PILE DRIVER	85	1.043	3.985	6.272	568.297	0.007	0.583	0.000	0.094	--
SCRAPER, 21 CY, SELF-	356	0.589	2.296	5.332	568.297	0.006	0.210	0.000	0.053	--
WATER PUMP, DIESEL	84	0.887	3.653	5.897	568.297	0.007	0.477	0.000	0.080	--

Source: CARB OFFROAD2007

Table 12.10-3
Construction Equipment Emissions Factors (g/hp-hr) for 2013

		Exhaust								Evaporative
Equipment	hp	ROG	CO	NOX	CO2	SO2	PM10	N2O	CH4	ROG
AIR COMPRESSOR	5	11.375	134.370	5.162	429.438	0.015	0.140	0.635	0.649	0.942
BACKHOE / FRONT END	87	0.937	4.006	5.806	568.297	0.007	0.507	0.000	0.085	--
BACKHOE, TRACKED	75	0.764	3.877	5.018	568.297	0.007	0.421	0.000	0.069	--
CHIPPER, WOOD	18	6.470	285.217	3.177	429.438	0.011	3.332	0.231	0.371	6.256
COMPACTOR	84	0.951	3.915	6.027	568.297	0.007	0.515	0.000	0.086	--
CONCRETE / GROUT PUMP	8	6.838	251.813	4.974	429.437	0.012	3.600	0.453	0.391	1.406
CRANE, 40 TON	149	0.730	3.410	5.498	568.297	0.006	0.315	0.000	0.066	--
CRANE, 70 TON	208	0.527	1.493	5.043	568.297	0.006	0.178	0.000	0.048	--
DOZER, D5	175	0.931	3.712	6.832	568.297	0.006	0.392	0.000	0.084	--
DOZER, D6	248	0.754	2.115	6.449	568.297	0.006	0.273	0.000	0.068	--
DOZER, D8	358	0.689	3.049	5.857	568.297	0.006	0.243	0.000	0.062	--
DOZER, D10	539	0.690	3.035	5.958	568.297	0.006	0.244	0.000	0.062	--
DRILL, TRACKED	18	6.756	265.782	4.332	429.438	0.011	3.600	0.270	0.388	0.976
DUMP TRUCK, 15 TON	233	0.478	1.309	4.226	568.297	0.006	0.141	0.000	0.043	--
DUMP TRUCK, 34 TON	381	0.453	1.327	3.730	568.297	0.006	0.132	0.000	0.041	--
DUMP TRUCK, SEMI TRAILER	618	0.456	1.326	3.855	568.297	0.006	0.135	0.000	0.041	--
EXCAVATOR	157	0.612	3.377	4.527	568.297	0.006	0.260	0.000	0.055	--
FORKLIFT, ROUGH TERRAIN	83	0.870	3.938	5.459	568.297	0.007	0.482	0.000	0.079	--
FRONT END LOADER, TRACKED	37	1.153	5.041	5.075	568.297	0.007	0.350	0.000	0.104	--
GENERATOR, DIESEL	84	0.782	3.559	5.430	568.297	0.007	0.419	0.000	0.071	--
HYDROSEED SPRAYER, TRUCK	4	10.110	165.786	4.628	429.438	0.015	0.140	0.698	0.580	--
MOTOR GRADER	162	0.674	3.369	5.138	568.297	0.006	0.290	0.000	0.061	--
PILE DRIVER	85	0.960	3.941	5.848	568.297	0.007	0.533	0.000	0.087	--
SCRAPER, 21 CY, SELF-	356	0.563	2.140	5.002	568.297	0.006	0.194	0.000	0.051	--
WATER PUMP, DIESEL	84	0.812	3.614	5.513	568.297	0.007	0.438	0.000	0.073	--

Source: CARB OFFROAD2007

Table 12.10-4
Construction Equipment Emissions Factors (g/hp-hr) for 2014

		Exhaust								Evaporative
Equipment	**hp**	**ROG**	**CO**	**NOX**	**CO2**	**SO2**	**PM10**	**N2O**	**CH4**	**ROG**
AIR COMPRESSOR	5	11.376	134.392	5.162	429.438	0.015	0.140	0.635	0.649	0.941
BACKHOE / FRONT END	87	0.871	3.974	5.458	568.297	0.007	0.460	0.000	0.079	--
BACKHOE, TRACKED	75	0.698	3.849	4.675	568.297	0.007	0.370	0.000	0.063	--
CHIPPER, WOOD	18	6.329	282.286	3.213	429.437	0.011	3.377	0.232	0.363	6.021
COMPACTOR	84	0.888	3.883	5.693	568.297	0.007	0.476	0.000	0.080	--
CONCRETE / GROUT PUMP	8	6.748	250.861	4.993	429.438	0.012	3.600	0.454	0.386	1.228
CRANE, 40 TON	149	0.692	3.400	5.171	568.297	0.006	0.291	0.000	0.062	--
CRANE, 70 TON	208	0.496	1.427	4.608	568.297	0.006	0.161	0.000	0.045	--
DOZER, D5	175	0.893	3.683	6.522	568.297	0.006	0.369	0.000	0.081	--
DOZER, D6	248	0.719	2.030	6.047	568.297	0.006	0.254	0.000	0.065	--
DOZER, D8	358	0.659	2.852	5.490	568.297	0.006	0.227	0.000	0.059	--
DOZER, D10	539	0.660	2.840	5.589	568.297	0.006	0.228	0.000	0.060	--
DRILL, TRACKED	18	6.696	265.135	4.356	429.438	0.011	3.600	0.271	0.384	0.875
DUMP TRUCK, 15 TON	233	0.452	1.283	3.774	568.297	0.006	0.126	0.000	0.041	--
DUMP TRUCK, 34 TON	381	0.431	1.280	3.329	568.297	0.006	0.118	0.000	0.039	--
DUMP TRUCK, SEMI TRAILER	618	0.434	1.279	3.445	568.297	0.006	0.121	0.000	0.039	--
EXCAVATOR	157	0.575	3.373	4.219	568.297	0.006	0.232	0.000	0.052	--
FORKLIFT, ROUGH TERRAIN	83	0.799	3.906	5.110	568.297	0.007	0.432	0.000	0.072	--
FRONT END LOADER, TRACKED	37	0.987	4.890	4.811	568.297	0.007	0.299	0.000	0.089	--
GENERATOR, DIESEL	84	0.710	3.523	5.094	568.297	0.007	0.379	0.000	0.064	--
HYDROSEED SPRAYER, TRUCK	4	10.107	165.875	4.626	429.437	0.015	0.140	0.698	0.580	--
MOTOR GRADER	162	0.636	3.362	4.825	568.297	0.006	0.265	0.000	0.057	--
PILE DRIVER	85	0.879	3.899	5.471	568.297	0.007	0.482	0.000	0.079	--
SCRAPER, 21 CY, SELF-	356	0.536	2.006	4.622	568.297	0.006	0.179	0.000	0.048	--
WATER PUMP, DIESEL	84	0.739	3.578	5.172	568.297	0.007	0.397	0.000	0.067	--

Source: CARB OFFROAD2007

Table 12.10-5
Construction Equipment Emissions Factors (g/hp-hr) for 2015

					Exhaust					Evaporative
Equipment	**hp**	**ROG**	**CO**	**NOX**	**CO2**	**SO2**	**PM10**	**N2O**	**CH4**	**ROG**
AIR COMPRESSOR	5	11.378	134.414	5.162	429.438	0.015	0.140	0.635	0.649	0.941
BACKHOE / FRONT END	87	0.807	3.946	5.045	568.297	0.007	0.416	0.000	0.073	--
BACKHOE, TRACKED	75	0.635	3.824	4.255	568.297	0.007	0.323	0.000	0.057	--
CHIPPER, WOOD	18	6.188	279.367	3.251	429.438	0.011	3.416	0.234	0.355	5.781
COMPACTOR	84	0.827	3.854	5.299	568.297	0.007	0.438	0.000	0.075	--
CONCRETE / GROUT PUMP	8	6.700	250.375	5.002	429.438	0.012	3.600	0.455	0.383	1.093
CRANE, 40 TON	149	0.651	3.391	4.732	568.297	0.006	0.268	0.000	0.059	--
CRANE, 70 TON	208	0.469	1.374	4.201	568.297	0.006	0.145	0.000	0.042	--
DOZER, D5	175	0.853	3.657	6.124	568.297	0.006	0.347	0.000	0.077	--
DOZER, D6	248	0.684	1.951	5.662	568.297	0.006	0.236	0.000	0.062	--
DOZER, D8	358	0.629	2.670	5.139	568.297	0.006	0.211	0.000	0.057	--
DOZER, D10	539	0.630	2.660	5.234	568.297	0.006	0.213	0.000	0.057	--
DRILL, TRACKED	18	6.664	264.808	4.369	429.438	0.011	3.600	0.272	0.382	0.800
DUMP TRUCK, 15 TON	233	0.427	1.263	3.354	568.297	0.006	0.112	0.000	0.039	--
DUMP TRUCK, 34 TON	381	0.409	1.241	2.958	568.297	0.006	0.105	0.000	0.037	--
DUMP TRUCK, SEMI TRAILER	618	0.411	1.241	3.063	568.297	0.006	0.107	0.000	0.037	--
EXCAVATOR	157	0.533	3.369	3.755	568.297	0.006	0.205	0.000	0.048	--
FORKLIFT, ROUGH TERRAIN	83	0.730	3.877	4.702	568.297	0.007	0.383	0.000	0.066	--
FRONT END LOADER, TRACKED	37	0.842	4.761	4.569	568.297	0.007	0.252	0.000	0.076	--
GENERATOR, DIESEL	84	0.639	3.490	4.710	568.297	0.007	0.341	0.000	0.058	--
HYDROSEED SPRAYER, TRUCK	4	10.110	165.787	4.628	429.438	0.015	0.140	0.698	0.580	--
MOTOR GRADER	162	0.596	3.357	4.377	568.297	0.006	0.241	0.000	0.054	--
PILE DRIVER	85	0.799	3.860	5.044	568.297	0.007	0.431	0.000	0.072	--
SCRAPER, 21 CY, SELF-	356	0.510	1.888	4.263	568.297	0.006	0.164	0.000	0.046	--
WATER PUMP, DIESEL	84	0.667	3.544	4.781	568.297	0.007	0.357	0.000	0.060	--

Source: CARB OFFROAD2007

Table 12.10-6
Motor Vehicle Emissions Factors (g/mile)

Light Duty Auto -- Emission Factor									
Year	**ROG**	**CO**	**NOX**	**CO2**	**SO2**	**PM10**	**PM2.5**	**N2O**	**CH4**
2012	0.073	2.400	0.218	310.221	0.003	0.032	0.017	0.005	0.022
2013	0.062	2.138	0.193	309.667	0.003	0.032	0.017	0.005	0.020
2014	0.052	1.910	0.159	309.214	0.003	0.032	0.017	0.005	0.018
2015	0.044	1.718	0.152	308.851	0.003	0.032	0.017	0.005	0.016
Heavy Heavy Duty Vehicle -- Emission Factor									
Year	**ROG**	**CO**	**NOX**	**CO2**	**SO2**	**PM10**	**PM2.5**	**N2O**	**CH4**
2012	1.050	5.161	11.967	2027.333	0.019	0.540	0.459		0.050
2013	0.948	4.601	10.574	2026.682	0.019	0.472	0.397		0.045
2014	0.850	4.078	9.047	2026.088	0.019	0.411	0.340		0.041
2015	0.761	3.615	8.101	2025.597	0.019	0.358	0.291		0.036

Source: CARB EMFAC 2007

For on-road employee vehicles, the anticipated vehicle miles traveled were estimated to determine annual emissions. Assumptions included a one-way trip distance of 65 miles and two trips per day (one-way to/from Indio and Palm Desert) for employee trips. For on-road haul trucks, the anticipated vehicle miles traveled were estimated to determine annual emissions. Assumptions included a one-way trip distance of 5 miles and two trips per day for onsite concrete and dump trucks and a one-way trip distance of 150 miles and two trips per day for offsite hauling (one-way to/from from Ontario). The number of haul trucks was based on the *Schedule, Manpower and Equipment Utilization during Construction of the Eagle Mountain Pumped-Storage Project* developed by GEI Consultants and applied to a grams-mile emissions factor. The following equations were used to obtain annual emission rates for off-road equipment and on-road vehicles:

*Emission Rate (tons/year) = OFFROAD Emission Factor (g/hp-hr) * size (hp) * 8 hours per day * days/year * Load Factor * Usage Factor * (453.59/2000 tons/g)*

*Emission Rate (tons/year) = EMFAC Emission Factor (g/mile) * trips per day * miles per trip * days/year * (453.59/2000 tons/g)*

*Emission Rate (tons/year) = EMFAC Emission Factor (g/hour) * total hours in use * Usage Factor * (453.59/2000 tons/g)*

Additionally, the construction emissions inventories for fugitive dust sources were calculated using emission factors within EPA's AP-42 and SCAQMD *CEQA Air Quality Handbook* and other publications. Fugitive dust emissions result from the following activities: grading, moving soil, and digging, loading/unloading of trucks, movement of trucks on unpaved surfaces, and wind erosion of stockpiles. A particulate matter less than 10 micrometers (PM_{10}) fugitive dust emission factor of 26.4 pounds per day per acre disturbed was used. Particulate matter less than 2.5 micrometers ($PM_{2.5}$)was assumed to be 20.8 percent and 92 percent of PM_{10} for the purposes of this analysis for fugitive dust and offroad equipment, respectively, based on SCAQMD's $PM_{2.5}$ fractions within the *CEQA Air Quality Handbook*.

Erosion control measures and water programs are typically taken to minimize these fugitive dust and particulate emissions. A dust control efficiency of 75 percent due to daily watering and other measures was estimated. Application of water reduces fugitive dust emissions by a factor of approximately 34 to 68 percent (per SCAQMD *CEQA Air Quality Handbook*). It is assumed that one water application per day reduces fugitive dust by 34 percent, two water applications per day reduces fugitive dust by 50 percent, and three water applications per day reduces fugitive dust by 68 percent. Additional measures would allow for a total control efficiency of 75 percent and compliance with SCAQMD Rule 403.

Additionally, construction activities (i.e. tunnel excavation) that involved blasting employed the following emissions factor[5]:

$$\text{Blasting Emissions Factor (lbs } PM_{10} \text{ per day)} = 0.2 * 961 * \text{Blast Area (sq.ft)}^{0.8} / [\ \text{Blast Depth (ft)}^{1.8} * \text{Moisture Content (\%)}^{1.9}\ ]$$

Square footage of the blast area for each associated task was derived from the *Schedule, Manpower and Equipment Utilization during Construction of the Eagle Mountain Pumped-Storage Project* developed by GEI Consultants, and if a blast depth was not provided, 30 feet was assumed. Additionally, one percent moisture content was applied.

[5] Source: *Sonoma County Aggregate Resources Management Plan and Environmental Impact Report (Sonoma County, 1994)*

Concrete Batch Plant

Concrete is composed essentially of water, cement, sand (fine aggregate), and coarse aggregate, consisting of crushed stone. Sand, aggregate, cement, and water are all gravity fed from a weigh hopper into the mixer trucks. The cement is transferred to elevated storage silos. The sand and coarse aggregate are transferred to elevated bins. From these elevated bins, the constituents are fed by gravity or screw conveyor to weigh hoppers, which combine the proper amounts of each material.

Air emissions were determined for the operation of the concrete batching plants. The air emission calculations accounted for the proposed production level, the number, types, and size of equipment. The emission factors can be calculated using the methodology found in EPA *Compilation of Air Pollutant Emission Factors* (AP-42) Section 11.12. The cement unloading and truck loading points have air emission controls applied to them.

Construction Activities

The construction requirements for the Proposed Project will involve a variety of air emissions sources including on- and off-road construction vehicles, machinery and equipment. These emission sources are associated with the following activities:

- Site preparation and earth-moving;
- Transport and placement of fill;
- Leveling and grading of project footprint;
- Drilling, blasting and excavation of tunnel sites;
- Storage and movement of raw and construction materials; and
- Other miscellaneous construction operations (e.g., installation of roadways and underground utilities.).

This section outlines the procedures, data sources, and other analytical parameters to be used in developing the air emissions estimates for constructing the Proposed Project.

Construction Equipment Types

For the purposes of this analysis, the construction equipment types will be subdivided into two categories: off-road equipment and on-road vehicles. Off-road equipment is used to move and grade fill materials, install utilities, pave surfaces, construct necessary structures and install other miscellaneous support features. These include a wide array of scrapers, loaders, dozers, cranes and off-road haul trucks. On-road vehicles include transport trucks for the delivery of raw materials, supplies and equipment, as well as the personal vehicles used by the construction workers. Typical on-road vehicles include automobiles, vans and trucks of various sizes and functions.

Activity Levels and Load Factors

Activity levels are defined as the hours of operation for a piece of equipment over a given time, and load factors are the engine performance demands, as a percent of maximum power. Equipment activity levels are based on the construction requirements and schedule for each project component. GEI Consultants have reviewed the work cycles for each type of equipment to estimate an average activity level for each project and type of equipment. These estimated activity levels for the construction equipment vary depending on the individual project elements and phase.

The peak work force is estimated to be 209 laborers. The total work force is estimated to be 4,674 person months over the duration of construction. The peak monthly on-site equipment items are estimated to be 150 items. The peak daily concrete trucks (on-site) are estimated to be 210 trucks. This estimate assumes the trucks are traveling to and from an on-site batch plant. The peak daily heavy trucks (on-site) are estimated to be 258 trucks. This estimate assumes the trucks are hauling materials to and from locations on-site. The peak monthly off-site truck volume is estimated to be 79 trucks. The total off-site truck volume is estimated to be 925 trucks for the duration of construction. This estimate assumes the off-site trucks are importing the necessary construction materials to the site such as steel linings, steel reinforcement, electrical components, etc.

The average crew size for each major feature of the project construction, the associated average duration in months, and the total number of person months for each item and for the complete project were provided. The type and total number of equipment required for each major feature of the project construction were also provided. Equipment and crew size calculation spreadsheets for each major feature of the project construction were also provided.

Equipment & Vehicle Emissions Factors

The construction-related emission inventories were calculated using emission factors obtained from the CARB OFFROAD 2007 model and EMFAC2007 model, as well as U.S. EPA's *Compilation of Air Pollutant Emission Factors* (AP-42), SCAQMD's *CEQA Air Quality Handbook*, and other accepted guidance.

Fugitive Dust

Fugitive dust emissions during construction are estimated based on the surface area disturbed, expected duration of activity in a given area, and an emissions factors and an emissions reduction based on expected control measures (under CEQA). This emissions factor accounts for fugitive dust emissions from land clearing, ground excavation, cut and fill operations, blasting and excavation operations vehicle travel over construction areas, and wind erosion of exposed areas.

Based on expected exposed area, the construction schedule and acceptable emission factors, the PM_{10} and $PM_{2.5}$ annual emissions from fugitive dust are expected to be 11.0 and 2.53 tons per year, respectively. The PM_{10} and $PM_{2.5}$ daily emissions from fugitive dust are expected to be 84.6 and 19.5 pounds per day, respectively.

Detailed Results

Construction-related annual and daily emissions associated with the Proposed Project are presented, segregated by project year, pollutant type, and equipment/vehicle category, in Tables 12.10-7 through 12.10-10. Off-road equipment amounts to a greater percentage of the emissions for all pollutants except PM_{10} and $PM_{2.5}$, which is dominated by fugitive dust sources.

Off-road equipment contributes approximately 80, 90, 90, 18, 45, and 75 percent of the total CO, VOC, NO_x, PM_{10}, $PM_{2.5}$, and SO_2 emissions, respectively. On-road equipment contributes approximately 20, 10, 10, 2, 5, and 25 percent of the total CO, VOC, NO_x, PM_{10}, $PM_{2.5}$, and SO_2 emissions, respectively. Fugitive dust contributes approximately 80 and 50 percent of the total PM_{10} and $PM_{2.5}$ emissions

The daily emissions are less than the SCAQMD CEQA thresholds for all pollutants except NO_x where the threshold is 100 pounds per day. Without mitigation, the NO_x impact would be significant.

Table 12.10-7
Offroad Equipment Annual Construction Emissions (tons)

Year	CO	VOC	NO_X	PM_{10}	$PM_{2.5}$	SO_2	CO_2	N_2O	CH_4
2012	48.7	6.86	49.6	2.54	2.33	0.06	6,236	0.03	0.58
2013	46.3	7.01	49.1	2.52	2.32	0.07	6,486	0.03	0.60
2014	48.7	7.13	47.3	2.49	2.29	0.07	7,012	0.04	0.61
2015	13.3	1.58	9.20	0.56	0.51	0.02	1,445	0.02	0.13

Source: KB Environmental Sciences, Inc., 2009.

Table 12.10-8
Onroad Vehicles Annual Construction Emissions (tons)

Year	CO	VOC	NO_X	PM_{10}	$PM_{2.5}$	SO_2	CO_2	N_2O	CH_4
2012	10.3	0.60	4.60	0.29	0.21	0.02	1,762	0.02	0.10
2013	11.5	0.85	7.54	0.43	0.32	0.02	2,535	0.02	0.11
2014	11.5	0.54	3.65	0.30	0.20	0.02	2,285	0.03	0.11
2015	2.52	0.08	0.41	0.05	0.03	0.005	486	0.01	0.02

Source: KB Environmental Sciences, Inc., 2009.

Table 12.10-9
Offroad Equipment Daily Construction Emissions (pounds)

Year	CO	VOC	NO_X	PM_{10}	$PM_{2.5}$	SO_2
2012	375	52.8	382	19.5	18.0	0.49
2013	356	53.9	378	19.4	17.8	0.52
2014	375	54.8	364	19.1	17.6	0.56
2015	102	12.2	70.8	4.29	3.95	0.12
CEQA Threshold	550	75	100	150	55	150

Source: KB Environmental Sciences, Inc., 2009.

Table 12.10-10
Onroad Vehicles Daily Construction Emissions (pounds)

Year	CO	VOC	NO_X	PM_{10}	$PM_{2.5}$	SO_2
2012	79.0	4.59	35.4	2.21	1.60	0.13
2013	88.4	6.58	58.0	3.31	2.48	0.19
2014	88.5	4.17	28.1	2.30	1.51	0.17
2015	19.4	0.62	3.17	0.41	0.24	0.04
CEQA Threshold	550	75	100	150	55	150

Source: KB Environmental Sciences, Inc., 2009.

12 Appendix C – Technical Memoranda

12.11 Class I Cultural Resources Investigation for the Proposed Eagle Mountain Pumped Storage Project.

A CLASS I CULTURAL RESOURCES INVESTIGATION
for the
PROPOSED EAGLE MOUNTAIN PUMPED STORAGE PROJECT, RIVERSIDE COUNTY, CALIFORNIA

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October 2009

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MANAGEMENT SUMMARY

A Class I cultural resources inventory of previously recorded sites was conducted for Eagle Crest Energy's proposed Eagle Mountain Pumped Storage Project. This information is provided for the proponent, the Federal Energy Regulatory Commission, and the Bureau of Land Management (BLM) in support of regulatory and permitting procedures, including the Applicant Prepared Environmental Impact Report. The inventory focused on the 500 kV transmission line and alternatives, a preferred and alternative interconnection collection substation, water pipeline, and water wells. The preferred transmission line extends for 13.5 miles (mi.). and alternatives include an additional 6 mi. of alignment, with a right-of-way 200-foot (ft.) wide. The water line routes include 15 mi. of alignment with a 60-ft.-wide right-of-way. The records search also included the general site plan that encompasses the former Kaiser Eagle Mountain Mine within which two reservoirs and an electrical generating station are proposed. A larger buffer extending 1 mi. out from the all of the above project components was used as the study corridor for the records search, encompassing 49,833 acres. This larger corridor provides additional information to interpret sites within the project area, assess general areas of potential sensitivity, and accommodates increasingly precise project design specifications and potential redesigns as constraints and opportunities are assessed in the environmental analysis.

The inventory included cultural resource records at the Eastern Information Center (EIC) of the California Historic Resources Inventory System (CHRIS), housed at the University of California, Riverside and of sacred lands records at the California Native American Heritage Commission. The BLM Palm Springs Field Office, was also consulted concerning possible unrecorded sites and sensitivities in the study area. ASM Affiliates files identified 26 reports and 31 cultural resources previously recorded within the study corridor. The reports document archaeological inventory efforts in an undetermined but fairly small portion (3 mi. of transmission line – less than 10 percent) of the linear study corridor, and a somewhat greater portion of the project area proper.

About 50 percent (15 sites) of the recorded resources in the study area are prehistoric, and 50 percent (15 sites) are historic in age. The majority of the recorded resources are comparatively minor. Some 16 percent (5 resources) are isolated finds, including three prehistoric lithics, one milling stone, and one historic ceramic. Many other sites consist of small prehistoric lithic scatters, a pot drop, possible rock rings and cleared circles, and bedrock milling. However, potentially more significant resources are also present in the study area, consisting of several portions of a major east-west trail network with associated features. Significant historic sites in the study area include two stick figure petroglyphs associated with an early wagon road and possibly a cenotaph associated with "Desert Steve" Ragsdale, three historic sites associated with Camp Young/Desert Center and the World War II-era Desert Training Center/California-Arizona Maneuver Area, a historic well, the Eagle Mountain Mine and community and radio control tower, and the Colorado River Aqueduct and Eagle Mountain Pumping Station. Less significant historic sites include remains of a blacktopped road and various historic post-World War II trash scatters.

The only potentially significant previously recorded historic period resources in the project's Area of Potential Effects (APE) are the Colorado River Aqueduct, an underground portion of which the transmission line would span, and possibly portions of Eagle Mine and Industrial Railroad.

Generally speaking, the project area appears to contain the potential for significant prehistoric and historic cultural resources, although they are widely distributed and to a large extent avoided by the proposed transmission line and water line portion of the project. The California State Historic Preservation Officer (SHPO) has already concurred with the BLM that the Eagle Mountain Mine, Townsite, and rail yard are not eligible for listing in the National Register of Historic Places. When the project's APE has been more exactly defined, further cultural resource studies should include systematic archaeological surveys to inventory the portions of the APE that have not previously been addressed, evaluation of resources within the APE for National Register of Historic Places (NRHP) eligibility; Native American and SHPO consultation, and development of measures to mitigate any impacts to NRHP-eligible properties. Current record search data suggest that no historic properties will be affected by the proposed project.

1. PROJECT DESCRIPTION

The Eagle Mountain Energy Company proposes to develop the Eagle Mountain Pumped Storage Project located near the towns of Eagle Mountain and Desert Center in Riverside County, California (Figure 1). The proposed project is a hydroelectric pumped storage project that will provide system peaking capacity and electrical system regulating benefits to Southwestern electric utilities. The project will use off-peak energy to pump water from the lower reservoir to the upper reservoir during periods of low electrical demand and generate on-peak energy by conveying water from the upper to the lower reservoir through the generating units during periods of high electrical demand. The upper and lower reservoirs will be formed from existing mining pits; however, two small dams will be required at the upper reservoir to create the proposed volume of energy storage. Other important elements of the project and the focus of this Class I cultural resource records search are the preferred and alternate 500 kV transmission line routes (Figure 2). The preferred route follows an alignment from the Eagle Mountain Mine through a pass to the east of Eagle Mountain Pumping Plant of the Colorado River Aqueduct, and south along Eagle Mountain Road. Approximately 2 mi. north of Interstate 10 the route proceeds southeast to the preferred Interconnection Collector Substation, located west of Desert Center. An alternative transmission line route would continue south along Eagle Mountain Road and then veer southwest to the alternative Network Connection Point. This alternative is not preferred because of potential impacts to cultural resources associated with the evacuation hospital of the World War II Camp Desert Center. The other principal element is the water line that proceeds southeast from the Eagle Mountain Mine and parallel to an existing transmission line and gas corridor to the vicinity of the Desert Center Airport.

The preferred 500 kV line is approximately 13.5 mi. long and 200 ft. wide while the alternative lines add an additional 6 mi. of examined route. Each of the Interconnection Collector Substation areas covers 25 acres. The eastern substation is the preferred one for the reasons stated above. The water line routes extend for approximately 13.5 mi. and are 60 ft. wide. Three currently identified well locations in the Chuckwalla Valley were also examined for the records search (Figure 2).

The present study is designed to provide Class I cultural resources investigations to support a Traditional License Application to the Federal Energy Regulatory Commission (FERC) and the Application for Water Quality Certification to the State Water Resources Control Board by Eagle Crest Energy Company. It includes a collection and assessment of existing information concerning cultural resources likely to be affected by the project, an evaluation of the potential for additional resources in the affected areas, and recommendations for future studies needed to comply with Section 106 of the National Historic Preservation Act and other applicable cultural resources laws and regulations.

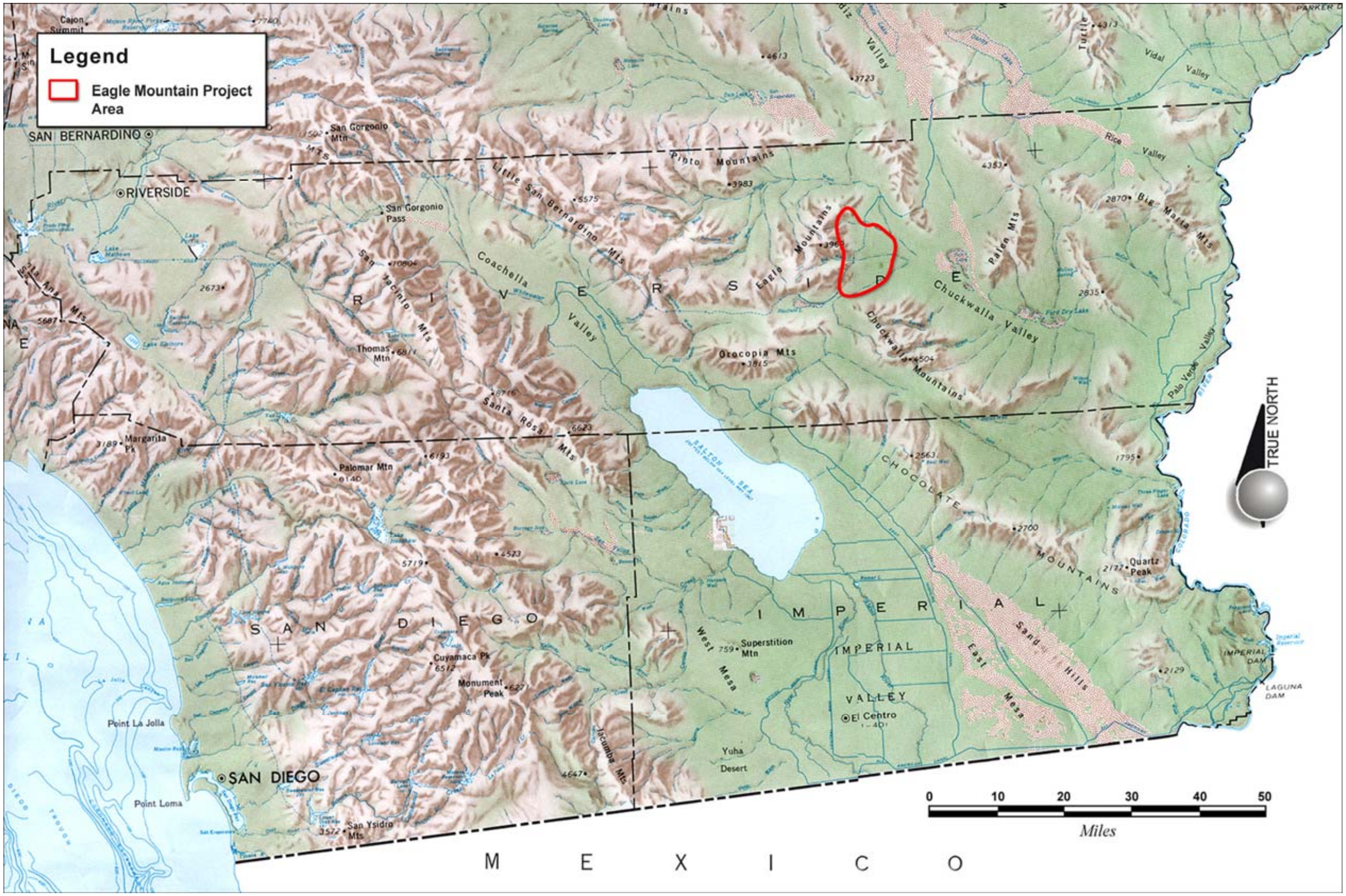

Figure 1. Project location map.

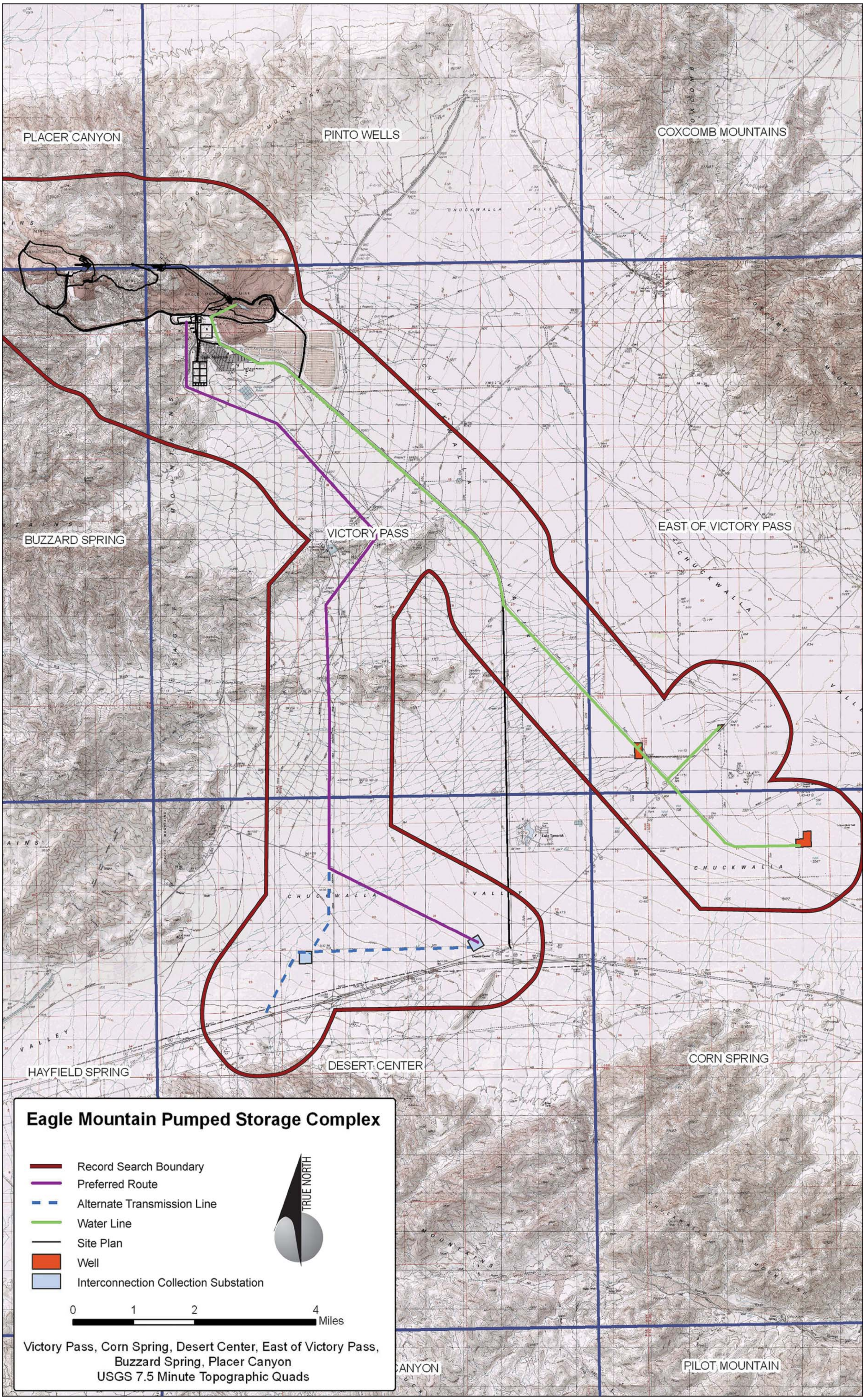

Figure 2. Eagle Mountain Pumped Storage Project.

2. ENVIRONMENTAL AND CULTURAL CONTEXT

The following discussion draws substantially upon the background discussion for a previous project that was located, in part, in the same region (Schaefer 2003).

This chapter describes the natural and cultural setting of the project area. The project traverses the north-central margin of the Colorado Desert, centering on the Chuckwalla Valley and north-eastern Eagle Mountains. This region has a long cultural history extending back more than 10,000 years. The affiliation of a particular Native American group with Chuckwalla Valley is somewhat uncertain (Heizer 1978); ethnographic and historic evidence suggests possible links with three distinct groups: the Halchidhoma, Desert Cahuilla, and Chemehuevi. Since the Euro-American occupation of the region, the cultural landscape has been altered by a variety of land uses relating to travel, settlement, mining, water reclamation, and military preparedness.

Throughout the cultural history of the Colorado Desert, human activities have been closely tied to the distribution of natural resources and other aspects of the natural setting. Water, vegetation communities, animal habitat, and lithic raw material were not evenly distributed across the landscape. Prehistoric archaeological evidence is therefore also likely to be non-randomly distributed, as the prehistoric hunter-gatherers keyed onto these critical resources during their seasonal rounds. Both short-term and long-term climatic fluctuations almost certainly also affected the intensity of land use over time. The natural topography influenced the location of trails and other land use patterns. Dynamic forces of erosion and of alluvial and eolian deposition also determined the preservation, integrity, and visibility of archaeological sites.

NATURAL SETTING

The project area is located on the northern margin of the Colorado Desert Region area, which in turn is a northwestern subregion within the more widespread Sonoran Desert. This area typically consists of a series of northwest-to-southeast trending mountain ranges interspaced with basins filled with alluvial or lacustrine sediments. Elevations along the project corridor range from more than 1,600 ft. above mean sea level (amsl) in the northwest, on the eastern margin of Eagle Mountains, to 345 ft. amsl at the eastern extreme.

Few areas of North America are hotter or dryer than the Colorado Desert. Modern climatic conditions provide for dry, mild winters and dry, hot summers. Mean winter lows of 44º F and a mean summer highs of 104º F are typical, with record highs of 120º F. Rainfall data from Indio between 1877 and 1987 record an annual average of 5.54 in., with extremes between 0.18 and 11.50 in. annually. Violent summer storms are not unusual, but most precipitation falls in mid-winter. The Colorado River was the most reliable and abundant source of water in the region, supplemented by a few widely dispersed springs elsewhere. Water sources are extremely scarce through the Chuckwalla Valley, but several springs are widely dispersed in the mountains to the north and south, outside the project area. They include, from west to east, Lost Palms Oasis, Hayfield Springs, Corn Springs, and McCoy Springs. Such water sources were foci of prehistoric activities. More ephemeral water sources are represented by the dry lakes (playas) and pans that were used during periods of relatively greater rainfall or especially wet winters. They include Palen Lake and Ford Dry Lake.

Geomorphology and Geology

The project area owes many of its characteristic features to its location adjacent to the Salton Rift. This distinct physiographic feature consists of a massive graben created at an interface of the North American and Pacific tectonic plates. The San Andreas Fault and the Transverse Ranges are prominent geomorphic features marking this plate boundary. The mountain ranges and alluvial basins farther north and east are more characteristic of the Basin and Range Province, caused by crustal extension.

The Eagle Mountains are composed primarily of Precambrian igneous and metamorphic rocks, Mesozoic granitic rocks, and Pleistocene nonmarine sediments (*see* Figure 3.3.1-1 in Environmental Impact Report)– lithologies of only limited usefulness to the region's prehistoric inhabitants, although Euro-American miners subsequently exploited them (Jennings 1967). Other ranges framing the project area include the Coxcomb, Palen, and McCoy mountains to the north of Chuckwalla Valley and the Chuckwalla, Little Chuchwalla, and Mule mountains to the south, adding pre-Cretaceous metasediments to the mix of lithologies. The project area proper runs almost exclusively through areas of Quaternary alluvium, lake deposits, and dune sand. Very active geomorphic processes of erosion and deposition along this route may have been responsible for poor preservation or visibility of archaeological sites.

One geological deposit in the Chuckwalla Valley – Alligator Rock – was the focus of extensive prehistoric lithic procurement activities. Located just southwest of Desert Center, Alligator Rock is a prominent ridge containing dikes of aplite, a relatively fine-grained plutonic rock composed of quartz and alkali feldspar. Thousands of years of aplite procurement as a lithic raw material have resulted in a substantial quarry site complex that extends over a 1-mi.^2 area. The quarry site complex is listed on the NRHP as the North Chuckwalla Mountain Quarry District. The other major sources of prehistoric tool stone were the many pebble covered desert pavements of fine-grained cryptocrystalline silicate rock along the Colorado River Valley.

Vegetation

The project route crosses two main vegetation communities: creosote bush scrub and desert microphyll woodland (Carrico et al. 1982). The creosote bush scrub community ranges from non-alkali alluvial flats to rocky slopes. Characteristic species include creosote (*Larrea tridentata*) and white bursage or burrobush (*Ambrosia dumosa*). Well-drained alluvial slopes also support encelia (*Encelia farinosa*) and desert trumpet (*Eriogonum inflatum*). Annual grasses that occur throughout this community were primary food resources for prehistoric Native Americans.

The desert microphyll woodland community occurs in drainages descending from the mountains on either side of Chuckwalla Valley. Characteristic trees include catclaw (*Acacia gregii*), palo verde (*Cercidium floridum*), desert willow (*Chiopsis lindearis*), smoke tree (*Dalea spinosa*), and ironwood (*Olneya tesota*). Shrub species include sweetbush (*Bebbia juncea*), cheese bush (*Hymenoclea salsola*), and desert lavender (*Hyptis emoryi*). Native Americans harvested catclaw and palo verde bean pods in late spring and early summer to pound them into a nutritious meal. Willow bark fiber was made into cordage, skirts, breechcloths, and other objects, while firewood and construction materials were available from all the trees (Bean and Saubel 1972).

Vertebrate Fauna

Mammals with the greatest economic importance to Colorado Desert peoples included desert cottontail (*Sylvilagus audubonii*), black-tailed jackrabbit (*Lepus californicus*), several rodent species, mule deer (*Odocoileus hemionus*), and Nelson's bighorn sheep (*Ovis canadensis nelsoni*). Predators that are known to occur in the area include mountain lion (*Felis concolor*), badger (*Taxidea taxus*), kit fox (*Vulpes macrotis*), and bobcat (*Felis rufus*). Desert cottontail is most abundant in sand dune areas such as those found in the eastern Chuckwalla Valley. Black-tailed jackrabbits have a more widespread distribution on desert floors, floodplains, washes, and rocky slopes. Mule deer were most likely to be encountered in desert washes, while the elusive bighorn sheep could be ambushed at desert tanks or oases when they came down from the mountain slopes to get water (Jaeger 1965; Ryan 1968).

Wild game played a less significant role in the diet of ethnohistoric Colorado River peoples than for the desert groups, but it may have had more importance in earlier times, prior to the introduction of horticulture. A wide variety of fish, reptiles, birds, and mammals are found along the Colorado River and its adjacent deserts, and many species had economic importance to the Colorado River peoples (Castetter and Bell 1951). Fish were the most important source of animal protein and included razorback sucker (*Xyrauchen texanus*), bonytail chub (*Gila elegans*), striped mullet (*Mugil cephalus*), various minnows (Cyprinidae), and machete (*Elops affinis*). Some of these species are now extinct on the lower Colorado River, having been replaced by introduced species such as catfish (Gobalet 1994; McGinnis 1984). Many species of raptors, wading birds, songbirds, and migratory waterfowl inhabited the riparian margins of the Colorado River. Raptors had ceremonial uses, while migratory birds and their eggs were exploited for food. Bird species included bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), Wilson's warbler (*Wilsonia pusillus*), American coot (*Fulica americana*), mallard (*Anas plathyrhynchos*), great blue heron (*Ardea herodias*), and clapper rail (*Rallus longirostris*).

PALEOENVIRONMENTS

Evidence of prehistoric environmental conditions in the study region is very limited. Pollen-bearing stratified deposits from caves or lake beds are not as common in the Colorado Desert as they are in the Great Basin, where most of the desert climatic reconstructions are based.

Evidence indicates that while early Holocene conditions were wetter and cooler than present, permitting greater use of the study area and especially around the boundaries of Palen Lake and Ford Dry Lake. Generally modern desert conditions were already in existence by the end of the early Holocene period with periods of more extensive drought in the Late Holocene (Thompson 1984).

Paleoclimatic reconstructions, based on pack rat (*Neotoma* sp.) midden analyses, indicate that at elevations below 1,000 ft. there has been little climatic change along the Lower Colorado and Gila rivers over the last 13,000 years (Van Devender 1990). The region may have been a refugium for lower Sonoran creosote-scrub habitat during the Pleistocene period (Cole 1986). At higher elevations in the mountains, pack rat midden analyses indicate the presence of a juniper woodland habitat in the Late Pleistocene between 20,000 and 9,000 B.C. These xeric woodlands continued through the early Holocene between 9,000 and 6,000 B.C., before finally retreating to higher elevations during the Middle Holocene and being replaced with the current creosote scrub and desert riparian habitat (King and Van Devender 1977; Van Devender and Spaulding 1983). The last century has seen some of the hottest and driest conditions in at least the last 400 years (Hastings and Turner 1965:188).

Based on current information, the climatic history of the general region may be summarized as follows (Van Devender and Spaulding 1983):

- Late Pleistocene (20,000 to 9,000 B.C.): Cooler and wetter conditions supported pinyon-juniper woodlands, extensive deep lakes, and savannah grasslands or creosote scrub at low elevations.
- Early Holocene (9,000 to 6,000 B.C.): Gradual warming and drying conditions resulted in the shrinking of lakes and replacement of woodlands by creosote scrub communities at lower levels.
- Middle to Late Holocene (6,000 B.C. to present): Warm and dry conditions continued, dominated by summer monsoons in the desert Southwest and winter storms along the Pacific Coast. Lakes in low-lying basins completely dried up or became ephemeral in nature. Local fluctuations in temperature and aridity may have produced ecological variations of no greater magnitude than those known from historic records. Droughts may have been more frequent and severe during the period between 5,000 and 2500 B.C.

CULTURAL SETTING

History of Research

An outline of Colorado Desert culture history has been generally accepted by the archaeological community, but not without the realization that it is a tentative construct, with many details that are still unknown or not well understood. Ironically, the problem is most acute along the lower Colorado River itself, where late prehistoric and ethnohistoric period occupations were most intense. Most of the major aboriginal occupation sites were on the lower terraces of the Colorado River, but none of these have been investigated, evidently because they are buried beneath many feet of alluvial deposits, have been destroyed by agricultural development, are now obscured by impenetrable stands of tamarisk and reeds, or submerged under artificial reservoirs.

The culture history for the region is based on the pioneering work of Malcolm J. Rogers in many parts of the Colorado Desert, primarily carried out during the 1920s and 1930s (Rogers 1939, 1945, 1966). Since then, several overviews and syntheses have been prepared, and each succeeding effort had been able to draw upon previous studies and add new data and interpretations. Rogers established the first systematic culture history and artifact typologies of the Colorado Desert. His investigations of San Dieguito and Archaic flaked stone tools and settlement patterns (Rogers 1929, 1939, 1958, 1966) and of Yuman ceramics and culture history (Rogers 1936, 1945) remain a foundation for current archaeological research in the area.

Most research during the last 25 years has been sponsored or mandated by government agencies for compliance with state and federal laws. Independent research has also been conducted for academic theses and dissertations and by local institutions such as Imperial Valley College and University of California, Riverside. Of particular note is the corpus of federal agency overviews and management plans that identified cultural contexts, research domains, and management issues for most of the Colorado Desert.

Margaret Weide and Pat Barker prepared one of the earliest syntheses of information on the Yuha Desert in southwestern Imperial County for the BLM (see Wilke 1978). This study included discussions relevant to the culture history of the Colorado Desert as a whole, including the Colorado River Valley (Weide 1974). An updated synthesis addressing the Colorado Desert Planning Units was prepared by Elizabeth von Till Warren and her collaborators (1981). This is a particularly succinct and useful review of information on environments, prehistory, and ethnography, although a bit out of date.

For southwestern Arizona, Randall H. McGuire and Michael B. Schiffer (1982) reviewed over 50 previous research projects and prepared cultural syntheses that are also applicable to southern California. One of the most valuable contributions in that volume is Michael R. Waters' (1982a, 1982b) study of Patayan ceramics, based largely on the unpublished notes and field collections of Rogers. More recently, Jerry Schaefer (1994a) updated and corrected Waters' discussion of the time ranges and spatial distribution of various Patayan ceramic types, based on a review of recent excavations in the Colorado Desert.

At present, the earliest sites in the vicinity of the project area date to the early-middle Archaic period (5,000-3,000 B.C.), as represented by the lithic complex in the Pinto Basin of Joshua Tree National Monument (Campbell and Campbell 1935) and at ephemeral pans such as the ones found within the Chuckwalla Valley. Absolute dates for this period remain problematical (Schroth 1994; Warren 1984).

For the lower Colorado River Valley, Jeannne Swarthout and Christopher E. Drover (Swarthout 1981a, 1981b, 1981c; Swarthout and Drover 1981) prepared detailed overviews that divided the river into four reaches: from Lee's Ferry to Grand Wash Cliffs, from Grand Wash Cliffs to Davis Dam, from Davis Dam to the International Border, and the Lower Virgin River. These studies emphasized the limitations of previous work because of inconsistent site records and a lack of stratified sites. However, they did provide a careful review of the environment and culture history, as well as present proposals for future research. The study of Reach 3, from Davis Dam to the International Border (Swarthout and Drover 1981) is most applicable to the study area and one of the best in the series. Two ethnographically based settlement models were presented, one for the Mohave in Mohave Valley and the other for the Halchidhoma and Quechan on the Colorado River. Although the lack of preserved sites on the valley floor makes it difficult to test Swarthout and Drover's models, related test implications can be developed for the temporary camps and resource extraction sites in the deserts away from the river.

A more recent overview of the lower Colorado River by Connie L. Stone (1991) extended the history of research and review of current research issues. Stone identified major cultural resource types, from rock rings to rockshelters, and provided summary statements of their potential research values and applicable investigative procedures. She also provided valuable maps of major intaglio and rock art sites, trail systems, and generalized prehistoric land use. Finally, Stone updated the discussion of management issues.

Statistical Research has been engaged in a series of surveys along the lower Gila and Colorado rivers. One aspect of these studies was the documentation of milling implement quarries, the closest of which is at Palo Verde Point (Schneider 1994). Of particular interest are the many geoglyph and rock art sites that Jeffrey H. Altschul and Joseph A. Ezzo interpreted as part of a ceremonial complex involving the entire Lower Colorado River region. A symposium highlighted the cultural significance of these sites for the Yuman tribes of the Colorado River and the productive results that can be derived from uniting Native American perspectives and scientific archaeological interpretation (Ezzo 1994; Ezzo and Altschul 1993).

Schaefer (1994b) proposed additional research issues that linked the treatment of archaeological sites in the desert and river valley zones. In another article, he summarized and critiqued recent data recovery projects in the Colorado Desert with an emphasis on understanding the chronology of Lake Cahuilla, settlement patterns, and the problems of interpreting sites on desert pavements (Schaefer 1994c). Most recently, Schaefer and Don Laylander (2007) offered a synthesis of work on Colorado Desert prehistory over the last 20 years.

Cultural Periods and Patterns

Five successive periods, each with distinctive cultural patterns, may be suggested for the Colorado Desert, extending back over a period of at least 12,000 years. They include (1) Early Man (Malpais); (2) Paleoindian (San Dieguito); (3) Archaic (Pinto and Amargosa); (4) Late Prehistoric (Patayan); (5) Historic (Ethnohistoric and Euro-American).

Early Man Period (Malpais Pattern) (50,000-10,000 B.C.)

The Malpais Pattern is represented by a complex of archaeological remains that has been hypothesized by some scholars to date between 50,000 to 10,000 B.C. (Begole 1973, 1976; Davis et al. 1980; Hayden 1976). Rogers (1939, 1966) originally used the term for cleared circles, tools, and rock alignments that appeared to be ancient and that he later classified as San Dieguito I. Malpais has continued to be applied to heavily varnished choppers and scrapers found on desert pavements of the Colorado, Mojave, and Sonoran deserts that are believed to predate the Paleoindian period of projectile point use. Although few would reject most of the items as being culturally produced artifacts and features, the methods used to date them are highly subjective and have been assailed on many grounds (McGuire and Schiffer 1982:160-164). Arguments in favor of early occupations in the Colorado Desert have been further eroded by the redating of the Yuha Man. Originally dated as over 20,000 years old on the basis of radiocarbon analysis of caliche deposits, more reliable dates of actual human bone fragments based on the accelerator mass spectrometer (AMS) radiocarbon method now place the burial at only about 5,000 years B.C. (Taylor et al. 1985).

Paleoindian Period (San Dieguito Pattern) (10,000-6,000 B.C.)

Most of the aceramic lithic assemblages, rock features, and cleared circles in the Colorado Desert have been assigned to the San Dieguito pattern. Rogers first defined the pattern on the basis of surface surveys in western San Diego County, but he later refined his understanding of the pattern with at excavations at the C. W. Harris site, a few miles up the San Dieguito River from the Pacific coast (Rogers 1939, 1966). Rogers saw three phases of the San Dieguito pattern in its Central Aspect (which included the Colorado and Mojave deserts and the western Great Basin). Each successive phase was thought to have been characterized by the addition of new, more sophisticated tool types to the preexisting tool kit.

Current understanding of the lithic technology of the San Dieguito pattern focus on percussion-flaked cores and the resulting debitage, with little or no pressure flaking evident during the first two phases. Tools from San Dieguito I and II phases include bifacially and unifacially reduced choppers and chopping tools, concave-edge scrapers (spokeshaves), bilaterally notched pebbles, and scraper planes. Appearing in the San Dieguito II phase are finely made blades, smaller bifacial points, and a greater variety of scraper and chopper types. It appears that the San Dieguito III phase tool kit became appreciably more diverse with the introduction of fine pressure flaking. Tools include pressure-flaked blades, leaf-shaped projectile points, scraper planes, plano-convex scrapers, crescentics (which may have been amulets), and elongated bifacial knives (Rogers 1939, 1958, 1966; Warren 1967; Warren and True 1961). Various attempts have also been made to associate cleared circle features with the San Dieguito phases, but no convincing chronological scheme has yet emerged (Pendleton 1984).

Because of the largely surface character typical of desert sites and the scarcity of chronological indicators, it has been difficult to substantiate the validity of Rogers' phase designations as temporal indicators, that is, chronologically successive changes in the tool kit of a long-lived culture. Some of the variations may have developed contemporaneously, in response to ecological or aesthetic requirements. Subsequent excavations at the C. W. Harris site in coastal San Diego County also failed to confirm Rogers' original observation of a stratigraphic separation between San Dieguito II and III assemblages (Warren 1967:171-172). Indeed, without a stratified context to demonstrate succession, the distinctions may as likely be due to economic specialization at a specific site or to sampling error, rather than to technological change through time. Rogers (1966:39) also identified different settlement patterns for each phase, but Sheila J. Vaughan (1982:6-11) argued that these distinctions were inadequately defined and inconsistently applied.

The San Dieguito pattern, as reconstructed from assemblage characteristics and site associations, represented a hunter-gatherer adaptation by which small mobile bands exploited small and large game and collected seasonally available wild plants. The absence or scarcity of milling tools in San Dieguito assemblages has been seen as reflecting a lack of hard nuts and seeds in the diet, as well as being a cultural marker separating the San Dieguito culture from the later Desert Archaic culture (Moratto 1984; Rogers 1966; Warren 1967). However, manos and portable metates are now increasingly recognized at coastal sites that have been radiocarbon dated to earlier than 6,000 B.C. Arguments have also been made for the presence of a well-developed early grinding tool assemblage, based on finds from the Trans-Pecos area of Texas (Ezell 1984). In regard to the Colorado Desert, Lorann Pendleton (1984:68-74) noted that most ethnographically documented pounding equipment for processing hard seeds and wild mesquite and screwbeans was made out of wood and would not have been preserved at open archaeological sites.

Site distributions indicate some of the basic elements of the San Dieguito settlement system. The sites may be located on any flat area, but the largest aggregations occur on mesas and terraces overlooking large washes or the margins of lakes. These are areas where a variety of plant and animal resources were located and where water was at least seasonally available. Pendleton (1984) made a strong case, based on an ethnographic analogy with the Colorado River Yumans, that San Dieguito occupation in the eastern Colorado Desert would have been focused on the river floodplain. She tested her model with the large array of data from the Picacho Basin and argued desert areas away from the river were used only to a limited degree, to take advantage of special resources within the foraging radius of logistically organized collecting groups.

Archaic Period (Pinto and Amargosa Patterns) (6,000 B.C.-A.D. 500)

The Pinto and Amargosa patterns are considered regional specializations within the widespread hunting-gathering adaptations that characterized the Archaic period (Campbell and Campbell 1935). Pinto and Amargosa sites occur more frequently in the Great Basin, Mojave Desert, and Sonoran Desert east of the Colorado River than in the Colorado Desert, where few Pinto or Amargosa (i.e., Elko series) projectile points have been identified on the desert pavements. It has been suggested that the California deserts were inhospitable during the Archaic period due to hotter climatic conditions, particularly during the so-called Altithermal phase between 5,000 and 2,000 B.C., and that the mobile hunter-gatherers were forced to concentrate around limited locations or move to more habitable regions (Crabtree 1981; Schaefer 1994c; Weide 1974).

Some late Archaic sites have been identified along the boundary between the low desert and the Peninsular Ranges and at favored habitats at springs and tanks. The most substantial site from this period documented in the Colorado Desert is Indian Hill Rockshelter in Anza-Borrego Desert State Park where 1.5 meters (m) of Archaic period cultural deposits were excavated below a late prehistoric component (McDonald 1992). Most significant were 11 rock-lined cache pits and numerous hearths, indicative of either a residential base or a temporary camp in which food storage was integral to the settlement-subsistence strategy. Also recovered were numerous Elko Eared dart points, flaked stone and milling tools, and three inhumations, one of which was radiocarbon dated to 4,070 ±100 years before present (B.P.) Two similar rock-lined pits were excavated at a small rockshelter in Tahquitz Canyon near Palm Springs (Bean et al. 1995). The small quantity of artifacts at the latter site suggested strategically stored food and seed processing equipment that was used by small mobile groups. More recently, a late Archaic period campsite was also identified in 8-m-deep dune deposits adjacent to the north shoreline of Lake Cahuilla (Love 1996). Other Archaic sites have been recently discovered in interlacustral deposits on the bed of Lake Cahuilla in the northern Coachella Valley and also the first substantial habitation site from this period has been found near Desert Hot Springs (Schaefer and Laylander 2007). Radiocarbon dates of almost 3,000 B.P. and associated bird and fish bone confirm a late Archaic period Lake Cahuilla occupational horizon. Additional Archaic sites fairly certainly are still to be discovered, buried under alluvial fans and wash deposits, sand dunes, Lake Cahuilla sediments, or Colorado River valley alluvium.

Late Prehistoric Period (Patayan Pattern) (A.D. 500-1900)

Major innovations during this period included the introduction of pottery making by the paddle-and-anvil technique and bow-and-arrow technology, perhaps around A.D. 800, and the introduction of floodplain agriculture at about the same time (Rogers 1945). Exact dating of early domesticates is lacking (Schroeder 1979). Agriculture and ceramics were probably introduced either from northwestern Mexico or from the Hohokam culture on the Gila River (McGuire and Schiffer 1982; Rogers 1945; Schroeder 1975, 1979).

Between A.D. 1,000 and 1700, desert peoples of this region appear to have extended their focus somewhat away from the Colorado River floodplains to a more mobile, diversified resource procurement pattern, with increased travel between the river and Lake Cahuilla to the west (Pendleton 1984). Long-range travel to special resource collecting zones and ceremonial locales, trading expeditions, and possibly warfare are reflected by the numerous trail systems seen throughout the Colorado Desert. Pot drops, trailside shrines, and other evidence of transitory activities are often associated with these trails (McCarthy 1982, 1993). The present study corridor roughly parallels an important travel route between the Colorado River and the Coachella Valley.

Several local varieties of pottery appeared during the Late Prehistoric period (Waters 1982a, 1982b). Many of the pictographs, petroglyphs, and bedrock grinding features in the Colorado Desert have also been associated with the Patayan pattern, although it is difficult to date such features directly or to determine their cultural affiliations. During this period, and possibly also in the preceding Archaic period, specific volcanic and sandstone rock outcrops along the Colorado and Gila rivers were exploited for the manufacture of stone pestles and portable milling slabs (Schneider 1993, 1994). With the completion of the final recession of Lake Cahuilla around A.D. 1700, the Patayan III phase emerged, apparently including a return to reliance on the Colorado River floodplain as well as some floodplain agriculture along the New and Alamo rivers in Imperial Valley, where mixed horticultural/hunter-gatherer economies were practiced.

Historic Period (Native American Ethnohistoric and Euro-American Patterns) (post A.D. 1540)

Colorado River People

The Halchidhoma were a Yuman-speaking group who lived along the Palo Verde Valley of the lower Colorado River Valley in the vicinity of modern Parker and Blythe. Although somewhat distant from the project area, they are likely to have traveled between their homeland and the Coachella Valley via the Chuckwalla Valley. In the early seventeenth century, they were living on the lower Colorado River below its junction with the Gila River, but in the eighteenth century they were reported in the area around Blythe. During the early nineteenth century, conflicts with their River Yuman neighbors, the Quechan and the Mohave, forced the Halchidhoma to move east to the middle Gila River, where they merged socially and culturally with the Maricopa. Because of these historical circumstances, traditional Halchidhoma culture is less well known than that of other River Yuman groups (Harwell and Kelly 1983; Spier 1933). However, studies of the other groups shed light on Halchidhoma lifeways (Bee 1981, 1983, 1989; Castetter and Bell 1951; Forbes 1965; Forde 1931; Knack 1981; Kroeber 1925; Pendleton 1984; Stewart 1983; Woods 1982).

The first historic accounts of the native inhabitants of the lower Colorado River were made by Spanish explorers. The first professional anthropological account was by Alfred L. Kroeber (1920, 1925), who conducted extensive fieldwork, particularly among the Mohave in the Needles area, between 1900 and 1910. Because the River Yumans were generally so successful in keeping Spanish missionaries out of their territory, through use of force, and because of their relative spatial and cultural isolation from Euro-Americans for a long period, the Colorado River Yumans maintained their languages, religion, and cultural practices to a much greater degree than most coastal California groups. Early ethnographers during the period between 1900 and 1950 were able to record a rich oral literature and reconstruct pre-contact lifeways to a considerable degree. However, many aspects of traditional technology, such as ceramics and the production of flaked and ground stone tools, had been lost due to the rapid adoption of Western material culture. A Yuman emphasis on spiritual concerns over material things and a preoccupation with warfare meant that a rich oral tradition of myths, epic stories, and battle narratives was still extant at the beginning of this century and continues down to the present.

The lower Colorado River area was characterized by shifting tribal territory and tribal boundaries throughout early historic times due to intensive inter-tribal warfare (Forbes 1965). When Hernando Alarcón sailed up the lower Colorado River in 1540, he described a condition of incessant warfare. During Juan de Oñate's 1605 expedition, he found the Halchidhoma living south of the Gila River confluence. In the area that included Palo Verde Valley, south of the ethnographically familiar Mohave, Oñate encountered a group labeled the Bahacecha, whose identification with any subsequently known ethnographic group is uncertain (Laylander 2004).

Almost a century passed until the Jesuit missionary Eusebio Francisco Kino's 1700 and 1701 visits to the juncture of the Gila and Colorado rivers. The Yuma crossing area was again visited by the 1774 and 1775-1776 Anza expeditions that brought settlers from Sonora to California. The Franciscan missionary Francisco Garcés left the second expedition at Yuma and explored the Colorado River as far north and east as the Hopi mesas. Garcés wrote one of the first detailed descriptions of the Halchidhoma, who at that period were found to have moved north between the Quechan and Mohave territories, from the Palo Verde Valley to the area just below Parker.

Spanish-Quechan interactions increased for a few years after the Anza expeditions, until two settlements with attached missions were established in 1780 near the confluence of the Colorado and Gila rivers. These efforts at Spanish colonization were motivated by the strategic important of the Colorado River crossing. However, conflicts between the settlers and the Quechan soon led to an uprising and massacre of the Euro-Americans in 1781. Contacts between the River Yumans and outsiders were few and often hostile throughout the ensuing half-century.

It appears from historical accounts and Yuman oral histories that the Halchidhoma were in an almost constant state of war with the Quechan and Mohave. The Halchidhoma, in turn, established alliances with the Cocopa and Maricopa, among others, in their efforts to maintain their territory. Eventually the Halchidhoma could no longer withstand the two-front attacks from the north and south. They gradually moved off the river to join kindred River Yuman groups in Maricopa territory on the middle Gila River after a temporary stay in northern Sonora. By around 1825-1830, most Halchidhoma had left the Colorado River, and the last families left by 1840.

There is no complete description of the lifeways of the Halchidhoma as they were lived on the Colorado River, because the Halchidhoma had begun to be assimilated into the Maricopa more than a half century before scientific ethnographies began to be written. Today the Halchidhoma are most closely associated with the Laveen community on the Salt River Reservation in Arizona, although descendants are distributed over several reservations (Harwell and Kelly 1983:74). Leslie Spier (1933) was fortunate to have a Halchidhoma elder as the principal informant for his landmark study of Gila River Yumans. By this time, many elements of Piman and Maricopa culture had been adopted, but some valuable information could still be derived concerning oral traditions. It is reasonable to assume Halchidhoma lifeways were very similar to those the Quechan and Mohave when they occupied the Colorado River. In principle, the following description of Yuman society would apply to all of the River Yumans.

The focus on riverine subsistence resources encouraged a mixed foraging way of life for the River Yumans. Foods procured by seasonal rounds of hunting, fishing, and gathering supplemented small-scale agricultural practices. According to Robert L. Bee (1983), the Mohave relied more heavily on agriculture than did the Cocopa in the Colorado River's delta or the Quechan. In their study of Yuman agricultural strategies, Edward F. Castetter and William H. Bell (1951) estimated that about half of the Mohave diet derived from farming. They estimated that the Cocopa, by contrast, derived only about 30 percent of their diet from agriculture because of greater access to a diversity of habitats; the Quechan (and presumably also the Halchidhoma) diet was intermediate between the Mohave and the Cocopa (Bee 1983).

Agricultural strategies were designed to optimize use of floodwaters bringing the necessary moisture to the fields, which tended to be quite small in size (2-3 acres). Aboriginal cultivated crops included maize, beans, squash, melon, and various semi-wild grasses. Seeds were planted in newly deposited sediments after the floodwaters had receded. The River Yumans also used more than 75 wild plant foods as food sources, the most important being mesquite and screwbean. The primary source of dietary animal protein came from fish caught in the Colorado River. Among the more important species were the humpbacked sucker and Colorado pike minnow. Regularly hunted game included small mammals such as rabbits, squirrels, and pack rats. Larger game that figured in the diet included deer and bighorn sheep, but these were probably hunted with less frequency and were less abundant than small game. However, their meat was highly regarded by the River Yumans, particularly in winter, when reliable sources of dietary fat were in especially short supply.

Swarthout and Drover's (1981) Model II characterizes the Quechan and Halchidhoma settlement and subsistence strategy on the Colorado River below Topoc. This model presumes a low reliance on cultigens, accounting for no more than 30 to 40 percent of the annual dietary intake (Castetter and Bell 1951:74). Residential bases were centered on the Colorado River but conformed to a bipolar pattern. Spring and summer houses were located near each agricultural field, but up on the mesas, where they would be safe from floods (Kelly n.d.:55), while open-air ramadas were constructed on the floodplains adjacent to the fields. During this time, small parties sought out wild vegetal resources along the floodplain and adjacent washes. Mesquite and screwbean were important staples that were relied upon as stored staples during the winter months, especially if domestic crop harvests were inadequate. The winter season was a time to relocate to residential bases on upper Colorado River terraces, lower bajadas, and lower mountain slopes. Winter homes were more substantial earth-covered lodges (Kelly n.d.:55). The population subsisted on stored domestic and wild foods, in addition to what wild game could be had. Additional temporary camps would be established in outlying areas for extracting specific animal, vegetal, or lithic resources. As soon as the spring floods subsided, the population would then resume their lower terrace residences.

Yuman groups were organized into patrilineal, exogamous, totemic clans (referred to as sibs in the early literature). Each clan or *cimul* was named after a plant, animal, or natural object, and this name was borne only by female members (Gifford 1918). There were no clan leaders, and the clan did not have special ceremonial or sociopolitical functions. Clans were not localized at specific rancherias; the latter contained members of several clans. Each localized rancheria or band recognized a leader (*pi'pa taxa'n*) who was called on to settle disputes, be responsible for the social and economic welfare of his people, decide on seasonal moves, and determine when to move the entire rancheria if necessary. His power was quite restricted, and he had limited influence. His position was achieved through dreaming, force of character, and demonstrated ability. Each tribal group also recognized a paramount chief (*kwoxot*) who might rise from the ranks of the rancheria leaders. This position may have become more important during the historic period as a result of contacts with Euro-American political and military institutions. A chief was not required to show prowess in warfare, and indeed he was expected to remain in the village or refrain from battle. Special war leaders (*kwanami*) were recognized for military tasks.

Unlike other southern California groups where the primary political allegiance and identity lay with the localized band, members of the River Yuman groups thought of themselves as belonging to a true nation. Julian H. Steward (1955:159-161) postulated that Yuman clans evolved from localized patrilineages like those found among the Cahuilla, but which had become dislocated and clustered into larger settlements as a result of the higher population densities afforded by horticulture. Growing population size in other areas of southern California brought about increasingly sedentary bands, but instead of band size growing there was shrinking of band territories. This pattern did not occur on the Colorado River, where people moved freely from one settlement to another. Entire settlements had to shift within the confines of the floodplain, depending on the location of arable land after each flood season. Steward identified warfare as another factor inhibiting the localization of clans and promoting increases in band size. Larger social groups afforded greater protection against enemy attacks.

The apparent emphasis on warfare in Colorado River Yuman culture has been the subject of considerable anthropological discussion. Chris White (1974) emphasized the ecological reasons for warfare, including environmental circumscription, high population density, and environmental instability. Edward W. Gifford (1931:161), Clifton B. Kroeber (1980), and Kroeber and Bernard L. Fontana (1986) stressed the deeply ingrained ideological and cultural values that were attached to personal battle in River Yuman culture. They argue that fighting was seen by its participants as a necessary means to enhance the spiritual power of the entire tribe, without regard to any material benefits. Probably both factors operated to shape the Yuman warrior tradition over time. Both ecological and cultural/ideological factors are intertwined in a complex and dynamic system, much as Roy A. Rappaport (1968) demonstrated for the role of warfare among New Guinea tribes people.

It is difficult to portray the complex and esoteric nature of River Yuman spirituality because it is a dynamic belief system in which dreaming, adherence to traditional learning, personal experiences, and varying patterns of acculturation affect its expression. This worldview stresses the interconnection of daily life with religion, in contrast to Western culture, in which the sacred and secular are more clearly segregated. The secular world exists concurrently with the spiritual world for traditional River Yumans, and the spiritual world can be experienced through dreams, vision quests, song cycles, the telling of the creation narrative, and many other oral traditions (Hinton and Watahomigie 1984; Kroeber 1925, 1948).

The Desert Cahuilla: An Interior Southern California People

Good ethnographic studies of the Cahuilla who lives to the west of the project area are comparatively numerous (e.g., Barrows 1900; Bean 1972; Bean and Saubel 1972; Curtis 1926; Drucker 1937; Heizer 1974; Hooper 1920; Kroeber 1908; Patencio 1943; Strong 1929). Lowell John Bean (1978) summarized much of the information on the Cahuilla. While the principal residential loci of the Cahuilla were in the Coachella Valley and the Santa Rosa and San Jacinto Mountains, they were known to have traveled and maintained cultural contact with lower Colorado River peoples. The Chuckwalla Valley would have been one of their principal travel corridors for this purpose.

Cahuilla and related Takic (“Shoshonean”) speakers of the Uto-Aztecan linguistic stock, such as the Luiseño, Serrano, and Gabrielino, may have migrated south from the southern Great Basin into coastal southern California and the Colorado Desert. However, the specific period or periods, directions, and circumstances of this migration remain unclear (e.g., Golla 2007; Koerper 1979; Laylander 2007; Moratto 1984:165). Some estimates based on glottochronology (the statistical and lexical comparison of languages or dialects to determine how long ago they diverged from a common source) and the distribution of archaeological assemblages would put the movement somewhere between A.D. 1 and 1,000, most likely around A.D. 500 but possibly as early as 500 B.C. What role these Takic speakers had in the development of the Patayan pattern in the Colorado Desert remains unclear. The ancestors of the River Yumans are most often identified as the source of ceramics, cremation practices, agriculture, some architectural forms, and some stylistic and symbolic representations. The Takic migrations may have coincided with the introduction of bow-and-arrow technology, but no direct association has been established. They may have contributed specific hunting and gathering techniques as well as cosmological and symbolic elements to the Patayan cultural system.

A dozen or more politically autonomous landholding clans owned territories within the region. Ideally, each of these territories extended from the desert or valley floor to mountain areas, encompassing several biotic zones. Clans were composed of one or more lineages, each of which owned an independent community area within the larger clan area. Cahuilla oral histories indicate that some clans replaced others, often by force, and also that new lineages would bud off from clans to establish new territories. Cahuilla mythology and oral tradition indicate that when Lake Cahuilla dried up, it was the mountain people who resettled the desert floor. By 1850, at least 17 rancherias are known in the Coachella Valley, most of them associated with hand-dug wells, springs, or palm oases. Reservoirs, irrigation ditches, and agricultural fields are documented at least as far back as the early nineteenth century (Wilke and Lawton 1975:21, 30ff).

In addition to each lineage's residential area and other locations within a clan territory that it owned in common with other lineages, ownership rights to various food-collecting, hunting, and other areas were claimed by the various lineages. Individuals owned specific areas or resources, such as plant foods, hunting areas, mineral collecting places, and sacred spots used only by shamans, healers, and ritual practitioners.

While villages were occupied year-round, a large number of their inhabitants would leave at specific times to exploit seasonally ripening foods in different environmental zones. Temporary camps would be established in these food-collecting areas, and surpluses would be transported back to the main village. Mountain Cahuilla would move to the upper desert areas and establish temporary camps to process agave in late winter and early spring, and then move to lower desert areas to harvest mesquite beans in the late spring. Conversely, the Desert Cahuilla ascended the mountains in the fall for the pinyon and acorn harvests. Other springtime resources included yucca, wild onion, barrel cactus and other cactus fruits, goosefoot, and grass seeds. Other major upper-desert resources collected in summer included berries, manzanita, and wild plum. Fall was the season to gather grass seeds, chia, saltbush seeds, palm tree fruit, thimbleberry, wild raspberry, juniper berry, and choke berry. Many animal resources were hunted; bighorn sheep and deer hunts often coincided with the pinyon harvest. Rabbits were the most common game throughout the year.

Bean and Katherine Saubel (1972:20) estimated that no village was located more than 26 kilometers (km) from all of the food-gathering areas within its territory and that 80 percent of all food resources could be found within an 8-km foraging radius around the village. Such ideal proximity to diverse habitats was made possible by the steep topographic gradient on the eastern side of the San Jacinto and Santa Rosa mountains.

Cahuilla clans varied in population size from 100 to several thousand people. They were arranged so that each community was placed in an area near significant water and food resources. Communities were generally several kilometers from their neighbors, and within a community, houses and structures were placed at some distance from each other. Often a community would spread across 2-3 km. Each nuclear and extended family had houses and associated structures for food storage and shaded work places for processing foods and manufacturing tools. Each community contained the house of the lineage or clan leader: the *net*. This position was often hereditary within families of high social status. The *paxa* was another hereditary leader with responsibilities for managing ritual events. Other important ceremonial positions included the shaman (*púul*), singer (*háwaynik*), and diviner (*tet♣ayawiš*). There were a number of non-official ritual practitioners.

Within each community was a ceremonial house (*kiš♣ámnawet*) where most major religious ceremonies of the clan were held. These took place with considerable frequency. The most significant ceremonies focused upon the proper care of the deceased members of the linage or clan. In addition to house and ceremonial structures, there were storage granaries, sweathouses, and song houses (for recreational music). Close to each community were many food resources, building materials, minerals, and medicines. Usually an area within 1-5 km contained the bulk of materials needed for daily subsistence, although the territory of a given clan might be larger, and longer distances were traveled to get precious or necessary resources that were located at higher elevations. While most daily secular and religious activities took place within the community, there were places at some distance from the community, such as acorn and pinyon groves, where people stayed for extended periods. Throughout the area there were sacred places used primarily for rituals, inter-clan meetings, caching sacred materials, and shamans' activities. Cave sites or walled cave sites were used for temporary camping, storing of foods, fasting by shamans, and use as hunting blinds.

The Desert Cahuilla began to become familiar with Europeans as early as 1797. Often their relatives in western Cahuilla areas were baptized and worked among the Spanish. In addition, runaway neophytes sought refuge among the desert tribes. The impact of the Spanish mission system and colonization along the coast was much less immediate and profound among the isolated desert and mountain groups. More direct influence was not felt until after the establishment of the San Bernardino *estancia* in 1819 and of a cattle ranch at San Gorgonio subsequently. When the Romero Expedition passed though the area in 1823-1824, it was clear that the Cahuilla were accustomed to seeing vaqueros employed by the rancho driving cattle through the area. Certainly by 1823 the Cahuilla were not only familiar with Hispanic ways but were comfortable in dealing with them, as evidenced by their reaction to the members of the Romero Expedition (Bean and Mason 1962). The expedition reported that the Cahuilla at Toro were engaged in agricultural pursuits, growing corn and melons, and were already familiar with the use of horses and cattle.

Political leadership became more centralized during the Spanish and Mexican periods, as Europeans recognized high-ranking or charismatic clan leaders as representing entire tribal areas (Strong 1929:149). Emerging as central figures were Juan Antonio among the Mountain Cahuilla and Chief Cabazon in the desert. As early as 1844, Juan Antonio led several mountain clans to the San Gorgonio pass area to provide security for Rancho San Bernardino. His group played a significant role during the Mexican-American War, siding with the Mexicans against the Luiseño who supported the American invaders (Phillips 1975).

The 1848 Treaty of Guadalupe Hidalgo obligated the Americans to preserve the liberty and property of the prior inhabitants of California. The U.S. government in 1850 appointed three commissioners to conduct negotiations with tribal leaders across California in order to settle all land rights issues. One of the 18 treaties to be drafted covered the Cahuilla, Serrano, and Luiseño and was signed in Temecula on January 5, 1852. The tribal leaders were promised supplies, food, and technical training in return for accepting specified reservation lands. But as was so often repeated throughout the American West, local Euro-Americans lobbied against the treaty and the U.S. Senate never ratified it. The traditional territorial base of the Cahuilla continued to shrink as whites flooded into the area to claim the best farming and grazing lands.

European diseases were probably beginning to take their toll on the Cahuilla in the early 1800s, but they became particularly severe in the 1860s. The most dramatic episode was the great smallpox epidemic of 1863 that killed Juan Antonio as well as many bearers of traditional tribal culture. Survivors of previously autonomous clans clustered into the remaining villages or founded new settlements in an accelerated process of population aggregation and reorganization. This process continued through the following decades.

The Cahuilla land base was substantially reduced in the 1860s and 1870s as the U.S. government ceded alternate sections within 10 mi. of the new transcontinental railroad route to the railroad companies. Sections 16 and 36 of every township were also removed from federal control as a school tax base. Any de facto Native American control of larger territorial bases was undermined in 1876 when President Ulysses S. Grant issued an Executive Order setting aside small reservations for all groups classified as “Mission Indians.” These reservations included the sections or parcels in which the Cahuilla had aggregated during the previous decades and in which they had made improvements for farming. The following year, another Executive Order by President Rutherford Hayes set aside even-numbered sections and certain other unsurveyed portions of townships for Indian reservations. The result was a checkerboard pattern of Indian-controlled land, encompassing 48 sections, spread across the eastern edge of the Santa Rosa and San Jacinto mountains and the Coachella Valley (Cultural Systems Research 1983). With various additions and withdrawals over time, this has remained the permanent land base of the Cahuilla to the present.

As traditional lifeways became more difficult to maintain, the Cahuilla adapted to their new geographical and political environment by taking jobs at American ranches, towns, and cities. The 1860s through 1880s was a period of increased acculturation, as new technologies, material goods, and practices were incorporated into the traditional lifeways of the reservation. Ceremonial practices remained particularly strong despite Catholic and Protestant influences on the reservations. Ceremonial houses still existed through the 1950s, 1960s, and early 1970s, and many cultural traditions still remain part of westernized lifestyles. Many Cahuilla retain an acute interest in the cultural heritage and cultural resources of their traditional territories.

The Chemehuevi: A Great Basin People

In late prehistoric times, the Chemehuevi occupied desert areas west of the Mohave and north of the Cahuilla. Subsequently, during the early historic period, they took over the portion of the lower Colorado River valley that had previously been held by the Bahacecha and the Halchidhoma. Chemehuevi speech is a dialect of the Southern Paiute or Ute language, belonging to the Numic branch of Uto-Aztecan family. Although the time of Chemehuevi entry into eastern California remains unclear, it was probably in the period between A.D. 1200 and 1500, when brown ware pottery and twined basketry became conspicuous in archaeological sites (Kelly and Fowler 1986).

The Chemehuevi lived in smaller and more mobile groups than the Cahuilla or the Yumans, in order to adapt to the sparser and more widely distributed resources of their desert. They subsisted primarily on small game and a wide variety of seasonally available wild plants. Seed plants were especially important.

The Chemehuevi were allied with the Mohave and Quechan, and they were allowed plots of land to cultivate crops in Mohave territory. One of Isabel Kelly's consultants related that most Chemehuevi did not begin to move down to the Colorado River until after 1833 and before the founding of Fort Mojave in 1859 (Kelly n.d.:28). This would also have been the period when the Halchidhoma left the river. As a result of their close association, the Chemehuevi share some elements of material culture with the Mohave, such as ceramic styles, square metates, some earth-covered house forms, storage platforms, song series, dream emphasis, warfare patterns, and personal adornment. Other aspects of Chemehuevi culture are distinctively Great Basin, such as their extremely fine basketry. The Chemehuevi have distinguished themselves from their Yuman neighbors by their very different mythology, worldview, religious practices, kinship system, and political organization (Laird 1976, 1984).

Like the Yumans, the Chemehuevi were great travelers and regularly visited the Kawaiisu, Serrano, Vanyume, Cahuilla, Quechan, and Kumeyaay. They may even have visited the western California coast to trade. They occasionally joined the Quechan and Mohave in battles against the Halchidhoma. When the Halchidhoma finally left the river by 1840, the Chemehuevi made use of some of the vacated river valley, particular the Parker and Chemehuevi valleys. However, hostilities broke out between the Chemehuevi and Mohave between 1865 and 1871 when the Mohave began moving south to inhabit the newly created Colorado River Reservation. The Chemehuevi retreated westward into the desert, where they took refuge with the Cahuilla near Banning and in the Coachella Valley, and with the Serrano at Twentynine Palms. Additional land was added to the Colorado River Reservation in 1874 in order to encourage the Chemehuevi to move there from areas near Blythe, Needles, Beaver Lake, and Chemehuevi Valley. Both peaceful and forceful efforts by the U.S. government to move the Chemehuevi onto the reservation were met with mixed results, and it was not until the early 1900s that the Chemehuevi agreed to move.

The Euro-Americans and Other Newcomers

The following brief discussion focuses on several historic-period themes for which cultural resources are most likely to be represented in the project area: features relating to mining, transportation, and World War II military training.

Mining

The first mining efforts in the general region may have taken place in the Cargo Muchacho Mountains (hard rock mining) and Potholes (placer mining) areas in 1780-1781 near Yuma, contemporary with the short-lived Franciscan missionary efforts at the confluence of the Gila and Colorado rivers. Extensive mineral exploration began in the early 1860s, when the Mother Lode gold mines in the Sierra Nevada were becoming played out and miners looked for new discoveries in other parts of the American West. One of the first and largest mining booms occurred in the La Paz and Castle Dome districts on the Arizona side of the Colorado River opposite Blythe. Miners from California and Sonora poured into the area in the early 1860s and 1870s. The Bradshaw Road (Trail) was established as a stagecoach and supply haul route from 1862 to 1877 providing a major transportation link between Los Angeles and the ferry to Ehrenberg, Arizona (Johnston 1987). It ran from San Bernardino through the San Gorgonio Pass, down the Coachella Valley to Dos Palmas, through Salt Creek Pass between the Orocopia and Chocolate mountains, then along the Chuckwalla Mountains and through the Little Mule Mountains to the Colorado River. It is generally accepted that this route follows the Native American Cocomaricopa Trail, although McCarthy (1982) identifies the major east-west trail through Chuckwalla Valley, CA-RIV-79, as the Cocomaricopa Trail. The greatest period of activity was between the 1870s through 1890s and was facilitated by the Southern Pacific Railroad, which reached Yuma in 1877, and by links on the river provided by commercial riverboat traffic (Vredenburgh et al. 1981:8). This improved means of access to the Colorado River and the initiation of a tri-weekly stage between Yuma and Ehrenberg in 1880 finally put the Bradshaw Road out of business.

Early prospects are known from Mule Mountains in 1861 and in the Big Maria Mountains and neighboring McCoy Mountains as early as 1862 when they were part of the Ironwood Mining District (Vredenburgh et al. 1981:24, 40; Warren et al. 1981:97). The Big Maria Mountains, originally called the Half-Way Mountains by the 1858 Ives expedition, were referred to as the Chemehuevi Mountains on maps from the 1860s (Gunther 1984:310-311). It was probably during this period that portions of the Big Marias, the McCoy Mountains (named after prospector William McCoy), and the Palen Mountains (named after prospector Matt Palen) were included in the Chemehuevi Mining District (Vredenburgh et al. 1981:40; Warren et al. 1981:105). By 1909, the so-called Chemehuevi Mountains were christened the Santa Marias and divided into the Big Maria (east) and Little Maria (west) ranges. Mineral deposits include gold, silver, fluorite, manganese, copper, gypsum, and uranium (Warren et al. 1981:96).

Eagle Mountain, at the northern and western end of the present project area, was the focus of prospecting by Joe Torres as early as late 1870s and early 1880s. He identified a magnetite deposit but made no claim as he was after previous metals. That distinction came to Jack Moore who in 1881-1882 staked a claim and with his father and two other partners founded the Eagle Mountain Mining District for the exploitation of iron, gold, and silver. The Iron Chief, Black Eagle, and other claims were among those with gold but also rich iron content. They failed to maintain the necessary assessment work to validate the claim, however, and the area was abandoned for mineral development until 1895. That year L. S. Barnes of Mecca, a former student of the Colorado School of Mines, began to consolidate the claims after examining Joe Torres' original iron ore samples. Barnes completed his consolidation by 1912 and sold the package to Henry E. Harriman, CEO of the Southern Pacific Railroad (SPRR). Harriman's goal was to challenge J. P. Morgan's U.S. Steel Trust by threatening a viable West Coast industry, thereby lowering the price of steel he had to pay for his own railroad. Harriman bought a steel mill in San Pedro, California and surveyed a rail spur. Possibly a bluff, he succeeded in lowering the price of steel for the SPRR but died before it could be determined if he meant to carry through with his scheme (Belden 1964a; Hilton 1949; Love 1994).

World War II saw an enormous demand for steel, but during this time the Joshua Tree National Monument was formed, including the Eagle Mountain claims, thus protecting the ore bodies from mining. Henry J. Kaiser then took interest in the Eagle Mountain claims. From road contracting, Kaiser distinguished himself as a member of the team who built Boulder and Bonneville dams. He owned a steel mill at Fontana and the Vulcan iron mine near Kelso in the Mojave Desert that supplied materials for his west coast shipyards. Requiring more steel, he managed to purchase the Eagle Mountain claims from the Harriman heirs with the proviso that the SPRR be used to ship the ore. Having won a legal challenge to the claims, Kaiser succeeded in having the Joshua Tree Monument boundaries shifted to exclude the Eagle Mountain properties. He then commenced work in 1944 to survey a new railroad route with a necessary limited grade of only 2 degrees between Eagle Mountain and the SPRR. Three routes were surveyed; the one chosen went south through Salt Creek to emerge between the Orocopia and Chocolate mountains at Durmid in the Coachella Valley where the line connected with the SPRR at Ferrum Junction, then continued west to the Fontana steel mill (Backman 1949; Belden 1964b). Construction on the railroad began in 1947 and was completed on June 23, 1948, as the Kaiser Industrial Railroad. Ore shipment from the mine began immediately and by 1971 the Eagle Mountain Iron Mine was producing 90 percent of California's total iron output (USDI Bureau of Mines 1971). Over 4,000 people were employed in the operation, making the Eagle Mountain Mine Riverside County's largest employer. The company town of Eagle Mountain included schools, fire and police departments, civic facilities, 416 rental houses, 185 trailers, 383 dormitory rooms, and 32 apartments (Bull et al. 1991). Kaiser Steel's need to provide medical care for their employees evolved into what we now know as Kaiser Permanente. Competition from abroad and other economic factors caused the mine to close in 1983 after 35 years in operation. Much of the housing stock was either removed, left vacant, or vandalized. By 1994, a school, a new low security prison (1988-2001), and some rental properties remained at Eagle Mountain but it is largely relegated to a ghost town today (Love 1994).

Transportation

A portion of the project area closely parallels Interstate 10, a major transportation artery connecting the Los Angeles area with Arizona and points east. The route was probably also used prehistorically as it represented a relatively low (but dry) corridor for travel between the lower Colorado River in Palo Verde Valley and the Coachella Valley. During the early twentieth century, as the region's highway system was gradually developed, the route was known under a succession of different designations, including Legislative Route 64 and U.S. Route 60. As late as 1926, the portion of the route through Chuckwalla Valley was unimproved. Interstate 10 was finally completed by 1968.

Water

The Colorado River Aqueduct runs through the study area, with the Eagle Mountain Pumping Station located at the far eastern tip of the Eagle Mountains. The proposed 500 kV transmission line and water line cross underground portions of the aqueduct along Phoneline Road, 3.1 and 6.2 mi., respectively, north of the pumping station. The aqueduct was constructed between 1931 and 1941 by the Metropolitan Water District (MWD) as one of the major Colorado River water delivery public works projects that included the construction of Boulder Dam and the All-American Canal. The first water deliveries began on January 7, 1939. The original engineering was conducted under a $2 million bond issued from the Department of Water and Power, with construction undertaken by MWD for $220 million. Originally conceived by William Mulholland and designed by MWD Chief Engineer, Frank E. Weymouth, it was intended to provide Los Angeles with more drinking water, but since the end of World War II, the distribution system has been extended to serve much of southern California's domestic, agricultural, and industrial needs from Ventura to San Diego. The intake pumps are located at Lake Havasu above Parker Dam on the Colorado River. From here, the aqueduct travels 242 mi. across the Colorado Desert through 63 mi. of open canals, 92 mi. of tunnels, and 84 mi. of buried conduit and siphons. The aqueduct terminates at Lake Mathews near Corona. Five pumping stations take the water over mountainous terrain. With a capacity of 1,600 cubic feet per second, the average annual throughput is estimated at 1.2 million acre-feet per year (Bean 1968:398-401; Cooper 1968:87-89; Metropolitan Water District of Southern California 1941).

As the largest public works project during the Great Depression, the project employed 10,000 people at any one time and when completed, was recognized as a pivotal component of Los Angeles' enormous growth during World War II and in the following decades. It remains a linchpin in southern California's vital infrastructure. In 1955 and 1994, the American Society of Civil Engineers (ASCE) recognized the Colorado River Aqueduct as one of the "Seven Engineering Wonders of American Engineering" (ASCE Website).

Homesteading and the Town of Desert Center

The town of Desert Center was founded in 1925 by Stephen ("Desert Steve") Ragsdale and his wife. They originally arrived with their four children to the area in 1921 when they bought the homestead of Wilbur C. and Peter S. Gruendike, who in 1913 and 1916, respectively, each received a patent to 160 acres along the Chuckwalla Road between Mecca and Blythe (Gunther 1984:150, 212). Peter Gruendike dug a well and installed a windmill on his parcel, some 200 ft. north of the road and their ranch house. The ruins are today listed as site CA-RIV-187. The Ragsdales operated a service station there from 1921-1925 when the State of California moved the Mecca-Blythe Road 1.25 miles south and named it U.S. Route 60. In response, the Ragsdales moved all their buildings about five miles to the southwest along the new highway and founded Desert Center, being 50 miles either way between Blythe and Indio. Ragsdale patented 40 acres at this location in 1927, which eventually grew to 700 acres on either side of the highway. He is said to have accomplished this by having his employees at the restaurant and store file for Desert Entry Lands while they lived and worked at Desert Center and then sell their parcels to Ragsdale. An ordained Methodist Minister, “Desert Steve” ran a dry privately-owed town, representing the law as a Deputy Sheriff. He even managed to organize a school district specifically for the education of his four boys. In addition to the Ragsdale home and those of his employees, the original town included a poured concrete café in the Southwestern adobe style, an attached gas station and mechanics shop, a market, post office, and school. The Ragsdale operation grew to include facilities at Shaver’s Summit (later Chiriaco Summit), Box Canyon, Skyway, Hell, and Cactus City.

“Desert Steve” left Desert Center for Santa Rosa Mountain in 1950 after being accused of an affair with an office worker, leaving the business to his sons, Stanley, Thurman, and Herbert. Stephen died in 1971. Stanley eventually purchased the entire town and ran the café and gas station for decades. He died in 1999. The town remains as a waypoint on Interstate 10.

Desert Training Center/California-Arizona Maneuver Area (DTC/C-AMA)

The deserts of southern California and western Arizona became the focus of important training exercises during World War II. This activity left abundant physical traces on the landscape.

The Desert Training Center (DTC) was opened on April 30, 1942. The normally serene desert gave way to the rumble of tanks and staccato of machine guns for almost two years, until 1944. The largest military training installation ever to be created (approximately 10,130 mi.^{2}), the facility had General George S. Patton, Jr., as its first commanding officer (Bischoff 2000; Henley 1989; Meller 1946). Patton proclaimed the DTC “probably the largest and best training ground in the United States” (Meller 1946:35). It served the vital purpose of conditioning troops to desert warfare conditions and tactics in preparation for the North African Campaign. The center was also used to field-test equipment and supplies. The original facility extended from the Colorado River on the east to a point slightly west of Desert Center on the west, and from Searchlight, Nevada, on the north, to Yuma, Arizona, on the south. This region was ideally suited for the purpose, in that it contained a variety of terrain types and no large population centers (Howard 1985:273-274).

Patton left with his troops for North Africa later in 1942, but the facility continued to operate throughout the war, processing several million troops. However, following the success in North Africa, an emphasis on desert warfare was no longer necessary. The name of the Desert Training Center was changed to the California-Arizona Maneuver Area (C-AMA or CAMA) on October 20, 1943, and its purpose was expanded to serve as a simulated theater of operations emphasizing large-scale logistics and not exclusively desert warfare tactics. This included solving complex communications and supply problems and Army Air Forces support of ground troops (Howard 1985). The facility provided training for combat troops, service units, and staff under conditions similar to a combat theater of operations. Under Major General Charles H. White, the training area was enlarged by another 6,251 mi.^{2} and extended from Gila Bend on the east to Pomona on the west, and from Yuma on the south to Boulder City on the north (Howard 1985:281-282). Command would change three more times before C-AMA closed.

Headquarters and the first camp for the DTC/C-AMA was at Camp Young, located at a place called Shaver's Summit, now known as Chiriaco Summit after Joseph Chiriaco from whom Patton bought 28 acres for a token sum of five dollars (Bischoff 2000:12-16). It is listed as a California State Historic Landmark (No. 985). This location and others along the Chuckwalla Valley corridor were chosen because of the easy access to supplies via the road to the Coachella Valley and the SPRR, and ample water to be derived from the Colorado River Aqueduct. Although most closely associated with Patton's short residence during the formative months of the DTC, Camp Young is located some 29 km west of Desert Center and the southern end of the study area.

In all, there were 11 major camps, seven of them in California and four in Arizona. Camp Rice, home to the 5th Armored Division, and Rice Army Airfield were one of the smaller bases strategically located on the Atchison, Topeka and Santa Fe Railroad line west of Parker (Lynch et al. 1982). Larger divisional camps that may have deployed troops into the project area include Camp Iron Mountain, Camp Granite, and Camp Coxcomb, located north of Desert Center. A network of railroad lines and major roads connected all the divisional camps and depots. Farther out across the desert landscape were the smaller camps and bivouacs for specific field exercises. For example, a platoon might build rock blinds from which they could practice the defense of a mountain pass (Vredenburgh et al. 1981).

During the DTC period, exercises emphasized operating with a restricted water supply, sustaining operations remote from railheads, navigating and resupplying under the cover of darkness, and combined training with the Army Air Forces (Howard 1985:274). A four-phase training program was developed that would not exceed six weeks in duration. First phase training emphasized the individual, crew, squad, section, and platoon. The second phase concentrated on the company and battery. The third phase consisted of battalion training, and the fourth emphasized the combat team whereby armored units, air, and ground forces were all coordinated. The training program ended with an exercise lasting several days and covering about 300 mi. Advanced supply bases were established along projected routes, tactical maneuvers were conducted in darkness, and tactical bivouacs were established in the presence of hostile air and mechanized threats (Howard 1985:278; Meller 1946:13).

Training during the C-AMA period consisted of a 13-week program. Firing ranges of all types were constructed and troops trained with pistols, machine guns, rifles, and artillery. They also took courses in infantry tactics using live ammunition. Emphasis was placed on development of platoon efficiency. Platoons of 40 to 45 men were sent out on six-day field problems involving directional skills and coordination with supply units. The three final weeks consisted of maneuvers. The first exercise involved a defensive force establishing a position for the purpose of protecting a vital area or installation. The second exercise consisted of field maneuvers that simulated a campaign of approximately 11 days and 10 nights designed to test the endurance of units and their ability to fight and resupply over great distances while providing daily maintenance of equipment and recovery and evacuation of disabled vehicles (Meller 1946:62).

Spartan camp conditions were deliberately maintained to provide soldiers with a realistic, battle-ready experience. Through the history of C-AMA, orders were periodically given to prevent any center from lapsing into more comfortable conditions, although Camp Young appears to have been an exception. No units were allowed to stay too long at any center. The most mobile were supplied with B-rations and C-rations, and no screened eating areas would be provided. The Ground Surgeon was well aware that during the warmer seasons, flies would cause near-epidemics of dysentery. Screened eating areas were therefore advised for service units that had to remain in certain areas, such as base camps, for longer periods. However, orders were subsequently given that no new screened areas were to be built and old ones would not be maintained. Iced fresh food was also prohibited. Lowered morale from the monotony of B-rations, disease outbreaks and even some reported deaths, and public protest eventually led to some relaxation of these severe conditions. Shortly before C-AMA was closed, all units were allowed to enjoy A-rations (Meller 1946:50-55).

The divisional camp closest to the project area was Camp Desert Center, located between Camp Young and Desert Center and extending immediately east of Eagle Mountain Road and north of the old highway that preceded Interstate 10. Very little documentary information is currently known for Camp Desert Center, nor are is its specific history and range of functions clearly understood. The BLM did not include Camp Desert Center in its interpretive plan for the major camps of the DTC/C-AMA, although it includes preservation and interpretive goals for the other major sites (USDI, Bureau of Land Management 1986). The 34,000-acre area included a cantonment with tent housing, an observer’s camp, an ordinance camp, an evacuation hospital, a quartermaster truck site, and an extensive maneuver area. Bischoff (2000:58-60) reports that not much is left of Camp Desert Center except for rock-lined paths, tent pads, oiled road surfaces, and trash scatters with many gas, oil, and food containers. Locals report artifacts extending for a substantial distance north of Desert Center. Bischoff also reports 1940s-era refuse near the Eagle Mountain Mine Industrial Railroad, although that association may indicate they postdate the DTC/C-AMA.

The full extent of the complex, including the hospital, has not been previously recorded. E Clampus Vitus historians have conducted more research on the hospital and have made a more committed identification of the site as such. With the BLM, they are about to unveil a new historical monument at the hospital site with the following text:

36TH EVACUATION HOSPITAL (SM)

During the opening days of World War II, more than 18,000 square miles of the Arizona and California desert were designated by the U.S. Army as a military training facility. The facility, conceived by General George Patton and referred to as the Desert Training Center (DTC), was designed to prepare troops for the rigors of desert warfare in the invasion of North Africa. Operating from 1942–1944, the DTC expanded far beyond its original scope, and became known as the California-Arizona Maneuver Area (C-AMA) in 1943. Numerous camps were established throughout the desert, in addition to airfields, supply depots, hospitals, firing ranges, and maneuver areas. Over the two year life of the Desert Training Center, more than 1.2 million troops were hardened for battle in the deserts of California and Arizona.

Located just to the north are the archaeological remnants of the Evacuation Hospital Camp Site. The 36th Evacuation Hospital was stationed here for training from May to December 1943. Evacuation hospitals were 400 bed facilities that provided care to sick and wounded soldiers under combat conditions. The 36th was located at this site until it participated in IX Corps maneuvers, whereupon it moved by Camp Dunlap, near Niland. During this time it maintained a 100-bed base hospital here while the rest of the unit was deployed elsewhere. At the end of maneuvers, the entire hospital was relocated to this original site. The 36th Evacuation Hospital served in the Pacific Theater of operations where it took part in the New Guinea, Luzon and Leyte campaigns and the occupation of Japan and was stationed in Vietnam from 1966 to 1969.

This monument is dedicated to the men and women who served in this unit

By the Billy Holcomb Chapter of the Ancient Order of E Clampus Vitus

and the Bureau of Land Management.

May 2nd, 2009

3. RESEARCH DESIGN AND METHODS

The present Class I study involved requesting information on previously identified cultural resources and studies on record at the Eastern Information Center (EIC), the regional repository of the State of California Historical Resources Information System, and with the California Native American Heritage Commission (NAHC) in Sacramento. The information is provided as the first step in identifying historic properties eligible for the National Register of Historic Places that may be affected by the proposed project, in compliance with Section 106 of the National Historic Preservation Act.

As noted above, for these investigations two areas have been considered: the provisional “project area proper” plotted by geographic information system (GIS) mapping as a 200-ft.- wide transmission line route, a 60-ft.-wide waterline route, three well locations, and the larger site plan of the proposed reservoirs and related facilities. A broader study corridor extends out 1 mi. around the project area proper.

The records search data have been used to assess:

- the extent of previous studies of cultural resources completed within the project area proper and within the study corridor;
- the number and character of previously recorded cultural resources within the project area proper and within the study corridor;
- the likelihood of additional cultural resources being present in portions of the study corridor that have not yet been systematically inventoried, and the probable character of such unidentified resources; and
- the additional inventories, evaluation studies, and mitigation measures that are likely to be needed to deal with cultural resources as the development of the project advances.

4. PREVIOUS CULTURAL RESOURCES INVESTIGATIONS

A search of cultural resource records at the EIC was performed on March 9, 2009, supplemented by reports available at ASM Affiliates. The search identified 26 previous reports that had addressed portions of the study corridor, of which nine are mapped as including portions of the project area proper. A total of 31 cultural resources had been recorded within the study corridor; of these only two fall at least in part within the preferred project: an underground portion of site P-33-011265, the Colorado River Aqueduct, is crossed by both the transmission line and water line. The transmission line also crosses the Eagle Mountain Industrial Railroad and all major elements of the project occur within the Eagle Mountain Mine area, recorded as P-33-006913.

PREVIOUS REPORTS

As noted, 26 reports addressing portions of the study corridor have been identified (Table 1). Of these, 35 percent ($n = 9$) address the project area proper. The study corridor amounts to approximately 49,833 acres. Because many of the previous reports have addressed small linear corridors or irregularly shaped areas, it is not possible to give a precise estimate as to how much of either the project area proper or the larger corridor has previously been systematically inventoried for cultural resources. Based on an impressionistic inspection of the coverage maps (Confidential Appendix C), it appears that the portion of the actual project area that has been systematically inventoried is unlikely to have exceeded 10 percent, with the smallest portions being the linear elements of the transmission line and water line. Larger contiguous areas within and around the Eagle Mountain Mine (4,656 acres) and Townsite (404 acres) near the northern terminus of the transmission line and the reservoirs have been surveyed (Bull et al. 1991; Schmidt 1995). A much smaller portion of the larger study corridor has been investigated.

Previous studies that are likely to be found to have addressed significant portions of the project's ultimate APE include Cowan and Wallof (1977; RI-00220), Wallof and Cowan (1977; RI-00222), Carrico et al. (1982; RI-00221), Bull et al. (1991; RI-03321), Love (1994; RI-03949), and Schaefer (2003):

- Cowan and Wallof (1977) and Wallof and Cowan (1977) reported a 1976 archaeological survey of 200 linear mi. for the earliest alternative routes of the Palo Verde-Devers 500 kV Transmission Line, both north and south of Interstate 10. The northern route bisects both the transmission and water line routes although no sites were recorded at the Information Center within the project area proper. The 1976 survey corridor was 400 ft. wide and was surveyed intensively, in 12-m interval transects. However, standards for recording sites were relatively restrictive: resources classified as isolates included lithic scatters with less than 15 items per 10 m^2; ceramic scatters with less than 5 items per 10 m^2; prehistoric trails, rock rings, and other isolated features; and historic remains except for pre-1950 scatters with more than 10 items per 10 m^2, structures, military

Table 1. Eastern Information Center Report Listing

Report No.	Year	Author(s)	Title	Affiliation	No. of Resources	Acreage
Rl-00099	1973	McWilliams, S.R.	Archaeological Survey Of Proposed County Dump 4 1/2 Miles North Of Desert Center.	Authors	2	160
Rl-00220*	1977	Cowan, Richard; Kurt Wallof	Interim Report-Fieldwork and Data Analysis: Cultural Resource Survey Of The Proposed Southern California Edison Palo Verde-Devers 500 Kv Power Transmission Line	ARU, UC Riverside	102	0
Rl-00221	1982	Carrico, R.; D. Quillen, D. Gallegos	Cultural Resource Inventory And National Register Assessment Of The Southern California Edison Palo Verde To Devers Transmission Line Corridor (California Portion)	Westec Services, Inc.	355	6120
Rl-00222	1977	Wallof, Kurt; Richard Cowan	Final Report: Cultural Resource Survey Of The Proposed Southern California Edison Palo Verde-Devers 500kv Power Transmission Line	ARU, UC Riverside	21	0
Rl-00498*	1978	Swenson, James	An Archaeological Assessment Of A Portion Of The Se 1/4 Of Section 36, T3s, R14e, SBBM, Near Eagle Mountain, Riverside County, California	ARU, UC Riverside	7	150
Rl-00672	1980	McManus, James	Addendum Phase I Archaeological Survey Report For Proposed Berm And Channel West Of Desert Center, Riverside County, California, 11-RIV-10, PM 104.7	Caltrans, District II, San Diego	6	0.4
Rl-00673	1980	Salazar, Lucian	Historic Property Survey Report: 11-RIV-10, 104.7, 11209-192511 (Construct Berm And Channel)	Caltrans, District II, San Diego	6	0.4
Rl-00674	1979	Oxendine, Joan	Archaeology Phase I Survey Report: Proposed Berm And Channel At 11-RIV-10, PM 104.7, Desert Center, 11209-192511	Caltrans, District II, San Diego	14	3.7

Report No.	Year	Author(s)	Title	Affiliation	No. of Resources	Acreage
Rl-00813	1980	Bureau of Land Management	Eastern Riverside County Geothermal Temperature Gradient Holes	Bureau of Land Management	13	0
Rl-00982	1980	Crew, Harvey	An Archaeological Survey Of Geothermal Drilling Sites In Riverside County	Scientific Applications	33	0
Rl-01654	1983	Bowles, Larry	An Archaeological Assessment For TPM 18983, Parcel No. 808-083-004	Authors	8	915
RI-01855	1984	Weil, Edward; Jill Weisbord; E.Blakeley	Cultural Resources Literature Search, Records Check And Sample Field Survey For The California Portion Of The Celeron/ All American Pipeline Project	Applied Conservation Technologies, Inc.	0	172.97
RI-02210	1986	Underwood, J.; J. Cleland; C Woods; R. Apple	Preliminary Cultural Resources Survey Report For The US Telecom Fiber Optic Cable Project, From San Timoteo Canyon To Socorro, Texas: The California Segment.	Dames and Moore	13	0
RI-02285*	1988	Mitchell, Mike	Letter Report: Proposed Land Exchange With The Nature Conservancy	Authors	0	110
RI-03151	1991	Broeker, Gale	Letter Report: CA066-9NO-1, Hindley Mining Test Units, CAMC238008.	Bureau of Land Management	1	14
RI-03321*	1991	Bull, C.; S. Wade; M. Davis	Cultural Resource Survey Of The Eagle Mountain Mine And The Kaiser Industrial Railroad, Cultural Resource Permit #CA881916	Regional Environmental Consultants	2	4659
RI-03648	1993	Laylander, Don	Negative Archaeological Survey Report, Desert Center Maintenance Station.	Caltrans, District II, San Diego	0	2
RI-03914*	1995	Schmidt, James	Cultural Resource Investigation Of Eagle Mountain Townsite	Greenwood & Associates	1	404

Report No.	Year	Author(s)	Title	Affiliation	No. of Resources	Acreage
RI-03948*	1993	Love, Bruce	Cultural Resources Reconnaissance: Eagle Mountain Pumped Storage Transmission Corridor, Riverside County, California	CRM TECH	4	0
RI-03949*	1994	Love, Bruce	Addendum Cultural Resources Reconnaissance: Eagle Mountain Pumped Storage Transmission Corridor, Riverside County	CRM TECH	0	0
RI-04152	1998	McLean, Deborah	Letter Report: Archaeological Assessment For Pacific Bell Mobile Services Telecommunications Facility CM 826-02, 1083 Washington Street, City And County Of Riverside, California	LSA Associates, Inc.	0	0.25
RI-04452*	1993	Love, Bruce	Cultural Resources Reconnaissance, Eagle Mountain Pumped Storage Transmission Corridor, Riverside County, California	CRM TECH	12	0
RI-04570	2000	DeBarros, Philip	Cultural Resources Survey And Assessment Of A Cellular Phone Tower Site And Associated Access Road And The Results Of Test Excavations At Historic Archaeology Site CA-RIV-6513H In Desert Center, Riverside County, California	Professional Archaeological Services	1	0.25
RI-05245	2005	Schmidt, James	Negative Archaeological Survey Report: Southern California Edison Company, Blythe-Eagle Mountain 161 kV Deteriorated Pole Replacement Project	Compass Rose Archaeological, Inc.	1	0
RI-05272*	2003	Robinson, Mark	Cultural Resources Survey And Assessment Of Approximately 40 Acres: Fraternal Order Of Eagles# 4455 Kaiser Road Project, North Of Desert Center, Riverside County, CA	Great Lakes Archaeology	0	40
RI-06707	2006	McDougall, D; J. George; S. Goldberg	Cultural Resources Surveys Of Alternative Routes Within California For The Proposed Devers-Palo Verde 2 Transmission Project	Applied Earthworks, Inc.	43	1243
RI-07790	2003	Schaefer, Jerry	A Class II Cultural Resources Assessment For The Desert-Southwest Transmission Line, Colorado Desert, Riverside And Imperial Counties, California	ASM Affiliates, Inc.	0	600

* Indicates reports that are mapped as spedcifically addressing portions of the project area proper.

encampments, and mine buildings. Most of these would be classified as sites under today's standards. These "isolates" were not recorded by Cowan and Wallof at the EIC and only appear as tabular listings in their report. Some may have been recorded during subsequent surveys along the same corridor.

- Carrico et al. (1982) reported a 1980 survey of the same alignment as the 1976 Palo Verde-Devers 500 kV Transmission Line survey. The 1980 survey also included a corridor that was 400 ft. wide and was surveyed in 12-m intervals. Criteria for distinguishing sites from isolates were less restrictive than in the 1976 study: isolates were defined as five or fewer prehistoric or historic artifacts within a 25-m distance. Most of the recorded sites were south of Interstate 10 and outside the project area. This route was ultimately built but the sites were evaluated in the field prior to construction and as a result, these sites no longer exist.

- Schaefer (2003) reported a Class I and II study for 527 linear mi. of alternative routes for the Desert-Southwest power transmission line, including 16.5 mi. of new surveys. The alignments addressed were generally the same as those previously addressed in the reports by Cowan and Wallof (1977), Wallof and Cowan (1977), and Carrico et al. (1982). Additional fieldwork in 2002 consisted of surveying 16.5 mi. of generally 1-mi. long, 150-m (500-ft.) wide sample units with transects at 20-m (65-ft.) intervals. The survey corroborated the Carrico et al. survey results and identified the Alligator Rock National Register of Historic Places site complex as the only known sensitive zone near the current project area.

- Bull et al. (1991) reported a 1990 survey of 4659 acres for the previously proposed solid waste landfill project. This survey overlaps much of the northern extent of the proposed transmission line and portions of the site plan at the former Eagle Mountain Mine, including the Eagle Mountain Industrial Railroad route. This area is generally characterized by relatively rugged terrain, and the 1990 survey coverage in this area was not systematic, but was focused on ridgelines, saddles, and drainages. Scatters of more than three items within a 25-m radius were classified as sites although none were recorded in the current project area. Their conclusion was that the area possessed low sensitivity for archaeological sites. The Bull et al. investigations included ethnographic interviews by subconsultant Cultural Systems Research, Inc., under the direction of Lowell J. Bean, Sylvia Brakke Vane, and Jackson Young. These ethnographic investigations included field visits and interviews with one Cahuilla, one Chemehuevi, and two Mohave consultants, as well as phone interviews with other groups and an ethnohistoric literature review. Both the Chemehuevi and Cahuilla elders recounted knowledge of hunting activities in the Eagle Mountains but no groups attributed sacred sites or special spiritual or cultural significance to the area. Opposition to the solid waste landfill project was noted, however, for environmental reasons. CSRI's conclusion was that the project posed no impacts to traditional cultural or sacred values.

- Love conducted Class I literature reviews and reconnaissance (i.e., windshield) level surveys for a similar (in part) transmission line route (1993) and water pipeline (1994) as the present project and for an earlier proposed pumped storage project at Eagle Mountain. The study area was visually inspected by driving on existing roads and doing on-foot spot checks. Unlike the present proposed transmission line corridor, the earlier proposed route paralleled the eastern side of Eagle Mountain Road and veered northeast at the Pumping Station holding pond. The literature reviews included inspection of 1850s Government Land Office (GLO) maps and surveyor notes and Riverside County Historical Division archives that informed on the present study. The only identifiable resource on the 1857 GLO maps within the current project is “Brown’s (Wagon) Road” which crosses the southern portion of Eagle Mountain Road. Love also conducted in-field visits with Cahuilla elder and former tribal historian, Anthony Andreas, Jr. He specifically identified the east-west trail segments as particularly important evidence of the cultural interaction between the Cahuilla and the Mohave (Love 1993:11). Otherwise, Love predicted that both the general areas of the current transmission line and water line routes would possess low sensitivity for cultural resources.

NATIVE AMERICAN HERITAGE COMMISSION RESULTS

A formal inquiry with the Native American Heritage Commission (NAHC) program analyst, David Singleton, resulted in no identified Native American sites in the Sacred Lands Files (Appendix A). Thirteen tribal groups or individuals were identified, however, who may have knowledge of cultural resources in the project area. They include John A. James, Chairperson, Cabazon Band of Mission Indians (Cahuilla); Joseph Hamilton, Chairman, Ramona Band of Cahuilla Mission Indians; Patricia Tuck, Tribal Historic Preservation Officer, Agua Caliente Band of Cahuilla Indians; Diana L. Chichuaha, Cultural Resources Coordinator, Torres-Martinez Band of Cahuilla Indians; Michael Contreras, Cultural Heritage Program Manager, Morongo Band of Cahuilla Indians (Cahuilla, Serrano); Luther Salgado, Sr., Cahuilla Band of Indians; Joseph Hamilton, Chairman, Ramona Band of Cahuilla Mission Indians; Ann Brierty, Policy/Cultural Resources Department, San Manuel Band of Mission Indians (Serrano); Darrell Mike, Chairperson, Twenty-nine Palms Band of Mission Indians (Chemehuevi); Charles Wood, Chairperson, Chemehuevi Reservation; Joseph (Mike) R. Benitez (Chemehuevi); Michael Tsosie, Cultural Contact, Colorado River Reservation (Mohave, Chemehuevi); and Linda Otero, Director, AhaMaKav Cultural Society, Fort Mojave Indian Tribe.

5. PREVIOUSLY RECORDED CULTURAL RESOURCES

Records from CHRIS document the presence of 31 previously recorded cultural resources within the study corridor (Table 2; Confidential Appendices B and C). About 50 percent (*n* = 15) of the recorded resources in the study area are prehistoric, and 50 percent (*n* = 16) are historic in age. The majority of the recorded resources are comparatively minor. Some 18 percent (*n* = 5) are isolated finds, including three prehistoric lithics, one milling stone, and one historic ceramic mug. Many other sites consist of small prehistoric lithic scatters, a pot drop, possible rock rings and cleared circles, and bedrock milling. However, potentially more significant resources are also present in the study area, consisting of several portions of a major east-west trail network with associated features. Significant historic sites in the study area include two stick figure petroglyphs associated with an early wagon road and possibly a cenotaph associated with "Desert Steve" Ragsdale, three historic sites associated with Camp Young/Desert Center and the World War II-era Desert Training Center/California-Arizona Maneuver Area, a historic well, and the Eagle Mountain community and mine, including the Eagle Mountain Mine radio control tower, the Colorado River Aqueduct, and the Eagle Mountain Pumping Station. Less significant historic sites include remains of a blacktopped road and various historic post-World War II trash scatters. The vast majority of sites are located either north or south of the Interstate 10 corridor and outside the currently proposed project area.

Table 2. Previously Recorded Cultural Resources in or near the Eagle Mountain Pumped Storage Project Area

Site		Within Project Area?	Description
P-33-	**CA-RIV-**		
000072	72	no	Prehistoric trail, 13 rock cairns, ceramics at one cairn, part of major e-w trail network recorded by Johnston and Johnston 1957
000187	187	no	Historic Gruendike Well, Cram Brothers cattle trough, scant residence, school, gas station remains, unconfirmed (prehistoric) camp site related to Johnston's e-w trail
001173	1173	no	Historic petroglyphs of two anthropomorphs on north tip of Alligator Rock, associated with e-w trail, San Pasqual Well, and historic Frink's Cutoff alternative to the Bradshaw Trail
002735	2735	no	Prehistoric rock circle, flake and milling stone scatter (temporary camp)
002736	2736	no	Prehistoric trail, bedrock milling

Site		Within	
P-33-	CA-RIV-	Project Area?	Description
002737	2737	no	Prehistoric chipping station associated with Alligator Rock quarry
002738	2738	no	Prehistoric lithic core fragments associated with Alligator Rock quarry
003108	3108	no	Prehistoric chipping station associated with Alligator Rock quarry
003109	3109	no	Prehistoric flake scatter associated with Alligator Rock quarry
006836		no	Historic Desert Center Army Air Field
006418		no	Prehistoric isolated milling stone
006913		yes	Historic Eagle Mountain community and mine
006914		no	Historic Eagle Mountain Pumping Station of the Colorado River Aqueduct
008392	6123H	no	Historic 1920s surveyors camp from the Colorado River Aqueduct surveys including hearth and artifacts; later 1969 claim marker
011265	6726H	yes	Historic Colorado River Aqueduct
012295	7019H	no	Historic mid-twentieth century trash pit, most removed during mechanical trenching
014207		no	Historic trash scatter, concrete cistern or well, dirt road, mid-nineteenth century
014181		no	Historic mine claim cairns (5) and trash scatter
014182		no	Prehistoric isolated basalt flake
014194		no	Prehistoric isolated quartz flake
014195		no	Prehistoric isolated quartz flake
015097		no	Historic WWII-era DTC/C-AMA tent pads, rock alignments and trash
015098		no	Prehistoric cleared circle or rock ring (problematic)
015100		no	Prehistoric cleared circle or rock ring (problematic)
015106		yes	Prehistoric ceramic “pot drop” of 12 buff ware sherds (in alternative alignment)
015970		yes	Prehistoric rock ring (in alternative alignment)
015971		no	Historic WWII-era DTC/C-AMA mortared rock alignment and clearings (hospital?)
015972		no	Historic blacktopped paved road

Site		Within Project Area?	Description
P-33-	CA-RIV-		
015973		no	Historic refuse dump associated with old gas station location
016946		no	Historic Eagle Mountain Mine radio control tower and storage structure
017343		no	Historic isolated ceramic mug

Prehistoric Cultural Resources

Prehistoric resource types represented in the sample include two different segments of the same east-west trail, a temporary camp, four lithic scatters or chipping stations, a rock ring and two cleared circle features, one ceramic pot drop, and four isolated finds (Table 3).

Table 3. Previously Recorded Prehistoric Sites, by Generalized Types (Primary Number P-33-).

Trail	Temporary Camp	Lithic Scatter/Chipping Station	Cleared Circle/Rock Ring	Ceramic Pot Drop	Isolates
000072	002735	002737	015098	015106	006418
002736		002738	015100		014182
		003108	015970		014194
		003108			014195

None of these resources are located within the APE.

- Temporary camps are informally distinguished from artifact scatters by the greater diversity of artifact types, often with features. The one site of this type, P-33-002735, included a rock ring, lithics, and two portable milling slabs. Because temporary camps contain more complex patterns of prehistoric remains, they are more likely than simple scatters to be determined to constitute significant resources. This site is located in relative isolation to the south of Interstate 10, but in the same general vicinity of the majority of prehistoric lithic scatters and isolates of materials derived from Alligator Rock. This southern location would also make it associated with the general east-west travel route through the Chuckwalla Valley.

- The two trails, P-33-000072 and P-33-002736, are the previously recorded segments of the major east-west transit route through the Chuckwalla Valley. Much of this route has been traced by Johnston and Johnston (1957), extending west through the San Gorgonio Pass and east to the Colorado River. Numerous pot drops were recorded along the route. A separate branch that goes south through the Coachella Valley and east through Salt Creek Pass is better known as the Cocomaricopa Trail but McCarthy (1982) identifies the route through the Chuckwalla Valley by the same name. Both routes, it seems, were major prehistoric and ethnohistoric transportation corridors, recognized by archaeologists and Native American consultants alike as a significant element in the regional cultural history. Depending on their integrity and further research, they are likely to be eligible for the National Register of Historic Places. The project area appears to remain north of the trail network and poses no impact to any preserved remains.

- Four lithic scatters sites are located south of Interstate 10 and contain the types of plutonic aplite associated with the North Chuckwalla Mountain Quarry National Register of Historic Places District around Alligator Rock. They are outside of the district boundaries and represent peripheral sites to the main lithic procurement area. They are not likely to be NRHP-eligible but in any event are not within the project area.

- One rock ring, P-33-015970, is located in the alternative transmission line route while the two cleared circles are located just to the south. The two cleared circles are problematic and may result from deflation of natural ground rodent mounds and not from cultural factors. If cultural, these type of features bear witness to temporary encampment. They typically have no associated cultural materials although should be tested if impacts are projected to occur, which is unlikely given this is not a preferred alignment.

- Prehistoric isolates consist of single artifacts in theses cases. Three of the four isolates are stone flakes and one is a milling stone. None are located in the project area with with the study corridor. Normally, isolates are treated as categorically ineligible for the NRHP due to limited research values and do not require any further treatment or consideration.

- One ceramic pot drop, P-33-015106, is of the site type often associated with routes of travel. Although pot drops are generally considered not NRHP-eligible, recent advances in thermoluminescence dating and materials analysis suggest they have greater research value than previously thought. It is located at the southernmost tip of the alternative powerline route near Interstate 10 and therefore outside the preferred project area.

Except for the trail segments, the likelihood of special ethnic importance for contemporary Native Americans is not evident at any of the resources previously identified in the study corridor, and as suggested by previous Native American ethnographic work associated with the proposed Eagle Mountain solid waste landfill project (Bull et al. 1991). Nevertheless, ongoing consultation with local Native American groups is likely to be required as the development of the project progresses.

Historic Cultural Resources

Historic-period cultural resources that have previously been identified in the study corridor include a well and cattle trough complex, the Colorado River Aqueduct and the Eagle Mountain Pumping Station, a workers camp associated with the construction of the aqueduct, two sites with rock alignments and other features associated with the World War II DTC/C-AMA, the Desert Center Army Air Base (now in part the Desert Center Airport), the Eagle Mountain Mine and all facilities, the Eagle Mountain Mine Radio Control Tower, two mining sites associated with claims or prospectors camps, one paved road surface, three post-war trash deposits, and one isolate (Table 4). In large measure, evaluating the significance of such resources is likely to be based on archival background research used to determine whether the archaeological remains can be linked to interpretable historic contexts and whether they possess either significant research potential or historic preservation values. A careful evaluation of integrity will also be important. In some cases, surface collections or test excavations may be required.

Table 4. Previously Recorded Historic Sites, by Generalized Types (Primary Number P 33-).

Rock Art	**Well, Cattle Trough, etc.**	**Colorado River Aqueduct**	**WWII Military**	**Mining**	**Road**	*Trash Deposit*	**Isolate**
001173	000187	006914	006836	**006913**	015972	012295	017343
		008392	015097	014181		014207	
		011265	016971	016946		015973	

Resources in bold are located at least partially within the APE

- The Gruendike Well site, P-33-000187, is located on the USGS Corn Springs 7.5-minute map southeast of the Desert Center Airport and was recorded in 1978 based on an interview with the son of Steve Ragsdale who was the original resident in 1915. Remains of an old school, cattle trough, and gas station complex were said to exist but integrity is noted to be very poor.
- One of the historic road segments, P-33-015972, is located south of the project APE, parallel to Interstate 10. The historic Brown's wagon road route crosses the transmission line alternative but is only known from GLO maps and has not been officially recorded.

An alternative to the Bradshaw Trail route known as Frink's Cutoff Alternative is associated with a historic petroglyph site at the northern tip of Alligator Ridge, P-33-000173. This is also located outside the project APE.

- Military features and deposits in the study corridor relate to the World War II Desert Training Center/California-Arizona Maneuver Area (P-33-015097 and P-33–016971). Most of the residential or cantonment facilities are concentrated around Interstate 10 but are known to extend over a large area. Bischoff (2000) suggests that the rock-lined walkways on the east side of Eagle Mountain Road near the southern extent along a pipeline road may remain from the evacuation hospital and not Camp Desert Center proper. E Clampus Vitus and the BLM are about to recognize this general area as such. Some alignments and clearings have been previously recorded in 2007 as P-33-016971, extending across Eagle Mountain Road and may be specifically associated. In any case, the preferred transmission line alignment will avoid this area. The Riverside County Historical Commission recognizes the Desert Training Center in the vicinity of Desert Center as a Point of Historical Interest (Riv-022). Remains of the DTC Army Air Base were recorded in 1982 by a Riverside Historical Commission staffer as P-33-006836. The current airport utilizes the southern arm of what was a V-shaped landing strip, with the apex pointing east. Remains from World War II include concrete slabs from the link trainer building, headquarters building, flagpole stump, and officers' facilities. All of these are outside the project APE.

- The proposed transmission line and water line will span a buried portion of the Colorado River Aqueduct, P-33-011265. This is the only previously recorded cultural resource that occurs directly within the project APE, except for the mine proper. An aqueduct feature, the Eagle Mountain Pumping Station (P-33-006914), is located 1 mi. from the project area proper and will not be subject to any direct impacts from the transmission line project.

- The entire Eagle Mountain Mine and company town of Eagle Mountain was recorded by a Riverside Historical Commission staffer as P-33-006913 in 1982, shortly before the mine closed for good. A historical marker commemorates the early claims from the 1880s, L. S. Barnes' sale to the SPRR in 1909, Kaiser Steel's acquisition in 1944, and the beginning of ore shipments to Fontana in 1948. Specific facilities that are mentioned include the iron ore mine with offices, mining equipment, railroad yard, residential community, stores, school, and playground that was constructed of discarded mining equipment. The site form, however, fails to identify the boundaries of the 57-acre site, specific feature locations, nor does it constitute a full inventory that may be found in Schmidt (1995) although no site form updates were prepared. More recently, the radio control tower and storage structure was recorded in the central part of the mine (P-33-016946). Other mining-related site, P-33-014181, is a group of late-dated mine claim cairns and associated trash. The Riverside County Historical Commission recognizes Eagle Mountain Iron and the Desert Center Area as a Point of Historical Interest (Riv-041). In 1996, SHPO concurred with BLM that the mine, townsite, and rail yard were not eligible for listing in the NRHP, due to its recent age and lack of exceptional significance (Widell 1996).

- Three historic trash deposits have been recorded within the project area proper (P-33-012295, P-33-014207, and P-33–015973). All of these deposits appear to date from the middle twentieth century and postdate the DTC-C/AMA.
- One historic isolate, a ceramic mug, was recorded (P-33-017343). As is the case with prehistoric isolates, such resources are normally treated as categorically ineligible for the NRHP and do not require any further consideration or treatment.

6. SENSITIVITY, DATA GAPS, AND RECOMMENDATIONS

SENSITIVITY

The small number of cultural resources previously recorded within the study corridor, based on moderately limited amounts of inventory work, indicates the general archaeological sensitivity of the area and the likely presence of additional resources that may be eligible for listing in the NRHP. The data suggest a low sensitivity for prehistoric cultural resources throughout the project area. The reasons include lack of permanent or seasonal water sources or stable food sources to sustain either residential or temporary camps, lack of lithic resources on the spotty desert pavements within the project area (with Alligator Rock to the south being the main local lithic tool stone source), location of the project to the north of the documented archaeological remains of the major east-west trail through the Chuckwalla Valley, and impacts to the integrity of old land surfaces from alluvial stream channels and historic era activities.

Historic sites are more likely to occur within the project area. The most sensitive would be the remains of Camp Desert Center and the evacuation hospital at the southern end of Eagle Mountain Road. These loci appear to be to the south of the alternative or western Interconnection Collection Substation. The preferred transmission line route and Interconnection Collection Station is located 2 mi. to the north and east, respectively, of the known DTC/C-AMA features. For that reason, the preferred eastern substation and transmission line route is less likely to cause impacts to significant cultural resources related to the DTC/C-AMA.

The transmission and water lines cross over buried portions of the Colorado River Aqueduct, which is very likely to be eligible for the NRHP based on its historical significance under Criteria A and C. The aqueduct is not visible from the surface in this area, however, except for a road and flood control berm. Impacts to materials, feeling, setting, and association are therefore expected to fall below a level of significance. The transmission line also crosses over the Eagle Mountain Industrial Railroad in two places. A formal significance determination of the rail line remains to be undertaken by the BLM but it is likely to be found ineligible for listing in the NRHP because the Eagle Mountain Mine, town site, and rail yard have been previously determined ineligible, with SHPO concurrence (Widell 1996).

A large majority of the previously recorded resources are either isolates or small artifact scatters, and these are likely to require only minimal treatment in connection with the project. However, a few more substantial prehistoric and historic sites, especially those related to the major prehistoric east-west trail network and later historical routes of travel are located in the study corridor, but remain outside the APE. Such sites still are likely to require consideration of measures to avoid impacts to them if they are determined to be historic properties eligible for the NRHP.

Potential cumulative indirect impacts from the proposed project are expected to be very low. The current roads throughout the project area provide abundant access that would not be appreciably increased by the proposed project. Currently anticipated results of a Class III survey of the transmission line and water line indicate no historic properties exist where these alignments diverge from existing access roads. Security measures around the Eagle Mountain Mine complex also would be expected to remain the same or be improved.

DATA GAPS AND RECOMMENDATIONS

At the time of this Class I literature review, a substantial portion of the 200-ft. transmission line right-of-way, 60-ft. water line right-of-way, well sites, and any associated areas that together will ultimately define the project's APE were not systematically inventoried for cultural resources. A Class III inventory has now been completed for those alignments outside Kaiser Steel property (Schaefer and Iverson 2009). The survey demonstrated that no prehistoric or historic archaeological sites that are eligible for listing in the NRHP are located in the accessible portions of the APE. The one historic property is a buried portion of the Colorado River Aqueduct that will not be impacted by the proposed project. It is currently premature to assess impacts to portions of the project area within the Kaiser Steel property boundaries. Early historic mining elements are likely to have been completely eliminated by the later iron mine and the existing mine and townsite are already determined not to be eligible for listing in the NRHP. In any event, a complete, intensive archaeological survey of all previously unsurveyed areas in the APE is recommended.

Both previously and newly recorded cultural resources that are identified within the project's APE will need to be evaluated for their potential eligibility for the NRHP, if avoiding them does not appear feasible. Evaluation is likely to involve such methods as archival research; surface observation, mapping, and collection; subsurface test excavations; and laboratory analyses.

If resources are determined to be eligible for the NRHP and project impacts to them cannot be prudently avoided, archaeological data recovery or other mitigation measures may be required by FERC.

If inventory or testing work identifies particular locations with a high potential to contain significant buried cultural resources, archaeological monitoring of ground-disturbing activities may be required during the construction of the project.

7. CONCLUSIONS

Several basic conclusions are supported by the data identified during a search of cultural resources records relating to previous reports and site/isolate records, and by an analysis of those data:

- Previous investigations have addressed a small fraction of what has been treated provisionally as the project area proper and a somewhat larger fraction of the wider study corridor (extending out 1 mi. on either side of the project area proper).
- Cultural resources previously recorded within the corridor include 31 prehistoric and historic sites or features including 5 isolated finds. Only two of these resources are located within the project area proper. They are the Eagle Mountain mine and town site (P-33-006913) and the Colorado River Aqueduct (P-33-011265).
- Areas particularly notable for cultural resources include Eagle Mountain for historic-period resources and the World War II DTC/C-AMA Facilities. However, sites and isolates are scattered throughout the study corridor as a whole, and, with the exception of the rugged uplands of the Eagle Mountains at the western end, most portions of the corridor can be considered to have low sensitivity.
- Archaeological isolates or relatively small, simple sites make up the largest portion of the previously recorded cultural resources. Such resources as these will require minimal efforts to manage, in connection with the project. However, several potentially more significant sites are also present in the study corridor and in the project area proper, and some additional sites of similar character may be anticipated when systematic inventory data become available. These resources will require further consideration.
- The logical next steps appear to be to define the project area (the 200-ft. right-of-way and any other areas of potential project impacts) more closely and to do a systematic archaeological survey of the portions of this APE that have not previously been adequately surveyed. Where sites are present and project impacts to them cannot easily be avoided, it will be necessary to evaluate their potential NRHP eligibility, for instance through background research and/or archaeological field-testing. Further measures may be required to mitigate project impacts to sites that are found to be NRHP-eligible, although current data suggest no adverse effects to historic properties.

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APPENDICES

APPENDIX A

Native American Heritage Commission Response

APPENDIX B

Confidential Site Records

This information is privileged and not for release. It has been redacted from this document and bound under separate cover, titled:

Confidential Cultural Resources - Appendix to the Environmental Impact Report

APPENDIX C

Confidential Previous Studies and Recorded Site Maps

This information is privileged and not for release. It has been redacted from this document and bound under separate cover, titled:

Confidential Cultural Resources - Appendix to the Environmental Impact Report

12 Appendix C – Technical Memoranda

12.12 Class III Cultural Resources Report

A CLASS III FIELD INVENTORY
for the
PROPOSED EAGLE MOUNTAIN PUMPED STORAGE PROJECT, RIVERSIDE COUNTY, CALIFORNIA

Prepared for:

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Keywords: USGS 7.5-minute Corn Springs, Desert Center, East of Victory Pass, and Victory Pass quads; Chuckwalla Valley, Eagle Mountain Mine, Riverside County; Desert Training Center, Camp Desert Center, World War II, Historic Trash Scatters; Class III Field Inventory.

October 2009

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MANAGEMENT SUMMARY

Eagle Crest Energy contracted ASM Affiliates, Inc. (ASM) to carry out a Class III field inventory for the proposed Eagle Mountain Pumped Storage Project Area of Potential Effects (APE) and a portion of a withdrawn alternative alignment in Riverside County, California. The proposed project consists of hydroelectric pumped storage that will provide system peaking capacity and electrical system regulating benefits to Southwestern electric utilities. ASM investigated 200-ft.-wide proposed and withdrawn alternative Transmission Lines and 60-ft.-wide preferred and alternative Water Lines, totaling approximately 33 linear miles, in addition to two proposed Interconnection Collection Substation locations, totaling 50 acres, and four potential Water Supply Well locations, for the Class III field inventory.

The project alignment crosses over previously recorded buried portions of the Colorado River Aqueduct (P-33-6726) and above ground portions of the Eagle Mountain Industrial Railroad. The Colorado River Aqueduct (P-33--6726) is evaluated as eligible for the National Register of Historic Places (NRHP), while the Eagle Mountain Industrial Railroad is not because of a lack of integrity. Nevertheless, the proposed project is expected to result in no impacts to these resources.

As a result of the survey, ASM recorded seven newly identified historic archaeological resources, including six historic sites and one historic-period isolate. Historic research and site integrity suggest that most of the newly identified historic sites and the historic isolate are not NRHP-eligible because they post-date World War II, represent road-side trash deposition associated with Desert Center, and have no historical or scientific values. The one significant site, P-33-17642, CA-RIV-9139 (Eagle Mountain 1), is in the withdrawn alternative transmission route and therefore outside the APE. It represents activity associated with military operations conducted during World War II as part of the Desert Training Center/California-Arizona Maneuver Area (DTC/C-AMA) under the command of General George S. Patton, and potentially related to an evacuation hospital complex servicing troop deployments throughout the training area. No treatment is recommended because it is located outside of the APE.

The one isolate is a 1914-1934-era California Highway boundary marker that although not NRHP-eligible is recommended to be avoided.

1. Project Name.	A Class III Field Inventory for the Proposed Eagle Mountain Pumped Storage Project.	
2. BLM State Permit Number.	CA-09-06, issued Nov. 8, 2008	
3. Field Authorization Number.	66.24 09-07	
4. Dates of Field Survey.	March 17-25, 2009	
5. Total acreage of lands surveyed at BLM Class III level.		620
Of Item 5 above:		
	A) Acreage of BLM lands surveyed	600
	B) Acreage of other lands surveyed (Private, State, Other Federal)	20
6. Total number of cultural properties in project Area of Potential Effect.		8
Of Item 6 above:		
	A) Total number of cultural properties for which site records were completed (newly recorded cultural properties).	7
	B) Number of new cultural properties on BLM lands	7
	C) Number of new cultural properties on other lands (Private, State, Other Federal)	0
7. Of the cultural properties located within the Area of Potential Effect:		
	A) Number of cultural properties that you are recommending as eligible for the National Register.	0
	B) Number of cultural properties you are a recommending as not eligible for the National Register.	6
Of Item 7A above:		
	a) Number of cultural properties that can/will be avoided.	7
	b) Number of cultural properties that will be affected.	0
	c) Number of cultural properties that you are recommending data recovery/mitigation.	0
Of Item 7B above:		
	a) Number of cultural properties that can/will be avoided.	N/A
	b) Number of cultural properties that will be affected.	N/A

1. INTRODUCTION

The Eagle Mountain Energy Company proposes to develop the Eagle Mountain Pumped Storage Project, located near the towns of Eagle Mountain and Desert Center in Riverside County, California (Figure 1.1). The proposed project is a hydroelectric pumped storage project that will provide system peaking capacity and electrical system regulating benefits to Southwestern electric utilities. The project will use off-peak energy to pump water from the lower reservoir to the upper reservoir during periods of low electrical demand and generate on-peak energy by conveying water from the upper to the lower reservoir through the generating units during periods of high electrical demand. The upper and lower reservoirs will be formed from existing mining pits; however, two small dams will be required at the upper reservoir to create the proposed volume of energy storage. An important element of the project and the focus of this Class III field inventory is the 500 kV transmission line route that follows an alignment from the Eagle Mountain Mine through a pass to the east of Eagle Mountain Pumping Plant of the Colorado River Aqueduct, and south along the west side of Eagle Mountain Road to a point approximately 2 mi. north of Interstate 10. The route proceeds southeast from there to the Interconnection Collector Substation, located west of Desert Center. A now-withdrawn alternative transmission line route that was originally considered would have continued south along Eagle Mountain Road and then veered southwest to the alternative Network Connection Point. This alternative was withdrawn from consideration because of potential impacts to cultural resources associated with the evacuation hospital of the World War II Camp Desert Center. The survey results of these withdrawn elements are included in this report as they were included in the original BLM Fieldwork Authorization. The other principal project element is the water line that proceeds southeast from the Eagle Mountain Mine and parallel to an existing transmission line and gas corridor to the vicinity of the Desert Center Airport where four proposed well locations are under consideration.

ASM surveyed the Proposed and withdrawn Alternative Transmission Lines, Preferred and Alternative Water Lines, the Proposed and withdrawn Interconnection Collection Substation locations, and four potential Water Supply Well locations for the current Class III field inventory (Figure 1.2). Potions of the project on private Kaiser property could not be surveyed. The preferred 500 kV line that was surveyed is approximately 13.5 mi. long and 200 ft. wide, while the alternative line adds an additional 6 mi. of examined route. Each of the Interconnection Collector Substation areas covers 25 acres. The eastern substation is the preferred one for the reasons stated above. The water line routes extend for approximately 13.5 mi. and are 60 ft. wide. A total of approximately 620 acres was surveyed. Again, although ASM surveyed the original alternative routes for the current investigation, the project proponent is not considering these alternative alignments, and they are not currently a part of the proposed Eagle Mountain Pumped Storage Project. ASM conducted archaeological survey of the project area utilizing 15-m-interval pedestrian transects. The primary goal of the survey was to identify, record, and inventory all cultural resources, prehistoric and historic, through full-coverage survey, and to identify any resources that may be eligible for the National Register of Historic Places (NRHP). These results provide data in support of the Federal

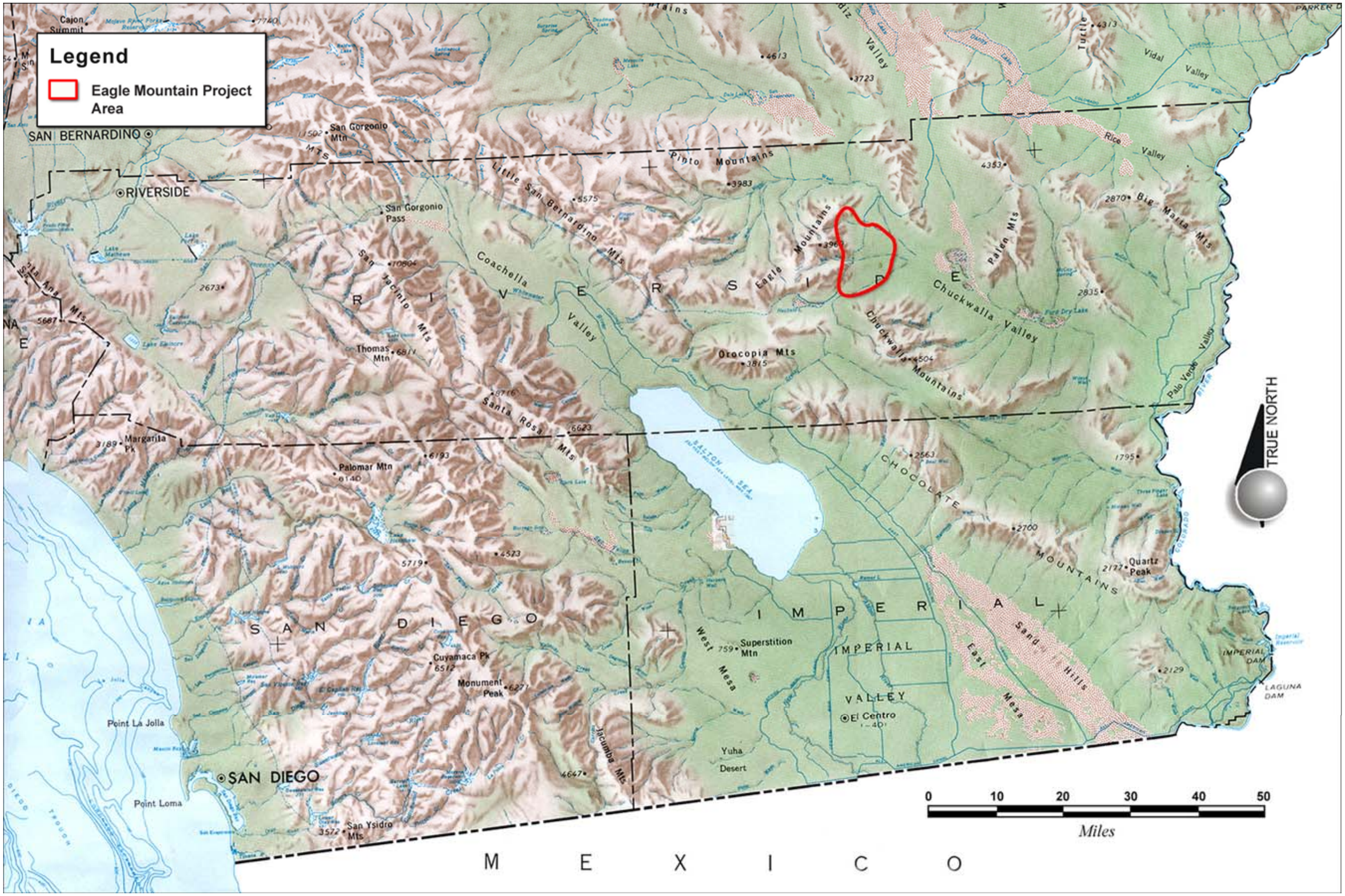

Figure 1.1 Eagle Mountain Pumped Storage Project vicinity.

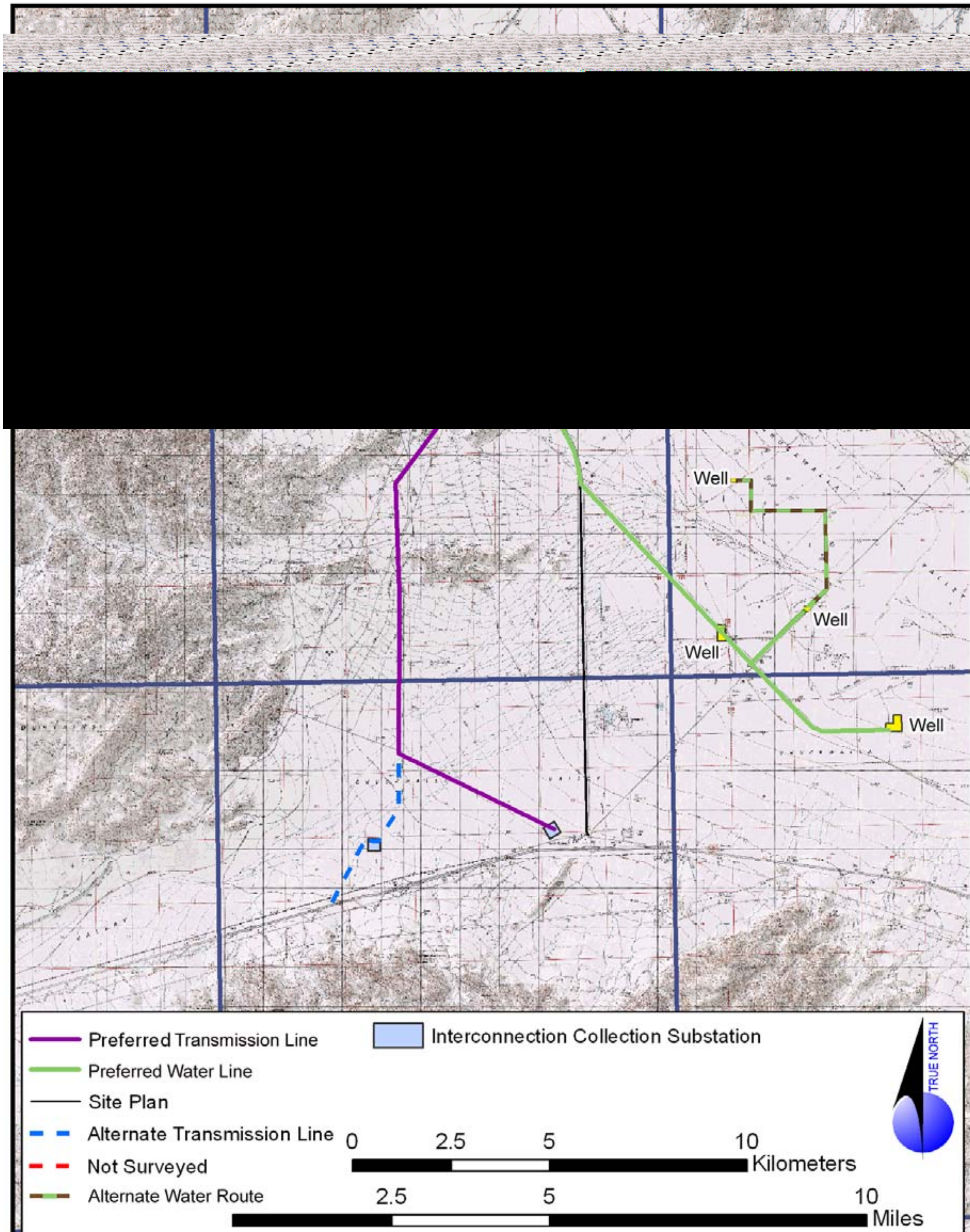

Figure 1.2 Eagle Mountain Pumped Storage Project Area of Potential Effects and withdrawn alternative (dotted blue line). .

Energy Regulatory Commission (FERC) and the BLM compliance obligations for compliance with Section 106 of the National Historic Preservation Act (36 CFR 800; 16 U.S.C. 470(f); 16 CFR 4.41; 64 CFR 26618.380.14).

The following ASM personnel participated in the project: Project Manager John R. Cook, Principal Investigator Dr. Jerry Schaefer, Senior Archaeologist Dave Iversen, and Assistant Archaeologists Michael Taylor, Doug Mengers, and Tom Sowles. ASM Associate Archaeologist Michelle Dalope conducted GIS mapping. Desktop Publisher Marcia Sandusky, and Graphic Designers Zee Malas and Ty Belcher carried out document production. ASM conducted fieldwork from March 17 to 25, 2009.

This report is divided into five chapters. Chapter 1 provides the introduction to the report. Chapter 2 describes the environmental and archaeological context of region and reviews environment, paleoecological reconstruction, cultural history, and previous archaeological research. Chapter 3 defines the survey design and methods. Chapter 4 presents the survey findings. Chapter 5 provides a summary and management recommendations. Confidential California State Department of Parks and Recreation (DPR 523) site forms and Figure 4.1 showing site locations are included as Appendix A to this report under separate cover.

2. ENVIRONMENTAL AND CULTURAL CONTEXT

The following discussion draws substantially upon the background information for a previous Class I report on the project (Schaefer 2009) plus additional information relevant to the resources discovered during the Class III survey.

This chapter describes the natural and cultural setting of the project area. The project traverses the north-central margin of the Colorado Desert, centering on the Chuckwalla Valley and northeastern Eagle Mountains. This region has a long cultural history extending back more than 10,000 years. The affiliation of a particular Native American group with Chuckwalla Valley is somewhat uncertain (Heizer 1978); ethnographic and historic evidence suggests possible links with three distinct groups: the Halchidhoma, Desert Cahuilla, and Chemehuevi. Since the Euro-American occupation of the region, the cultural landscape has been altered by a variety of land uses relating to travel, settlement, mining, water reclamation, and military preparedness.

Throughout the cultural history of the Colorado Desert, human activities have been closely tied to the distribution of natural resources and other aspects of the natural setting. Water, vegetation communities, animal habitat, and lithic raw material were not evenly distributed across the landscape. Prehistoric archaeological evidence is therefore also likely to be nonrandomly distributed, as the prehistoric hunter-gatherers keyed onto these critical resources during their seasonal rounds. Both short-term and long-term climatic fluctuations almost certainly also affected the intensity of land use over time. The natural topography influenced the location of trails and other land use patterns. Dynamic forces of erosion and of alluvial and eolian deposition also determined the preservation, integrity, and visibility of archaeological sites.

NATURAL SETTING

The project area is located on the northern margin of the Colorado Desert Region area, which in turn is a northwestern subregion within the more widespread Sonoran Desert. This area typically consists of a series of northwest-to-southeast trending mountain ranges interspaced with basins filled with alluvial or lacustrine sediments. Elevations along the project corridor range from more than 1,600 ft. above mean sea level (amsl) in the northwest, on the eastern margin of Eagle Mountains, to 345 ft. amsl at the eastern extreme.

Few areas of North America are hotter or dryer than the Colorado Desert. Modern climatic conditions provide for dry, mild winters and dry, hot summers. Mean winter lows of 44º F and a mean summer highs of 104º F are typical, with record highs of 120º F. Rainfall data from Indio between 1877 and 1987 record an annual average of 5.54 in., with extremes between 0.18 and 11.50 in. annually. Violent summer storms are not unusual, but most precipitation falls in mid-winter. The Colorado River was the most reliable and abundant source of water in the region, supplemented by a few widely dispersed springs elsewhere. Water sources are extremely scarce through the Chuckwalla Valley, but several springs are widely dispersed in the mountains to the north and south, outside the project area. They include, from west to east, Lost Palms Oasis, Hayfield Springs, Corn Springs, and McCoy Springs. Such water sources were foci of prehistoric activities. Dry lakes (playas) and pans represent more ephemeral water sources used during periods of relatively greater rainfall or especially wet winters. They include Palen Lake and Ford Dry Lake.

Geomorphology and Geology

The project area owes many of its characteristic features to its location adjacent to the Salton Rift. This distinct physiographic feature consists of a massive graben created at an interface of the North American and Pacific tectonic plates. The San Andreas Fault and the Transverse Ranges are prominent geomorphic features marking this plate boundary. The mountain ranges and alluvial basins farther north and east are more characteristic of the Basin and Range Province, formed by crustal extension.

The Eagle Mountains are composed primarily of Precambrian igneous and metamorphic rocks, Mesozoic granitic rocks, and Pleistocene nonmarine sediments (*see* Figure 3.3.1-1 in the Environmental Impact Report)– lithologies of only limited usefulness to the region's prehistoric inhabitants, although Euro-American miners subsequently exploited them (Jennings 1967). Other ranges framing the project area include the Coxcomb, Palen, and McCoy mountains to the north of Chuckwalla Valley and the Chuckwalla, Little Chuckwalla, and Mule mountains to the south, adding pre-Cretaceous metasediments to the mix of lithologies. The project area proper runs almost exclusively through areas of Quaternary alluvium, lake deposits, and dune sand. Very active geomorphic processes of erosion and deposition along this route may have been responsible for poor preservation or visibility of archaeological sites.

One geological deposit in the Chuckwalla Valley – Alligator Rock – was the focus of extensive prehistoric lithic procurement activities. Located just southwest of Desert Center, Alligator Rock is a prominent ridge containing dikes of aplite, a relatively fine-grained plutonic rock composed of quartz and alkali feldspar. Thousands of years of procurement of aplite as a lithic raw material have resulted in a substantial quarry site complex that extends over a 1-mi.^{2} area. The quarry site complex is listed on the NRHP as the North Chuckwalla Mountain Quarry District. The other major sources of prehistoric tool stone were the many pebble-covered desert pavements of fine-grained cryptocrystalline silica rock along the Colorado River Valley.

Vegetation

The project route crosses two main vegetation communities: creosote bush scrub and desert microphyll woodland (Carrico et al. 1982). The creosote bush scrub community ranges from non-alkaline alluvial flats to rocky slopes. Characteristic species include creosote (*Larrea tridentata*) and white bursage or burrobush (*Ambrosia dumosa*). Well-drained alluvial slopes also support brittlebush (*Encelia farinosa*) and desert trumpet (*Eriogonum inflatum*). Annual grasses that occur throughout this community were primary food resources for prehistoric Native Americans.

The desert microphyll woodland community occurs in drainages descending from the mountains on either side of Chuckwalla Valley. Characteristic trees include catclaw (*Acacia gregii*), palo verde (*Cercidium floridum*), desert willow (*Chiopsis lindearis*), smoke tree (*Dalea spinosa*), and ironwood (*Olneya tesota*). Shrub species include sweetbush (*Bebbia juncea*), cheese bush

(*Hymenoclea salsola*), desert dandelion (*Malacothrix glabrata*), desert lupine (*Lupinus sparsiflorus*), desert marigold (*Baileya multiradiata*), and desert lavender (*Hyptis emoryi*). Native Americans harvested catclaw and palo verde bean pods in late spring and early summer to pound them into a nutritious meal. Willow bark fiber was made into cordage, skirts, breechcloths, and other objects, while firewood and construction materials were available from all the trees (Bean and Saubel 1972).

Vertebrate Fauna

Mammals with the greatest economic importance to Colorado Desert peoples included desert cottontail (*Sylvilagus audubonii*), black-tailed jackrabbit (*Lepus californicus*), several rodent species, mule deer (*Odocoileus hemionus*), and Nelson's bighorn sheep (*Ovis canadensis nelsoni*). Predators that are known to occur in the area include mountain lion (*Felis concolor*), badger (*Taxidea taxus*), kit fox (*Vulpes macrotis*), and bobcat (*Felis rufus*). Desert cottontail is most abundant in sand dune areas such as those found in the eastern Chuckwalla Valley. Black-tailed jackrabbits have a more widespread distribution on desert floors, floodplains, washes, and rocky slopes. Mule deer were most likely to be encountered in desert washes, while the elusive bighorn sheep could be ambushed at desert tanks or oases when they came down from the mountain slopes to get water (Jaeger 1965; Ryan 1968).

Wild game played a less significant role in the diet of ethnohistoric Colorado River peoples than for the desert groups, but it may have had more importance in earlier times, prior to the introduction of horticulture. A wide variety of fish, reptiles, birds, and mammals are found along the Colorado River and its adjacent deserts, and many species had economic importance to the Colorado River peoples (Castetter and Bell 1951). Fish were the most important source of animal protein and included razorback sucker (*Xyrauchen texanus*), bonytail chub (*Gila elegans*), striped mullet (*Mugil cephalus*), various minnows (Cyprinidae), and machete (*Elops affinis*). Some of these species are now extinct on the lower Colorado River, having been replaced by introduced species such as catfish (Gobalet 1994; McGinnis 1984). Many species of raptors, wading birds, songbirds, and migratory waterfowl inhabited the riparian margins of the Colorado River. Raptors had ceremonial uses, while migratory birds and their eggs were exploited for food. Bird species included bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), Wilson's warbler (*Wilsonia pusillus*), American coot (*Fulica americana*), mallard (*Anas platyrhynchos*), great blue heron (*Ardea herodias*), and clapper rail (*Rallus longirostris*).

PALEOENVIRONMENTS

Evidence of prehistoric environmental conditions in the study region is very limited. Pollen-bearing stratified deposits from caves or lake beds are not as common in the Colorado Desert as they are in the Great Basin, where most of the desert climatic reconstructions are based. Evidence indicates that while early Holocene conditions were wetter and cooler than at present, permitting greater use of the study area and especially around the boundaries of Palen Lake and Ford Dry Lake. Generally modern desert conditions were already in existence by the end of the early Holocene period, with periods of more extensive drought in the Late Holocene (Thompson 1984).

Paleoclimatic reconstructions, based on pack rat (*Neotoma* sp.) midden analyses, indicate that at elevations below 1,000 ft. there has been little climatic change along the Lower Colorado and Gila rivers over the last 13,000 years (Van Devender 1990). The region may have been a refugium for Lower Sonoran creosote scrub habitat during the Pleistocene period (Cole 1986). At higher elevations in the mountains, pack rat midden analyses indicate the presence of a juniper woodland habitat in the Late Pleistocene, between 20,000 and 9,000 B.C. These xeric woodlands continued through the early Holocene between 9,000 and 6,000 B.C., before finally retreating to higher elevations during the Middle Holocene and being replaced with the current creosote scrub and desert riparian habitat (King and Van Devender 1977; Van Devender and Spaulding 1983). The last century has seen some of the hottest and driest conditions in at least the last 400 years (Hastings and Turner 1965:188).

Based on current information, the climatic history of the general region may be summarized as follows (Van Devender and Spaulding 1983):

- Late Pleistocene (20,000 to 9,000 B.C.): Cooler and wetter conditions supported pinyon-juniper woodlands, extensive deep lakes, and savannah grasslands or creosote scrub at low elevations.
- Early Holocene (9,000 to 6,000 B.C.): Gradual warming and drying conditions resulted in the shrinking of lakes and replacement of woodlands by creosote scrub communities at lower levels.
- Middle to Late Holocene (6,000 B.C. to present): Warm and dry conditions continued, dominated by summer monsoons in the desert Southwest and winter storms along the Pacific Coast. Lakes in low-lying basins completely dried up or became ephemeral in nature. Local fluctuations in temperature and aridity may have produced ecological variations of no greater magnitude than those known from historic records. Droughts may have been more frequent and severe during the period between 5,000 and 2500 B.C.

CULTURAL SETTING

This section provides the background of the prehistoric cultural setting and of later historic occupation in the project vicinity and reviews previous archaeological work performed in the region.

History of Research

An outline of Colorado Desert culture history has been generally accepted by the archaeological community, but not without the realization that it is a tentative construct, with many details that are still unknown or not well understood. Ironically, the problem is most acute along the lower Colorado River itself, where late prehistoric and ethnohistoric period occupations were most intense. Most of the major aboriginal occupation sites were on the lower terraces of the Colorado River, but none of these have been investigated, evidently because they are buried beneath many feet of alluvial deposits, have been destroyed by agricultural development, or are now obscured by impenetrable stands of tamarisk and reeds.

The culture history for the region is based on the pioneering work of Malcolm J. Rogers in many parts of the Colorado Desert, primarily carried out during the 1920s and 1930s (Rogers 1939, 1945, 1966). Since then, several overviews and syntheses have been prepared, and each succeeding effort had been able to draw upon previous studies and add new data and interpretations. Rogers established the first systematic culture history and artifact typologies of the Colorado Desert. His investigations of San Dieguito and Archaic flaked stone tools and settlement patterns (Rogers 1929, 1939, 1958, 1966) and of Yuman ceramics and culture history (Rogers 1936, 1945) remain a foundation for current archaeological research in the area.

Most research during the last 25 years has been sponsored or mandated by government agencies for compliance with state and federal laws. Independent research has also been conducted for academic theses and dissertations and by local institutions such as Imperial Valley College and University of California, Riverside. Of particular note is the corpus of federal agency overviews and management plans that identified cultural contexts, research domains, and management issues for most of the Colorado Desert.

Margaret Weide and Pat Barker prepared one of the earliest syntheses of information on the Yuha Desert in southwestern Imperial County for the BLM (see Wilke 1978). This study included discussions relevant to the culture history of the Colorado Desert as a whole, including the Colorado River Valley (Weide 1974). An updated synthesis addressing the Colorado Desert Planning Units was prepared by Elizabeth von Till Warren and her collaborators (1981). This is a particularly succinct and useful review of information on environments, prehistory, and ethnography, although a bit out of date.

For southwestern Arizona, Randall H. McGuire and Michael B. Schiffer (1982) reviewed over 50 previous research projects and prepared cultural syntheses that are also applicable to southern California. One of the most valuable contributions in that volume is Michael R. Waters' (1982a, 1982b) study of Patayan ceramics, based largely on the unpublished notes and field collections of Rogers. More recently, Jerry Schaefer (1994a) updated and corrected Waters' discussion of the time ranges and spatial distribution of various Patayan ceramic types, based on a review of recent excavations in the Colorado Desert.

At present, the earliest sites in the vicinity of the project area date to the early-middle Archaic period (5,000-3,000 B.C.), as represented by the lithic complex in the Pinto Basin of Joshua Tree National Park (Campbell and Campbell 1935) and at ephemeral pans such as the ones found within the Chuckwalla Valley. Absolute dates for this period remain problematical (Schroth 1994; Warren 1984).

For the lower Colorado River Valley, Jeannne Swarthout and Christopher E. Drover (Swarthout 1981a, 1981b, 1981c; Swarthout and Drover 1981) prepared detailed overviews that divided the river into four reaches: from Lee's Ferry to Grand Wash Cliffs, from Grand Wash Cliffs to Davis Dam, from Davis Dam to the International Border, and the Lower Virgin River. These studies emphasized the limitations of previous work because of inconsistent site records and a lack of stratified sites. However, they did provide a careful review of the environment and culture history, as well as presenting proposals for future research. The study of Reach 3, from Davis Dam to the International Border (Swarthout and Drover 1981), is most applicable to the study area and one of the best in the series. Two ethnographically based settlement models were presented, one for the Mohave in Mohave Valley and the other for the Halchidhoma and Quechan on the Colorado River. Although the lack of preserved sites on the valley floor makes it difficult to test Swarthout and Drover's models, related test implications can be developed for the temporary camps and resource extraction sites in the deserts away from the river.

A more recent overview of the lower Colorado River by Connie L. Stone (1991) extended the history of research and review of current research issues. Stone identified major cultural resource types, from rock rings to rockshelters, and provided summary statements of their potential research values and applicable investigative procedures. She also provided valuable maps of major intaglio and rock art sites, trail systems, and generalized prehistoric land use. Finally, Stone updated the discussion of management issues.

Statistical Research has been engaged in a series of surveys along the lower Gila and Colorado rivers. One aspect of these studies was the documentation of milling implement quarries, the closest of which is at Palo Verde Point (Schneider 1994). Of particular interest are the many geoglyph and rock art sites that Jeffrey H. Altschul and Joseph A. Ezzo interpreted as part of a ceremonial complex involving the entire Lower Colorado River region. A symposium highlighted the cultural significance of these sites for the Yuman tribes of the Colorado River and the productive results that can be derived from uniting Native American perspectives and scientific archaeological interpretation (Ezzo 1994; Ezzo and Altschul 1993).

Schaefer (1994b) proposed additional research issues that linked the treatment of archaeological sites in the desert and river valley zones. In another article, he summarized and critiqued recent data recovery projects in the Colorado Desert with an emphasis on understanding the chronology of Lake Cahuilla, settlement patterns, and the problems of interpreting sites on desert pavements (Schaefer 1994c). Most recently, Schaefer and Don Laylander (2007) offered a synthesis of work on Colorado Desert prehistory over the last 20 years.

Cultural Periods and Patterns

Five successive periods, each with distinctive cultural patterns, may be suggested for the Colorado Desert, extending back over a period of at least 12,000 years. They include (1) Early Man (Malpais); (2) Paleoindian (San Dieguito); (3) Archaic (Pinto and Amargosa); (4) Late Prehistoric (Patayan); (5) Historic (Ethnohistoric and Euro-American).

Early Man Period (Malpais Pattern) (50,000-10,000 years B.C.)

A complex of archaeological remains that has been hypothesized by some scholars to date between 50,000 to 10,000 B.C. represents the Malpais Pattern (Begole 1973, 1976; Davis et al. 1980; Hayden 1976). Rogers (1939, 1966) originally used the term for cleared circles, tools, and rock alignments that appeared to be ancient and that he later classified as San Dieguito I. Malpais has continued to be applied to heavily varnished choppers and scrapers found on desert pavements of the Colorado, Mojave, and Sonoran deserts that are believed to predate the

Paleoindian period of projectile point use. Although few would reject most of the items as being culturally produced artifacts and features, the methods used to date them are highly subjective and have been assailed on many grounds (McGuire and Schiffer 1982:160-164). Arguments in favor of early occupations in the Colorado Desert have been further eroded by the redating of the Yuha Man burial. Originally dated as over 20,000 years old on the basis of radiocarbon analysis of caliche deposits, more reliable dates of actual human bone fragments based on the accelerator mass spectrometer (AMS) radiocarbon method now place the burial at only about 5,000 years B.C. (Taylor et al. 1985).

Paleoindian Period (San Dieguito Pattern) (10,000-6,000 years B.C.)

Most of the aceramic lithic assemblages, rock features, and cleared circles in the Colorado Desert have been assigned to the San Dieguito pattern. Rogers first defined the pattern on the basis of surface surveys in western San Diego County, but he later refined his understanding of the pattern with at excavations at the C. W. Harris site, a few miles up the San Dieguito River from the Pacific coast (Rogers 1939, 1966). Rogers saw three phases of the San Dieguito pattern in its Central Aspect (which included the Colorado and Mojave deserts and the western Great Basin), and hypothesized that each successive phase was characterized by the addition of new, more sophisticated tool types to the preexisting tool kit.

Current understanding of the lithic technology of the San Dieguito pattern focuses on percussion-flaked cores and the resulting debitage, with little or no pressure flaking evident during the first two phases. Tools from San Dieguito I and II phases include bifacially and unifacially reduced choppers and chopping tools, concave-edge scrapers (spokeshaves), bilaterally notched pebbles, and scraper planes. Appearing in the San Dieguito II phase are finely made blades, smaller bifacial points, and a greater variety of scraper and chopper types. It appears that the San Dieguito III phase tool kit became appreciably more diverse with the introduction of fine pressure flaking. Tools include pressure-flaked blades, leaf-shaped projectile points, scraper planes, plano-convex scrapers, crescentics (which may have been amulets), and elongated bifacial knives (Rogers 1939, 1958, 1966; Warren 1967; Warren and True 1961). Various attempts have also been made to associate cleared circle features with the San Dieguito phases, but no convincing chronological scheme has yet emerged (Pendleton 1984).

Because of the largely surface character typical of desert sites and the scarcity of chronological indicators, it has been difficult to substantiate the validity of Rogers' phase designations as temporal indicators, that is, chronologically successive changes in the tool kit of a long-lived culture. Some of the variations may have developed contemporaneously, in response to ecological or aesthetic requirements. Subsequent excavations at the C. W. Harris site in coastal San Diego County also failed to confirm Rogers' original observation of a stratigraphic separation between San Dieguito II and III assemblages (Warren 1967:171-172). Indeed, without a stratified context to demonstrate succession, the distinctions may as likely be due to economic specialization at a specific site or to sampling error, rather than to technological change through time. Rogers (1966:39) also identified different settlement patterns for each phase, but Sheila J. Vaughan (1982:6-11) argued that these distinctions were inadequately defined and inconsistently applied.

The San Dieguito pattern, as reconstructed from assemblage characteristics and site associations, represented a hunter-gatherer adaptation by which small, mobile bands exploited small and large game and collected seasonally available wild plants. The absence or scarcity of milling tools in San Dieguito assemblages has been seen as reflecting a lack of hard nuts and seeds in the diet, as well as being a cultural marker separating the San Dieguito culture from the later Desert Archaic culture (Moratto 1984; Rogers 1966; Warren 1967). However, manos and portable metates are now increasingly recognized at coastal sites that have been radiocarbon-dated to earlier than 6,000 B.C. Arguments have also been made for the presence of a well-developed early grinding tool assemblage, based on finds from the Trans-Pecos area of Texas (Ezell 1984). In regard to the Colorado Desert, Lorann Pendleton (1984:68-74) noted that most ethnographically documented pounding equipment for processing hard seeds and wild mesquite and screwbeans was made out of wood and would not have been preserved at open archaeological sites.

Site distributions indicate some of the basic elements of the San Dieguito settlement system. The sites may be located on any flat area, but the largest aggregations occur on mesas and terraces overlooking large washes or the margins of lakes. These are areas where a variety of plant and animal resources were located and where water was at least seasonally available. Pendleton (1984) made a strong case, based on an ethnographic analogy with the Colorado River Yumans, that San Dieguito occupation in the eastern Colorado Desert would have been focused on the river floodplain. She tested her model with the large array of data from Picacho Basin and argued that desert areas away from the river were used only to a limited degree, to take advantage of special resources within the foraging radius of logistically organized collecting groups.

Archaic Period (Pinto and Amargosa Patterns) (6,000 B.C.-A.D. 500)

The Pinto and Amargosa patterns are considered regional specializations within the widespread hunting-gathering adaptations that characterized the Archaic period (Campbell and Campbell 1935). Pinto and Amargosa sites occur more frequently in the Great Basin, Mojave Desert, and Sonoran Desert east of the Colorado River than in the Colorado Desert, where few Pinto or Amargosa (i.e., Elko series) projectile points have been identified on the desert pavements. It has been suggested that the California deserts were inhospitable during the Archaic period, particularly during the so-called Altithermal phase between 5,000 and 2,000 B.C., and that the mobile hunter-gatherers were forced to concentrate around limited locations or move to more habitable regions (Crabtree 1981; Schaefer 1994c; Weide 1974).

Some late Archaic sites have been identified along the boundary between the low desert and the Peninsular Ranges and at favored habitats at springs and tanks. The most substantial site from this period documented in the Colorado Desert is Indian Hill Rockshelter in Anza-Borrego Desert State Park, where 1.5 meters (m) of Archaic period cultural deposits were excavated below a late prehistoric component (McDonald 1992). Most significant were 11 rock-lined cache pits and numerous hearths, indicative of either a residential base or a temporary camp in which food storage was integral to the settlement-subsistence strategy. Also recovered were numerous Elko Eared dart points, flaked stone and milling tools, and three inhumations, one of which was radiocarbon dated to 4,070±100 years before present (B.P.) Two similar rock-lined pits were excavated at a small rockshelter in Tahquitz Canyon near Palm Springs (Bean et al. 1995). The small quantity of artifacts at the latter site suggested strategically stored food and seed processing equipment that was used by small mobile groups. More recently, a late Archaic period campsite was also identified in 8-m deep dune deposits adjacent to the north shoreline of Lake Cahuilla (Love 1996). Other Archaic sites have been recently discovered in interlacustral deposits on the bed of Lake Cahuilla in the northern Coachella Valley and also the first substantial habitation site from this period has been found near Desert Hot Springs (Schaefer and Laylander 2007). Radiocarbon dates of almost 3,000 years B.P. and associated bird and fish bone confirm a late-Archaic-period Lake Cahuilla occupational horizon. Additional Archaic sites fairly certainly are still to be discovered, buried under alluvial fans and wash deposits, sand dunes, Lake Cahuilla sediments, or Colorado River valley alluvium.

Late Prehistoric Period (Patayan Pattern) (A.D. 500-1900)

Major innovations during this period included the introduction of pottery making by the paddle-and-anvil technique and bow-and-arrow technology, perhaps around A.D. 800, and the introduction of floodplain agriculture at about the same time (Rogers 1945). Exact dating of early domesticates is lacking (Schroeder 1979). Agriculture and ceramics were probably introduced either from northwestern Mexico or from the Hohokam culture on the Gila River (McGuire and Schiffer 1982; Rogers 1945; Schroeder 1975, 1979).

Between A.D. 1,000 and 1700, desert peoples of this region appear to have extended their focus somewhat away from the Colorado River floodplains to a more mobile, diversified resource procurement pattern, with increased travel between the river and Lake Cahuilla to the west (Pendleton 1984). Long-range travel to special resource collecting zones and ceremonial locales, trading expeditions, and possibly warfare are reflected by the numerous trail systems seen throughout the Colorado Desert. Pot drops, trailside shrines, and other evidence of transitory activities are often associated with these trails (McCarthy 1982, 1993).

Several local varieties of pottery appeared during the Late Prehistoric period (Waters 1982a, 1982b). Many of the pictographs, petroglyphs, and bedrock grinding features in the Colorado Desert have also been associated with the Patayan pattern, although it is difficult to date such features directly or to determine their cultural affiliations. During this period, and possibly also in the preceding Archaic period, specific volcanic and sandstone rock outcrops along the Colorado and Gila rivers were exploited for the manufacture of stone pestles and portable milling slabs (Schneider 1993, 1994). With the completion of the final recession of Lake Cahuilla around A.D. 1700, the Patayan III phase emerged, apparently including a return to reliance on the Colorado River floodplain as well as some floodplain agriculture along the New and Alamo rivers in Imperial Valley, where mixed horticultural/hunter-gatherer economies were practiced.

Historic Period (Native American Ethnohistoric and Euro-American Patterns) (post A.D. 1540)

The ensuing sections describe the ethnohistoric and historic occupation of the project vicinity. The discussion includes brief accounts of the Colorado River People, the Desert Cahuilla, and the Chemehuevi, and concludes with a description of Euro-American land use patterns pertaining to the project area.

Colorado River People

The Halchidhoma were a Yuman-speaking group who lived along the Palo Verde Valley of the lower Colorado River Valley, in the vicinity of modern Parker and Blythe. Although somewhat distant from the project area, they are likely to have traveled between their homeland and the

Coachella Valley via the Chuckwalla Valley. In the early seventeenth century, they were living on the lower Colorado River below its junction with the Gila River, but in the eighteenth century they were reported in the area around Blythe. During the early nineteenth century, conflicts with their River Yuman neighbors, the Quechan and the Mohave, forced the Halchidhoma to move east to the middle Gila River, where they merged socially and culturally with the Maricopa. Because of these historical circumstances, traditional Halchidhoma culture is less well known than that of other River Yuman groups (Harwell and Kelly 1983; Spier 1933). However, studies of the other groups shed light on Halchidhoma lifeways (Bee 1981, 1983, 1989; Castetter and Bell 1951; Forbes 1965; Forde 1931; Knack 1981; Kroeber 1925; Pendleton 1984; Stewart 1983; Woods 1982).

Spanish explorers made the first historic accounts of the native inhabitants of the lower Colorado River. The first professional anthropological account was by Alfred L. Kroeber (1920, 1925), who conducted extensive fieldwork, particularly among the Mohave in the Needles area, between 1900 and 1910. Because the River Yumans were generally so successful in keeping Spanish missionaries out of their territory and because of their relative spatial and cultural isolation from Euro-Americans for a long period, the Colorado River Yumans maintained their languages, religion, and cultural practices to a much greater degree than most coastal California groups. Early ethnographers during the period between 1900 and 1950 were able to record a rich oral literature and reconstruct pre-contact lifeways to a considerable degree. However, many aspects of traditional technology, such as ceramics and the production of flaked and ground stone tools, had been lost due to the rapid adoption of Western material culture. A Yuman emphasis on spiritual concerns over material things and a preoccupation with warfare meant that a rich oral tradition of myths, epic stories, and battle narratives was still extant at the beginning of the twentieth century and continues down to the present.

The lower Colorado River area was characterized by shifting tribal territory and tribal boundaries throughout early historic times due to intensive inter-tribal warfare (Forbes 1965). When Hernando Alarcón sailed up the lower Colorado River in 1540, he described a condition of incessant warfare. During Juan de Oñate’s 1605 expedition, he found the Halchidhoma living south of the Gila River confluence. In the area that included Palo Verde Valley, south of the ethnographically familiar Mohave, Oñate encountered a group labeled the Bahacecha, whose identification with any subsequently known ethnographic group is uncertain (Laylander 2004).

Almost a century passed until the Jesuit missionary Eusebio Francisco Kino’s 1700 and 1701 visits to the juncture of the Gila and Colorado rivers. The Yuma crossing area was again visited by the 1774 and 1775-1776 Anza expeditions that brought settlers from Sonora to California. The Franciscan missionary Francisco Garcés left the second expedition at Yuma and explored the Colorado River as far north and east as the Hopi mesas. Garcés wrote one of the first detailed descriptions of the Halchidhoma, who at that period were found to have moved north between the Quechan and Mohave territories, from the Palo Verde Valley to the area just below Parker.

Spanish-Quechan interactions increased for a few years after the Anza expeditions, until two settlements with attached missions were established in 1780 near the confluence of the Colorado and Gila rivers. These efforts at Spanish colonization were motivated by the strategic important of the Colorado River crossing. However, conflicts between the settlers and the Quechan soon led to an uprising and massacre of the Euro-Americans in 1781. Contacts between the River Yumans and outsiders were few and often hostile throughout the ensuing half-century.

It appears from historical accounts and Yuman oral histories that the Halchidhoma were in an almost constant state of war with the Quechan and Mohave. The Halchidhoma, in turn, established alliances with the Cocopa and Maricopa, among others, in their efforts to maintain their territory. Eventually the Halchidhoma could no longer withstand the two-front attacks from the north and south. They gradually moved off the river to join kindred River Yuman groups in Maricopa territory on the middle Gila River after a temporary stay in northern Sonora. By around 1825-1830, most Halchidhoma had left the Colorado River, and the last families left by 1840.

There is no complete description of the lifeways of the Halchidhoma as they were lived on the Colorado River, because the Halchidhoma had begun to be assimilated into the Maricopa more than a half century before scientific ethnographies began to be written. Today the Halchidhoma are most closely associated with the Laveen community on the Salt River Reservation in Arizona, although descendants are distributed over several reservations (Harwell and Kelly 1983:74). Leslie Spier (1933) was fortunate to have a Halchidhoma elder as the principal informant for his landmark study of Gila River Yumans. By this time, many elements of Piman and Maricopa culture had been adopted, but some valuable information could still be derived concerning oral traditions. It is reasonable to assume Halchidhoma lifeways were very similar to those of the Quechan and Mohave when they occupied the Colorado River. In principle, the following description of Yuman society would apply to all of the River Yumans.

The focus on riverine subsistence resources encouraged a mixed foraging way of life for the River Yumans. Foods procured by seasonal rounds of hunting, fishing, and gathering supplemented small-scale agricultural practices. According to Robert L. Bee (1983), the Mohave relied more heavily on agriculture than did the Cocopa in the Colorado River’s delta or the Quechan. In their study of Yuman agricultural strategies, Edward F. Castetter and William H. Bell (1951) estimated that about half of the Mohave diet derived from farming. They estimated that the Cocopa, by contrast, derived only about 30 percent of their diet from agriculture because of greater access to a diversity of habitats; the Quechan (and presumably also the Halchidhoma) diet was intermediate between the Mohave and the Cocopa (Bee 1983).

Agricultural strategies were designed to optimize use of floodwaters bringing the necessary moisture to the fields, which tended to be quite small in size (2-3 acres). Aboriginal cultivated crops included maize, beans, squash, melon, and various semi-wild grasses. Seeds were planted in newly deposited sediments after the floodwaters had receded. The River Yumans also used more than 75 wild plant foods as food sources, the most important being mesquite and screwbean. The primary source of dietary animal protein came from fish caught in the Colorado River. Among the more important species were the humpbacked sucker and Colorado pike minnow. Regularly hunted game included small mammals such as rabbits, squirrels, and pack rats. Larger game that figured in the diet included deer and bighorn sheep, but these were probably hunted with less frequency and were less abundant than small game. However, their meat was highly regarded by the River Yumans, particularly in winter, when reliable sources of dietary fat were in especially short supply.

Swarthout and Drover's (1981) Model II characterizes the Quechan and Halchidhoma settlement and subsistence strategy on the Colorado River below Topoc. This model presumes a low reliance on cultigens, accounting for no more than 30 to 40 percent of the annual dietary intake (Castetter and Bell 1951:74). Residential bases were centered on the Colorado River but conformed to a bipolar pattern. Spring and summer houses were located near each agricultural field, but up on the mesas, where they would be safe from floods (Kelly n.d.:55), while open-air ramadas were constructed on the floodplains adjacent to the fields. During this time, small parties sought out wild vegetal resources along the floodplain and adjacent washes. Mesquite and screwbean were important staples that were relied upon as stored staples during the winter months, especially if domestic crop harvests were inadequate. The winter season was a time to relocate to residential bases on upper Colorado River terraces, lower bajadas, and lower mountain slopes. Winter homes were more substantial earth-covered lodges (Kelly n.d.:55). The population subsisted on stored domestic and wild foods, in addition to what wild game could be had. Additional temporary camps would be established in outlying areas for extracting specific animal, vegetal, or lithic resources. As soon as the spring floods subsided, the population would then resume their lower terrace residences.

Yuman groups were organized into patrilineal, exogamous, totemic clans (referred to as sibs in the early literature). Each clan or *cimul* was named after a plant, animal, or natural object, and this name was borne only by female members (Gifford 1918). There were no clan leaders, and the clan did not have special ceremonial or sociopolitical functions. Clans were not localized at specific rancherias; the latter contained members of several clans. Each localized rancheria or band recognized a leader (*pi'pa taxa'n*) who was called on to settle disputes, be responsible for the social and economic welfare of his people, decide on seasonal moves, and determine when to move the entire rancheria if necessary. His power was quite restricted, and he had limited influence. His position was achieved through dreaming, force of character, and demonstrated ability. Each tribal group also recognized a paramount chief (*kwoxot*) who might rise from the ranks of the rancheria leaders. This position may have become more important during the historic period as a result of contacts with Euro-American political and military institutions. A chief was not required to show prowess in warfare, and indeed he was expected to remain in the village or refrain from battle. Special war leaders (*kwanami*) were recognized for military tasks.

Unlike other southern California groups where the primary political allegiance and identity lay with the localized band, members of the River Yuman groups thought of themselves as belonging to a true nation. Julian H. Steward (1955:159-161) postulated that Yuman clans evolved from localized patrilineages like those found among the Cahuilla, but which had become dislocated and clustered into larger settlements as a result of the higher population densities afforded by horticulture. Growing population size in other areas of southern California brought about increasingly sedentary bands, but instead of band size growing there was shrinking of band territories. This pattern did not occur on the Colorado River, where people moved freely from one settlement to another. Entire settlements had to shift within the confines of the floodplain, depending on the location of arable land after each flood season. Steward identified warfare as another factor inhibiting the localization of clans and promoting increases in band size. Larger social groups afforded greater protection against enemy attacks.

The apparent emphasis on warfare in Colorado River Yuman culture has been the subject of considerable anthropological discussion. Chris White (1974) emphasized the ecological reasons for warfare, including environmental circumscription, high population density, and environmental instability. Edward W. Gifford (1931:161), Clifton B. Kroeber (1980), and Kroeber and Bernard L. Fontana (1986) stressed the deeply ingrained ideological and cultural values that were attached to personal battle in River Yuman culture. They argue that fighting was seen by its participants as a necessary means to enhance the spiritual power of the entire tribe, without regard to any material benefits. Probably both factors operated to shape the Yuman warrior tradition over time. Both ecological and cultural/ideological factors are intertwined in a complex and dynamic system, much as Roy A. Rappaport (1968) demonstrated for the role of warfare among New Guinea tribes people.

It is difficult to portray the complex and esoteric nature of River Yuman spirituality because it is a dynamic belief system in which dreaming, adherence to traditional learning, personal experiences, and varying patterns of acculturation affect its expression. This worldview stresses the interconnection of daily life with religion, in contrast to Western culture, in which the sacred and secular are more clearly segregated. The secular world exists concurrently with the spiritual world for traditional River Yumans, and the spiritual world can be experienced through dreams, vision quests, song cycles, the telling of the creation narrative, and many other oral traditions (Hinton and Watahomigie 1984; Kroeber 1925, 1948).

The Desert Cahuilla: An Interior Southern California People

Good ethnographic studies of the Cahuilla who live to the west of the project area are comparatively numerous (e.g., Barrows 1900; Bean 1972; Bean and Saubel 1972; Curtis 1926; Drucker 1937; Heizer 1974; Hooper 1920; Kroeber 1908; Patencio 1943; Strong 1929). Lowell John Bean (1978) summarized much of the information on the Cahuilla. While the principal residential loci of the Cahuilla were in the Coachella Valley and the Santa Rosa and San Jacinto Mountains, they were known to have traveled and maintained cultural contact with lower Colorado River peoples. The Chuckwalla Valley would have been one of their principal travel corridors for this purpose.

Cahuilla and other Takic (“Shoshonean”) speakers of the Uto-Aztecan linguistic stock, such as the Luiseño, Serrano, and Gabrielino, may have migrated south from the southern Great Basin into coastal southern California and the Colorado Desert. However, the specific period or periods, directions, and circumstances of this migration remain unclear (e.g., Golla 2007; Koerper 1979; Laylander 2007; Moratto 1984:165; Sutton 2009). Some estimates based on glottochronology (a statistical and lexical study of two languages deriving from a common source to determine the time of their divergence) and the distribution of archaeological assemblages would put the movement somewhere between A.D. 1 and 1,000, most likely around A.D. 500 but possibly as early as 500 B.C. What role these Takic speakers had in the development of the Patayan pattern in the Colorado Desert remains unclear. The ancestors of the River Yumans are most often identified as the source of ceramics, cremation practices, agriculture, some architectural forms, and some stylistic and symbolic representations. The Takic migrations may have coincided with the introduction of bow-and-arrow technology, but no direct association has been established. They may have contributed specific hunting and gathering techniques as well as cosmological and symbolic elements to the Patayan cultural system.

A dozen or more politically autonomous landholding clans owned territories within the region. Ideally, each of these territories extended from the desert or valley floor to mountain areas, encompassing several biotic zones. Clans were composed of one or more lineages, each of which owned an independent community area within the larger clan area. Cahuilla oral histories indicate that some clans replaced others, often by force, and also that new lineages would bud off from clans to establish new territories. Cahuilla mythology and oral tradition indicate that when Lake Cahuilla dried up, it was the mountain people who resettled the desert floor. By 1850, at least 17 rancherias are known in the Coachella Valley, most of them associated with hand-dug wells, springs, or palm oases. Reservoirs, irrigation ditches, and agricultural fields are documented at least as far back as the early nineteenth century (Wilke and Lawton 1975:21, 30ff).

In addition to each lineage’s residential area and other locations within a clan territory that it owned in common with other lineages, ownership rights to various food-collecting, hunting, and other areas were claimed by the various lineages. Individuals owned specific areas or resources, such as plant foods, hunting areas, mineral collecting places, and sacred spots used only by shamans, healers, and ritual practitioners.

While villages were occupied year-round, a large number of their inhabitants would leave at specific times to exploit seasonally ripening foods in different environmental zones. Temporary camps would be established in these food-collecting areas, and surpluses would be transported back to the main village. Mountain Cahuilla would move to the upper desert areas and establish temporary camps to process agave in late winter and early spring, and then move to lower desert areas to harvest mesquite beans in the late spring. Conversely, the Desert Cahuilla ascended the mountains in the fall for the pinyon and acorn harvests. Other springtime resources included yucca, wild onion, barrel cactus and other cactus fruits, goosefoot, and grass seeds. Other major upper-desert resources collected in summer included berries, manzanita, and wild plum. Fall was the season to gather grass seeds, chia, saltbush seeds, palm tree fruit, thimbleberry, wild raspberry, juniper berry, and choke berry. Many animal resources were hunted; bighorn sheep and deer hunts often coincided with the pinyon harvest. Rabbits were the most common game throughout the year.

Bean and Katherine Saubel (1972:20) estimated that no village was located more than 26 kilometers (km) from all of the food-gathering areas within its territory and that 80 percent of all food resources could be found within an 8-km foraging radius around the village. Such ideal proximity to diverse habitats was made possible by the steep topographic gradient on the eastern side of the San Jacinto and Santa Rosa mountains.

Cahuilla clans varied in population size from 100 to several thousand people. They were arranged so that each community was placed in an area near significant water and food resources. Communities were generally several kilometers from their neighbors, and within a community, houses and structures were placed at some distance from each other. Often a community would spread across 2-3 km. Each nuclear and extended family had houses and associated structures for food storage and shaded work places for processing foods and manufacturing tools. Each community contained the house of the lineage or clan leader: the *net*.

This position was often hereditary within families of high social status. The *paxa* was another hereditary leader with responsibilities for managing ritual events. Other important ceremonial positions included the shaman (*púul*), singer (*háwaynik*), and diviner (*tet♣ayawiš*). There were a number of non-official ritual practitioners.

Within each community was a ceremonial house (*kiš♣ámnawet*) where most major religious ceremonies of the clan were held. These took place with considerable frequency. The most significant ceremonies focused upon the proper care of the deceased members of the linage or clan. In addition to house and ceremonial structures, there were storage granaries, sweathouses, and song houses (for recreational music). Close to each community were many food resources, building materials, minerals, and medicines. Usually an area within 1-5 km contained the bulk of materials needed for daily subsistence, although the territory of a given clan might be larger, and longer distances were traveled to get precious or necessary resources that were located at higher elevations. While most daily secular and religious activities took place within the community, there were places at some distance from the community, such as acorn and pinyon groves, where people stayed for extended periods. Throughout the area there were sacred places used primarily for rituals, inter-clan meetings, caching sacred materials, and shamans' activities. Cave sites or walled cave sites were used for temporary camping, storing of foods, fasting by shamans, and use as hunting blinds.

The Desert Cahuilla began to become familiar with Europeans as early as 1797. Often their relatives in western Cahuilla areas were baptized and worked among the Spanish. In addition, runaway neophytes sought refuge among the desert tribes. The impact of the Spanish mission system and colonization along the coast was much less immediate and profound among the isolated desert and mountain groups. More direct influence was not felt until after the establishment of the San Bernardino *estancia* in 1819 and of a cattle ranch at San Gorgonio subsequently. When the Romero Expedition passed though the area in 1823-1824, it was clear that the Cahuilla were accustomed to seeing vaqueros employed by the rancho driving cattle through the area. Certainly by 1823 the Cahuilla were not only familiar with Hispanic ways but were comfortable in dealing with them, as evidenced by their reaction to the members of the Romero Expedition (Bean and Mason 1962). The expedition reported that the Cahuilla at Toro were engaged in agricultural pursuits, growing corn and melons, and were already familiar with the use of horses and cattle.

Political leadership became more centralized during the Spanish and Mexican periods, as Europeans recognized high-ranking or charismatic clan leaders as representing entire tribal areas (Strong 1929:149). Emerging as central figures were Juan Antonio among the Mountain Cahuilla and Chief Cabazon in the desert. As early as 1844, Juan Antonio led several mountain clans to the San Gorgonio Pass area to provide security for Rancho San Bernardino. His group played a significant role during the Mexican-American War, siding with the Mexicans against the Luiseño, who supported the American invaders (Phillips 1975).

The 1848 Treaty of Guadalupe Hidalgo obligated the Americans to preserve the liberty and property of the prior inhabitants of California. The U.S. government in 1850 appointed three commissioners to conduct negotiations with tribal leaders across California in order to settle all land rights issues. One of the 18 treaties to be drafted covered the Cahuilla, Serrano, and Luiseño and was signed in Temecula on January 5, 1852. The tribal leaders were promised supplies, food, and technical training in return for accepting specified reservation lands. But as was so often repeated throughout the American West, local Euro-Americans lobbied against the treaty and the U.S. Senate never ratified it. The traditional territorial base of the Cahuilla continued to shrink as whites flooded into the area to claim the best farming and grazing lands.

European diseases were probably beginning to take their toll on the Cahuilla in the early 1800s, but they became particularly severe in the 1860s. The most dramatic episode was the great smallpox epidemic of 1863 that killed Juan Antonio as well as many bearers of traditional tribal culture. Survivors of previously autonomous clans clustered into the remaining villages or founded new settlements in an accelerated process of population aggregation and reorganization. This process continued through the following decades.

The Cahuilla land base was substantially reduced in the 1860s and 1870s as the U.S. government ceded alternate sections within 10 mi. of the new transcontinental railroad route to the railroad companies. Sections 16 and 36 of every township were also removed from federal control as a school tax base. Any de facto Native American control of larger territorial bases was undermined in 1876 when President Ulysses S. Grant issued an Executive Order setting aside small reservations for all groups classified as “Mission Indians.” These reservations included the sections or parcels in which the Cahuilla had aggregated during the previous decades and in which they had made improvements for farming. The following year, another Executive Order by President Rutherford B. Hayes set aside even-numbered sections and certain other unsurveyed portions of townships for Indian reservations. The result was a checkerboard pattern of Indian-controlled land, encompassing 48 sections, spread across the eastern edge of the Santa Rosa and San Jacinto mountains and the Coachella Valley (Cultural Systems Research 1983). With various additions and withdrawals over time, this has remained the permanent land base of the Cahuilla to the present.

As traditional lifeways became more difficult to maintain, the Cahuilla adapted to their new geographical and political environment by taking jobs at American ranches, towns, and cities. The 1860s through 1880s was a period of increased acculturation, as new technologies, material goods, and practices were incorporated into the traditional lifeways of the reservation. Ceremonial practices remained particularly strong despite Catholic and Protestant influences on the reservations. Ceremonial houses still existed through the 1950s, 1960s, and early 1970s, and many cultural traditions still remain part of westernized lifestyles. Many Cahuilla retain an acute interest in the cultural heritage and cultural resources of their traditional territories.

The Chemehuevi: A Great Basin People

In late prehistoric times, the Chemehuevi occupied desert areas west of the Mohave and north of the Cahuilla. Subsequently, during the early historic period, they took over the portion of the lower Colorado River valley that had previously been held by the Bahacecha and the Halchidhoma. Chemehuevi speech is a dialect of the Southern Paiute or Ute language, belonging to the Numic branch of Uto-Aztecan family. Although the time of Chemehuevi entry into eastern California remains unclear, it was probably in the period between A.D. 1200 and 1500, when brown ware pottery and twined basketry became conspicuous in archaeological sites (Kelly and Fowler 1986).

The Chemehuevi lived in smaller and more mobile groups than the Cahuilla or the Yumans, in order to adapt to the sparser and more widely distributed resources of their desert. They subsisted primarily on small game and a wide variety of seasonally available wild plants. Seed plants were especially important.

The Chemehuevi were allied militarily with the Mohave and Quechan, and they were allowed plots of land to cultivate crops in Mohave territory. One of Isabel Kelly's consultants related that most Chemehuevi did not begin to move down to the Colorado River until after 1833 and before the founding of Fort Mojave in 1859 (Kelly n.d:28). This would also have been the period when the Halchidhoma left the river. As a result of their close association, the Chemehuevi share some elements of material culture with the Mohave, such as ceramic styles, square metates, some earth-covered house forms, storage platforms, song series, dream emphasis, warfare patterns, and personal adornment. Other aspects of Chemehuevi culture are distinctively Great Basin, such as their extremely fine basketry. The Chemehuevi have distinguished themselves from their Yuman neighbors by their very different mythology, worldview, religious practices, kinship system, and political organization (Laird 1976, 1984).

Like the Yumans, the Chemehuevi were great travelers and regularly visited the Kawaiisu, Serrano, Vanyume, Cahuilla, Quechan, and Kumeyaay. They may even have visited the western California coast to trade. They occasionally joined the Quechan and Mohave in battles against the Halchidhoma. When the Halchidhoma finally left the river by 1840, the Chemehuevi made use of some of the vacated river valley, particular the Parker and Chemehuevi valleys. However, hostilities broke out between the Chemehuevi and Mohave between 1865 and 1871 when the Mohave began moving south to inhabit the newly created Colorado River Reservation. The Chemehuevi retreated westward into the desert, where they took refuge with the Cahuilla near Banning and in the Coachella Valley, and with the Serrano at Twentynine Palms. Additional land was added to the Colorado River Reservation in 1874 in order to encourage the Chemehuevi to move there from areas near Blythe, Needles, Beaver Lake, and Chemehuevi Valley. Both peaceful and forceful efforts by the U.S. government to move the Chemehuevi onto the reservation were met with mixed results, and it was not until the early 1900s that the Chemehuevi agreed to move.

The Euro-Americans and Other Newcomers

The following brief discussion focuses on several historic-period themes for which cultural resources are most likely to be represented in the project area: features relating to mining and transportation, water conveyance, and World War II military training.

Mining

The first mining efforts in the general region may have taken place in the Cargo Muchacho Mountains (hard rock mining) and Potholes (placer mining) areas in 1780-1781 near Yuma, contemporary with the short-lived Franciscan missionary efforts at the confluence of the Gila and Colorado rivers. Extensive mineral exploration began in the early 1860s, when the Mother Lode gold mines in the Sierra Nevada were becoming played out and miners looked for new discoveries in other parts of the American West.

One of the first and largest mining booms occurred in the La Paz and Castle Dome districts on the Arizona side of the Colorado River opposite Blythe. Miners from California and Sonora poured into the area in the early 1860s and 1870s. The Bradshaw Road (Trail) was established as a stagecoach and supply haul route from 1862 to 1877 providing a major transportation link between Los Angeles and the ferry to Ehrenberg, Arizona (Johnston 1987). It ran from San Bernardino through the San Gorgonio Pass, down the Coachella Valley to Dos Palmas, through Salt Creek Pass between the Orocopia and Chocolate Mountains, then along the Chuckwalla Mountains and through the Little Mule Mountains to the Colorado River. It is generally accepted that this route follows the Native American Cocomaricopa Trail, although McCarthy (1982) identifies the major east-west trail through Chuckwalla Valley, CA-RIV-79, as the Cocomaricopa Trail. The greatest period of activity was between the 1870s through 1890s and was facilitated by the Southern Pacific Railroad, which reached Yuma in 1877, and by links on the river provided by commercial riverboat traffic (Vredenburgh et al. 1981:8). This improved means of access to the Colorado River and the initiation of a tri-weekly stage between Yuma and Ehrenberg in 1880 finally put the Bradshaw Road out of business.

Early prospects are known from Mule Mountains in 1861 and in the Big Maria Mountains and neighboring McCoy Mountains as early as 1862 when they were part of the Ironwood Mining District (Vredenburgh et al. 1981:24, 40; Warren et al. 1981:97). The Big Maria Mountains, originally called the Half-Way Mountains by the 1858 Ives expedition, were referred to as the Chemehuevi Mountains on maps from the 1860s (Gunther 1984:310-311). It was probably during this period that portions of the Big Marias, the McCoy Mountains (named after prospector William McCoy), and the Palen Mountains (named after prospector Matt Palen) were included in the Chemehuevi Mining District (Vredenburgh et al. 1981:40; Warren et al. 1981:105). By 1909, the so-called Chemehuevi Mountains were christened the Santa Marias and divided into the Big Maria (east) and Little Maria (west) ranges. Mineral deposits include gold, silver, fluorite, manganese, copper, gypsum, and uranium (Warren et al. 1981:96).

Eagle Mountain, at the northern end of the present project area, was the focus of prospecting by Joe Torres as early as late 1870s and early 1880s. He identified a magnetite deposit but made no claim as he was after precious metals. That distinction came to Jack Moore who in 1881-1882 staked a claim and with his father and two other partners founded the Eagle Mountain Mining District for the exploitation of iron, gold, and silver. The Iron Chief, Black Eagle, and other claims were among those with gold but also rich iron content. They failed to maintain the necessary assessment work to validate the claim, however, and the area was abandoned for mineral development until 1895. That year L. S. Barnes of Mecca, a former student of the Colorado School of Mines, began to consolidate the claims after examining Joe Torres' original iron ore samples. Barnes completed his consolidation by 1912 and sold the package to Henry E. Harriman, CEO of the Southern Pacific Railroad (SPRR). Harriman's goal was to challenge J. P. Morgan's U.S. Steel Trust by threatening a viable West Coast industry, thereby lowering the price of steel he had to pay for his own railroad. Harriman bought a steel mill in San Pedro, California and surveyed a rail spur. Possibly a bluff, he succeeded in lowering the price of steel for the SPRR but died before it could be determined if he meant to carry through with his scheme (Belden 1964a; Hilton 1949; Love 1994).

World War II saw an enormous demand for steel, but during this time the Joshua Tree National Monument was formed, including the Eagle Mountain claims, thus protecting the ore bodies from mining. Henry J. Kaiser then took interest in the Eagle Mountain claims. From road contracting, Kaiser distinguished himself as a member of the team who built Boulder and Bonneville dams. He owned a steel mill at Fontana and the Vulcan iron mine near Kelso in the Mojave Desert that supplied materials for his west coast shipyards. Requiring more steel, he managed to purchase the Eagle Mountain claims from the Harriman heirs with the proviso that the SPRR be used to ship the ore. Having won a legal challenge to the claims, Kaiser succeeded in having the Joshua Tree Monument boundaries shifted to exclude the Eagle Mountain properties. He then commenced work in 1944 to survey a new railroad route with a necessary limited grade of only 2 degrees between Eagle Mountain and the SPRR. Three routes were surveyed; the one chosen went south through Salt Creek to emerge between the Orocopia and Chocolate mountains at Durmid in the Coachella Valley where the line connected with the SPRR at Ferrum Junction, then continued west to the Fontana steel mill (Backman 1949; Belden 1964b). Construction on the railroad began in 1947 and was completed on June 23, 1948, as the Kaiser Industrial Railroad (Eagle Mountain Industrial Railroad).

Ore shipment from the mine began immediately, and by 1971 the Eagle Mountain Iron Mine was producing 90 percent of California's total iron output (USDI Bureau of Mines 1971). Over 4,000 people were employed in the operation, making the Eagle Mountain Mine Riverside County's largest employer. The company town of Eagle Mountain included schools, fire and police departments, civic facilities, 416 rental houses, 185 trailers, 383 dormitory rooms, and 32 apartments (Bull et al. 1991). Kaiser Steel's need to provide medical care for their employees evolved into what is now known as Kaiser Permanente. Competition from abroad and other economic factors caused the mine to close in 1983 after 35 years in operation. Much of the housing stock was either removed, left vacant, or vandalized. By 1994, a school, a new low security prison (1988-2001), and some rental properties remained at Eagle Mountain but it is largely relegated to a ghost town today (Love 1994).

Interstate 10, a major transportation artery connecting the Los Angeles area with Arizona and points east, runs near the southern edge of the project area. The route was probably also used prehistorically as it represented a relatively low (but dry) corridor for travel between the lower Colorado River in Palo Verde Valley and the Coachella Valley. During the early twentieth century, as the region's highway system was gradually developed, the route was known under a succession of different designations, including Legislative Route 64 and U.S. Route 60. As late as 1926, the portion of the route through Chuckwalla Valley was unimproved. Interstate 10 was finally completed by 1968.

<u>Desert Center</u>

The town of Desert Center was founded in 1925 by Stephen ("Desert Steve") Ragsdale and his wife. They originally arrived with their four children to the area in 1921 when they bought the homestead of Wilbur C. and Peter S. Gruendike, who in 1913 and 1916, respectively, each received a patent to 160 acres along the Chuckwalla Road between Mecca and Blythe (Gunther 1984:150, 212). Peter Gruendike dug a well and installed a windmill on his parcel, some 200 ft. north of the road and their ranch house. The ruins are today listed as site CA-RIV-187. The Ragsdales operated a service station there from 1921-1925 when the State of California moved the Mecca-Blythe Road 1.25 miles south and named it U.S. Route 60. In response, the

Ragsdales moved all their buildings about five miles to the southwest along the new highway and founded Desert Center, being 50 miles either way between Blythe and Indio. Ragsdale patented 40 acres at this location in 1927, which eventually grew to 700 acres on either side of the highway. He is said to have accomplished this by having his employees at the restaurant and store file for Desert Entry Lands while they lived and worked at Desert Center and then sell their parcels to Ragsdale. An ordained Methodist Minister, "Desert Steve" ran a dry privately-owed town, representing the law as a Deputy Sheriff. He even managed to organize a school district specifically for the education of his four boys. In addition to the Ragsdale home and those of his employees, the original town included a poured concrete café in the Southwestern adobe style, an attached gas station and mechanics shop, a market, post office, and school. The Ragsdale operation grew to include facilities at Shaver's Summit (later Chiriaco Summit), Box Canyon, Skyway, Hell, and Cactus City.

"Desert Steve" left Desert Center for Santa Rosa Mountain in 1950 after being accused of an affair with an office worker, leaving the business to his sons, Stanley, Thurman, and Herbert. Stephen died in 1971. Stanley eventually purchased the entire town and ran the café and gas station for decades. He died in 1999. The town remains as a waypoint on Interstate 10.

Water Conveyance

The Colorado River Aqueduct runs through the study area, with the Eagle Mountain Pumping Station located at the far eastern tip of the Eagle Mountains. The proposed 500 kV transmission line and water line cross underground portions of the aqueduct along Phoneline Road, 3.1 and 6.2 mi., respectively, north of the pumping station.

The aqueduct was constructed between 1931 and 1941 by the Metropolitan Water District (MWD) as one of the major Colorado River water delivery public works projects that included the construction of Boulder Dam and the All-American Canal. The first water deliveries began on January 7, 1939. The original engineering was conducted under a $2 million bond issued from the Department of Water and Power, with construction undertaken by MWD for $220 million. Originally conceived by William Mulholland and designed by MWD Chief Engineer Frank E. Weymouth, it was intended to provide Los Angeles with more drinking water, but since the end of World War II, the distribution system has been extended to serve much of southern California's domestic, agricultural, and industrial needs from Ventura to San Diego.

The intake pumps are located at Lake Havasu above Parker Dam on the Colorado River. From here, the aqueduct travels 242 mi. across the Colorado Desert through 63 mi. of open canals, 92 mi. of tunnels, and 84 mi. of buried conduit and siphons. The aqueduct terminates at Lake Mathews near Corona. Five pumping stations take the water over mountainous terrain. With a capacity of 1,600 ft^3 per second, the average annual throughput is estimated at 1.2 million acre-ft. per year (Bean 1968:398-401; Cooper 1968:87-89; Metropolitan Water District of Southern California 1941).

As the largest public works project during the Great Depression, the project employed 10,000 people at any one time and when completed, was recognized as a pivotal component of Los Angeles' enormous growth during World War II and in the following decades. It remains a linchpin in southern California's vital infrastructure. In 1955 and 1994, the American Society of

Civil Engineers (ASCE) recognized the Colorado River Aqueduct as one of the "Seven Engineering Wonders of American Engineering" (ASCE Website).

Desert Training Center/California-Arizona Maneuver Area (DTC/C-AMA)

The deserts of southern California and western Arizona became the focus of important training exercises during World War II. This activity left abundant physical traces on the landscape.

The Desert Training Center (DTC) was opened on April 30, 1942. The normally serene desert gave way to the rumble of tanks and staccato of machine guns for almost two years, until 1944. The largest military training installation ever to be created (approximately 10,130 $mi.^2$), the facility had General George S. Patton, Jr., as its first commanding officer (Bischoff 2000; Henley 1989; Meller 1946). Patton proclaimed the DTC as "probably the largest and best training ground in the United States" (Meller 1946:35). It served the vital purpose of conditioning troops to desert warfare conditions and tactics in preparation for the North African Campaign. The center was also used to field-test equipment and supplies. The original facility extended from the Colorado River on the east to a point slightly west of Desert Center on the west, and from Searchlight, Nevada, on the north, to Yuma, Arizona, on the south. This region was ideally suited for the purpose, in that it contained a variety of terrain types and no large population centers (Howard 1985:273-274).

Patton left with his troops for North Africa later in 1942, but the facility continued to operate throughout the war, processing several million troops. However, following the success in North Africa, an emphasis on desert warfare was no longer necessary. The name of the Desert Training Center was changed to the California-Arizona Maneuver Area (C-AMA or CAMA) on October 20, 1943, and its purpose was expanded to serve as a simulated theater of operations emphasizing large-scale logistics and not exclusively desert warfare tactics. This included solving complex communications and supply problems and Army Air Forces support of ground troops (Howard 1985). The facility provided training for combat troops, service units, and staff under conditions similar to a combat theater of operations. Under Major General Charles H. White, the training area was enlarged by another 6,251 $mi.^2$ and extended from Gila Bend on the east to Pomona on the west, and from Yuma on the south to Boulder City on the north (Howard 1985:281-282). Command would change three more times before C-AMA closed.

Headquarters and the first camp for the DTC/C-AMA was at Camp Young, located at a place called Shaver's Summit, now known as Chiriaco Summit after Joseph Chiriaco, from whom Patton bought 28 acres for a token sum of five dollars (Bischoff 2000:12-16). Camp Young is listed as a California State Historic Landmark (No. 985). This location and others along the Chuckwalla Valley corridor were chosen because of the easy access to supplies via the road to the Coachella Valley and the SPRR, and ample water to be derived from the Colorado River Aqueduct. Although most closely associated with Patton's short residence during the formative months of the DTC, Camp Young is located some 29 km west of Desert Center and the southern end of the study area.

In all, there were 11 major DTC/C-AMA camps, seven of them in California and four in Arizona. Camp Rice, home to the 5th Armored Division and Rice Army Airfield, was one of the smaller bases strategically located on the Atchison, Topeka and Santa Fe Railroad line west of

Parker (Lynch et al. 1982). Larger divisional camps that may have deployed troops into the project area include Camp Desert Center, Camp Iron Mountain, Camp Granite, and Camp Coxcomb, located north of Desert Center. A network of railroad lines and major roads connected all the divisional camps and depots. Farther out across the desert landscape were the smaller camps and bivouacs for specific field exercises. For example, a platoon might build rock blinds from which they could practice the defense of a mountain pass (Vredenburgh et al. 1981).

During the DTC period, exercises emphasized operating with a restricted water supply, sustaining operations remote from railheads, navigating and resupplying under the cover of darkness, and combined training with the Army Air Forces (Howard 1985:274). A four-phase training program was developed that would not exceed six weeks in duration. First phase training emphasized the individual, crew, squad, section, and platoon. The second phase concentrated on the company and battery. The third phase consisted of battalion training, and the fourth emphasized the combat team whereby armored units, air, and ground forces were all coordinated. The training program ended with an exercise lasting several days and covering about 300 mi. Advanced supply bases were established along projected routes, tactical maneuvers were conducted in darkness, and tactical bivouacs were established in the presence of hostile air and mechanized threats (Howard 1985:278; Meller 1946:13).

Training during the C-AMA period consisted of a 13-week program. Firing ranges of all types were constructed, and troops were trained with pistols, machine guns, rifles, and artillery. They also took courses in infantry tactics using live ammunition. Emphasis was placed on development of platoon efficiency. Platoons of 40 to 45 men were sent out on six-day field problems involving directional skills and coordination with supply units. The three final weeks consisted of maneuvers. The first exercise involved a defensive force establishing a position for the purpose of protecting a vital area or installation. The second exercise consisted of field maneuvers that simulated a campaign of approximately 11 days and 10 nights designed to test the endurance of units and their ability to fight and resupply over great distances while providing daily maintenance of equipment and recovery and evacuation of disabled vehicles (Meller 1946:62).

Spartan camp conditions were deliberately maintained to provide soldiers with a realistic, battle-ready experience. Through the history of C-AMA, orders were periodically given to prevent any center from lapsing into more comfortable conditions, although Camp Young appears to have been an exception. No units were allowed to stay too long at any center. The most mobile were supplied with B-rations and C-rations, and no screened eating areas would be provided. The Ground Surgeon was well aware that during the warmer seasons, flies would cause near-epidemics of dysentery. Screened eating areas were therefore advised for service units that had to remain in certain areas, such as base camps, for longer periods. However, orders were subsequently given that no new screened areas were to be built and old ones would not be maintained. Iced fresh food was also prohibited. Lowered morale from the monotony of B-rations, disease outbreaks and even some reported deaths, and public protest eventually led to some relaxation of these severe conditions. Shortly before C-AMA was closed, all units were allowed to enjoy A-rations (Meller 1946:50-55).

The divisional camp closest to the project area was Camp Desert Center, located between Camp Young and Desert Center and extending immediately east of Eagle Mountain Road and north of the old highway that preceded Interstate 10. Very little documentary information is currently known for Camp Desert Center, nor is its specific history and range of functions clearly understood. The BLM did not include Camp Desert Center in its interpretive plan for the major camps of the DTC/C-AMA, although it includes preservation and interpretive goals for the other major sites (USDI Bureau of Land Management 1986). The 34,000-acre area included a cantonment with tent housing, an observer's camp, an ordinance camp, an evacuation hospital, a quartermaster truck site, and an extensive maneuver area. Bischoff (2000:58-60) reports that not much is left of Camp Desert Center except for rock-lined paths, tent pads, oiled road surfaces, and trash scatters with many gas, oil, and food containers. Locals report artifacts extending for a substantial distance north of Desert Center. Bischoff also reports 1940s-era refuse near the Eagle Mountain Mine Industrial Railroad, although that association may indicate that they postdate the DTC/C-AMA.

The full extent of the complex, including the hospital, has not been previously recorded. E Clampus Vitus historians have conducted more research on the hospital and have made a more committed identification of the site as such. With the BLM, they are about to unveil a new historical monument at the hospital site with the following text:

36TH EVACUATION HOSPITAL (SM)

During the opening days of World War II, more than 18,000 square miles of the Arizona and California desert were designated by the U.S. Army as a military training facility. The facility, conceived by General George Patton and referred to as the Desert Training Center (DTC), was designed to prepare troops for the rigors of desert warfare in the invasion of North Africa. Operating from 1942–1944, the DTC expanded far beyond its original scope, and became known as the California-Arizona Maneuver Area (C-AMA) in 1943. Numerous camps were established throughout the desert, in addition to airfields, supply depots, hospitals, firing ranges, and maneuver areas. Over the two year life of the Desert Training Center, more than 1.2 million troops were hardened for battle in the deserts of California and Arizona.

Located just to the north are the archaeological remnants of the Evacuation Hospital Camp Site. The 36th Evacuation Hospital was stationed here for training from May to December 1943. Evacuation hospitals were 400 bed facilities that provided care to sick and wounded soldiers under combat conditions. The 36th was located at this site until it participated in IX Corps maneuvers, whereupon it moved by Camp Dunlap, near Niland. During this time it maintained a 100-bed base hospital here while the rest of the unit was deployed elsewhere. At the end of maneuvers, the entire hospital was relocated to this original site. The 36th Evacuation Hospital served in the Pacific Theater of operations where it took part in the New Guinea, Luzon and Leyte campaigns and the occupation of Japan and was stationed in Vietnam from 1966 to 1969.

This monument is dedicated to the men and women who served in this unit
By the Billy Holcomb Chapter of the Ancient Order of E Clampus Vitus
and the Bureau of Land Management.

Previous Cultural Resources Investigations

A search of cultural resource records at the Eastern Information Center (EIC) was performed on April 25, 2008, supplemented by reports available at ASM Affiliates. The search identified 26 previous reports within a 1-mi. radius of the project alignment, of which nine are mapped as including portions of the project area proper. A total of 31 cultural resources are recorded within a 1-mi. radius of the project area. Of these, only one falls at least in part within the preferred project: an underground portion of site CA-RIV-6726H, the Colorado River Aqueduct, which is crossed by both the Preferred Transmission and Water Lines. Additionally, the project alignment intersects the historic Eagle Mountain Industrial Railroad in at least two locations. The results of the records search are addressed in a separate report prepared by ASM for the proposed Eagle Mountain Pumped Storage Project (Schaefer 2009).

3. FIELD METHODS

The study area was subject to a full coverage pedestrian survey done at 15-m transect intervals. Full coverage survey, as it relates to this survey, is best defined as a 100 percent coverage involving systematic examination of blocks of terrain and linear alignments at a uniform level of intensity. Standard global positioning systems (GPS) aided in navigation, and a differential, post-processed, decimeter-level GPS unit recorded the location of each site datum at newly discovered sites. Thus, GPS systems obtained precise site location data.

The APE for survey coverage was supplied to BLM in a Fieldwork Authorization Request under ASM's Statewide Permit No. CA-09-06. BLM issued a Fieldwork Authorization, No. 66.24 09-07 on February 26, 2009. This survey design was a non-collection pedestrian survey. ASM recorded all new archaeological sites, defined as any concentration of three or more artifacts in a 25-m^2 area. Site boundaries were defined when over 50 m of open space separated artifact scatters. Isolated artifacts were defined as fewer than three artifacts in a 25-m^2 area. ASM assigned all cultural resources that meet the definition of an archaeological site with a temporary site number.

Site recording included definition of site boundaries, features, and formed artifacts. Detailed sketch maps demonstrate the relationship of the sites' location to topographic features and other landmarks. Site forms contain detailed information on environmental context, artifact content and density, cultural affiliation, and function. ASM completed California State Department of Parks and Recreation (DPR 523) site forms for submittal to the EIC for assignment of site trinomials to newly discovered sites (Appendix A). Recordation efforts included the plotting of each site on a USGS 7.5-minute quad map, and the establishment of a GPS recorded datum. Site forms are included in this technical report as an appendix. Digital photographs document the environmental associations and the specific features of all sites, as well as the general character of each survey area.

4. FIELD RESULTS

ASM surveyed approximately 33 linear mi., including accessible portions of the APE linear alignments (30.75 mi.) and withdrawn Alternative Transmission Line alignment (2.25 mi.) and withdrawn Interconnection Collection Substation. The surveyed portions of the APE include Proposed and Alternative Water Lines and four potential sites for Water Supply Wells (of which three were ultimately selected for Project use), the Transmission line route, and Proposed Interconnection Collection Substation location. Transmission Line routes were 200 ft. wide while Water Line routes were 60 ft. wide. A total of 640 acres were examined. ASM was unable to survey the northern ends of the Proposed Transmission and Water Lines or any other areas on Kaiser Steel property due to access issues (Figure 4.01).

The project area generally consisted of small alluvial terraces cut by east-west-trending intermittent drainages, with relatively well-defined desert pavements encountered in the southern end of the Transmission Lines. The survey alignment generally encompasses a relatively level landform with a gentle, south-trending slope, with the Proposed Transmission Line crossing over a relatively small saddle immediately west of Victory Pass. Vegetation within the surveyed areas typically consisted of sparse creosote, mesquite, palo verde, sage, cholla cactus, brittlebush, desert lupine, desert dandelion, and desert marigold, providing excellent ground visibility at the time of survey. The southern end of the Preferred Water Line and the majority of the Alternative Water Line contained relatively recently abandoned jojoba fields, with extensively plowed furrows and modern plastic and metal irrigation systems.

ASM identified numerous isolated tin cans in secondary contexts within intermittent drainages throughout the survey area, as have most previous surveys. The most ubiquitous can type consisted of church-key-opened, flat-top beverage cans with crimped machine-soldered seams. The cans generally measured 2 $^{11}/_{16}$ x 4 $^{3}/_{4}$ in. or 2 $^{11}/_{16}$ x 3 $^{3}/_{8}$ in. (Figure 4.2). Some of this material appears to derive from the gas station, store, and housing at Desert Center. These cans, while pervasive throughout the survey area, tended to cluster in larger numbers near Eagle Mountain Industrial Railroad and may be associated with the construction and/or maintenance of this mining railroad. Based on their likely age, secondary contexts, and potential association with the mining railroad, none of these cans were recorded as archaeological resources. The railroad was not recorded as a site.

ASM encountered portions of the Eagle Mountain Industrial Railroad within the Proposed Transmission Line. The current grade appears relatively recently improved, based on the condition of the riprap and base grade, and the presence of modern concrete and metal drainage culverts spanning underneath the grade. Additionally, examined portions of the existing steel tracks revealed date inscriptions from the 1970s, with relatively well-preserved wooden ties.

Figure Removed to Confidential Appendices

Figure 4.1 Areas surveyed with APE and withdrawn alternative and sites recorded by ASM for the Eagle Mountain Pumped Storage Project Class III Field Inventory.

The recorded portion of the Colorado River Aqueduct (P-33-006726) crossing the Proposed Transmission and Water Line is a subsurface tunnel. Consequently, ASM did not encounter this site during the current investigation except for the overlying road and earthern berm. The survey resulted in the identification of six historic archaeological sites and one historic isolate (see Figure 4.1). One of the sites (Eagle Mountain 1) is located in the northern end of the withdrawn Alternative Transmission Line alignment, while the remaining resources are all recorded in the easternmost Proposed Interconnection Collection Substation location. The following sections describe the results of site recordation for each of the newly identified resources.

Figure 4.2 Example of church key opened tin cans prevalent throughout the Eagle Mountain Pumped Storage project alignment.

P-33-17642, CA-RIV-9139 (EAGLE MOUNTAIN 1)

The site is located north of Interstate 10 on the west side of Eagle Mountain Road in the northern end of the withdrawn Alternative Transmission Line. It measures approximately 175 m north south and 140 m east west. Eagle Mountain 1 consists of a series of tent pads and related features constructed from locally occurring cobbles (Figure 4.3). The site is probably associated with General Patton's World War II DTC/C-AMA operations, specifically an evacuation hospital assigned to camp Desert Center. Historic debris in the vicinity of the tent pads probably represents dumping activity before and after military operations conducted at the site. The site sits on a relatively well-formed desert pavement bisected by intermittent drainages. Sparse vegetation covers portions of the site, consisting primarily of creosote and mesquite with lesser amounts of other desert brush. A number of dry washes intersect the site boundary. The site is open and exposed to erosion. Modern off-road vehicle tracks cross most of the site.

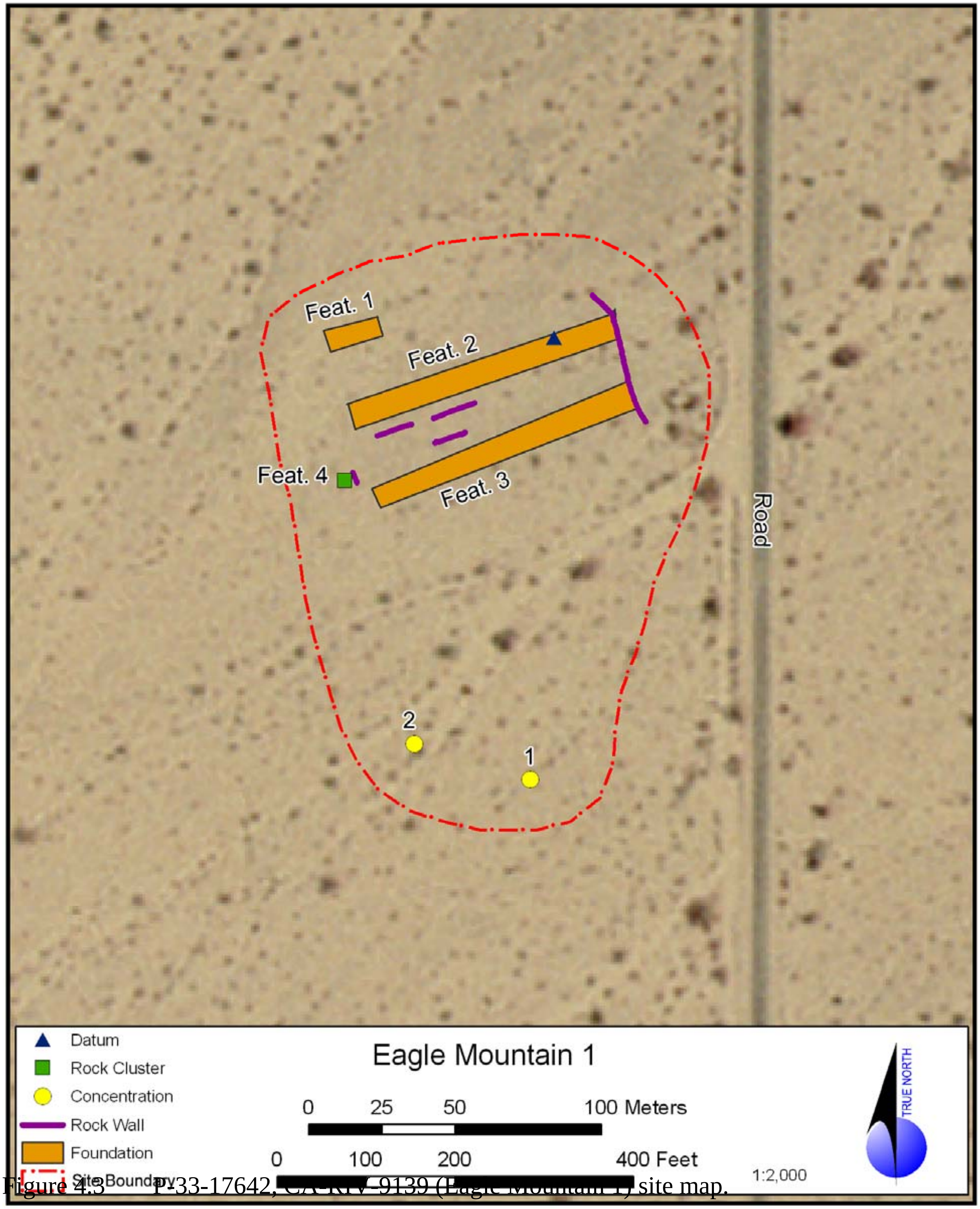

Figure 4.3 P-33-17642, CA-RIV-9139 (Eagle Mountain 1) site map.

The site contains a total of four features, including three tent pad features and a possible flag pole base. The tent pads consist of alignments of locally occurring cobbles, arranged east to west along a magnetic north orientation, on cleared portions of the ground surface. Feature 1 consists of a single pad measuring 27 x 64 ft. (Figure 4.4). The interior of the pad measures approximately 50 ft., with 4-ft.-wide entryways on the center of the east and west sides. Rectangular shaped cobble alignments flank either side of the entryways, potentially representing small "yards" at the front and back of the tent. Medium-sized river cobbles compose the yard alignments, with the interior of the pad lined with smaller rocks and gravel (Figure 4.5). Features 2 and 3 each contain four aligned pads, individually measuring 27 x 64 ft. and constructed in the same arrangement as Feature 1. The easternmost pad of Feature 2 contains an additional 12-ft.-square cobble outline with a rock alignment shaped in a "V" pattern, used here as the site datum (Figure 4.6). A linear cobble alignment connects the outside eastern end of the two features. The remnants of a stone-lined path or roadway lie between Features 2 and 3. Feature 4 is a circular alignment of cobbles at the western end of Feature 2 and 3. The circular feature measures approximately 48 x 36 in., and may represent the base of a flagpole or distinguishing marker (Figure 4.7).

Six tin cans are located in the vicinity of the site features, including a crimped-seam rotary-open sanitary can measuring 4 x 2 $^{1}/_{2}$ in., a 4 x 3 $^{1}/_{2}$ in. machine-soldered-seam key-strip-open can, and four crimped-seam rectangular screw-top cans, one measuring 6 $^{1}/_{2}$ x 4 $^{1}/_{4}$ x 9 $^{1}/_{2}$ in., one 3 $^{1}/_{16}$ x 2 $^{1}/_{8}$ x 2 $^{1}/_{2}$ in., and two top fragments with heavily eroded handles

Figure 4.4 Eastern overview of P-33-17642, CA-RIV-9139 (Eagle Mountain 1) Feature 1.

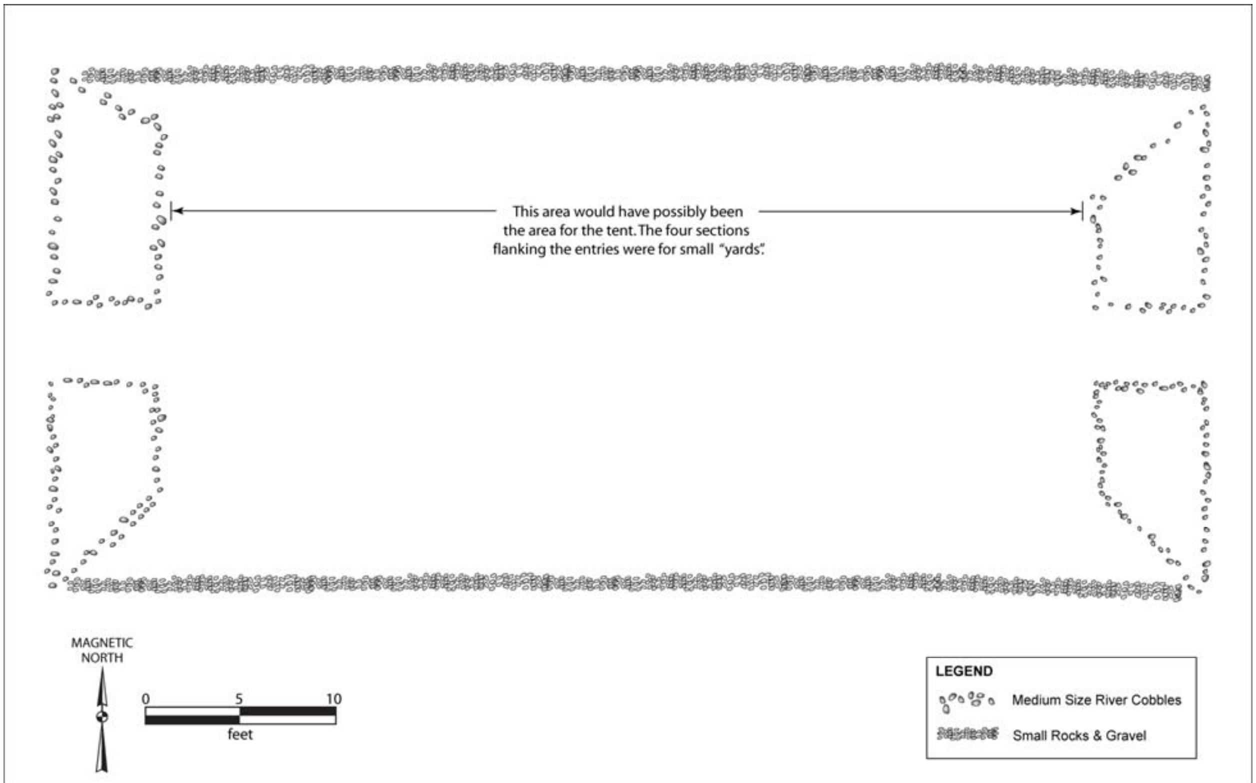

Figure 4.5 Sketch map of P-33-17642, CA-RIV-9139 (Eagle Mountain 1) Feature 1.

Figure 4.6 West end of P-33-17642, CA-RIV-9139 Feature 2 showing "V" rock alignment.

Figure 4.7 P-33-17642, CA-RIV-9139 (Eagle Mountain 1) Feature 4 view east

Two small artifact concentrations lie on the edge of drainages to the south of the site features. Concentration 1 consists of 15 tin cans and 10 amethyst glass fragments. Can types include seven crimped-seam knife-cut sanitary cans, seven crimped-seam hole-in-cap cans, and one aerosol can. The sanitary cans consist of four cans 3 x 4 $^{5}/_{8}$ in. in size and three measuring 4 x 4 $^{11}/_{16}$ in., all with "Sanitary" stamped on the base. Hole-in-cap cans at the concentration measure 3 x 4 $^{7}/_{16}$ in., and the aerosol can is 2 $^{7}/_{8}$ x 4 $^{3}/_{4}$ in. Concentration 2 contains one hole-in-top crimped-seam can with punched holes measuring 3 x 4 $^{3}/_{16}$ in., a crimped seam rotary opened sanitary can 3 x 3 $^{1}/_{2}$ in. in size, and a key-strip can lid with "Radiant Roast" embossed on the top.

The site features conform well to others found at DTC/C-AMA locations at Camp Young Camp Desert Center, among others (Bischoff 2000). However, the artifacts associated with the site appear to postdate World War II, with the exception of Concentration 1, which potentially predates the war based on the can types and occurrence of amethyst glass, and thus probably represents distinct and separate dumping episodes not associated with military activity conducted at the site.

P-33-17643, CA-RIV-9140 (EAGLE MOUNTAIN 2)

This site is located north of Interstate 10 along the north edge of a dirt road trending west off of Ragsdale Road. The site consists of two discreet concentrations containing modern and historic debris, encompassing an area 55 m east-west by 25 m north-south (Figure 4.8).

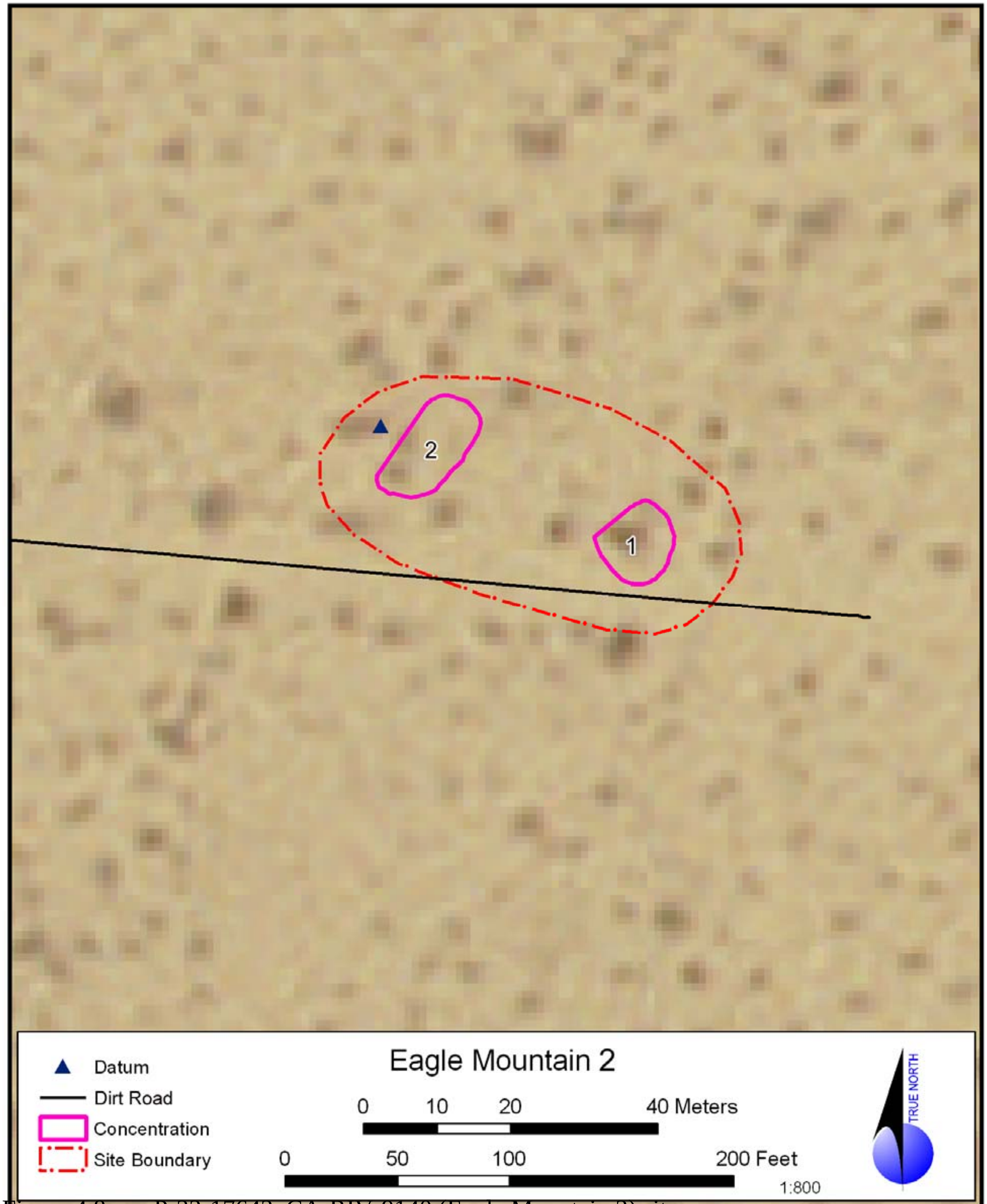

Figure 4.8 P-33-17643, CA-RIV-9140 (Eagle Mountain 2) site map.

A limited number of cans and metal fragments connect the two concentrations. The site sits on a level terrace above and between two large, intermittent drainages. Vegetation on site consists of creosote and mesquite. Dry washes bound the east and west ends of the site. Cans are eroding into the drainages on the east edge of Concentration 1 and through the central portion of Concentration 2. A dirt road bisects the southern edge of the site.

Concentration 1 measures approximately 10 m in diameter, and is located at the base of a large mesquite tree (Figure 4.9). The concentration contains over 100 artifacts, including tin cans and bottle glass. Tin cans identified consist primarily of flat-top beverage cans, including over 30 interlocked machine-soldered-seam church-key-opened cans with “Shasta Orange Soda” labels and measuring 2 $^{11}/_{16}$ x 4 $^{13}/_{16}$ in., and at least 10 pull-tab cans of the same size. At least five flat-top-crimped machine-soldered-seam cans display rotary openings, potentially representing fruit/vegetable containers. Diagnostic bottle glass identified in the concentration appears to date to the 1950s, including clear milk fragments with “Fresh/Milk/Carnation/Company/REG CAL” on red applied color labels with round bases and square bodies, embossed with “Owens Illinois, Duraglas” at the base, and an intact Owens Illinois aspirin bottle with continuous thread, metal cap, a year code of 4 and a plant code of 7 (Alton, Illinois, c. 1934).

Concentration 2 is approximately 16 x 8 m in size, sits on the eastern edge of a dry wash at the base of a large mesquite tree and contains metal wire, ceramic insulators, window glass, bottle glass, paint cans, and sanitary cans. Sanitary cans within the concentration consist primarily of crimped machine soldered seam cans, approximately 20 each with P38 openings and rotary openings, and at least five P38-opened cans. Bottle glass in Concentration 2 includes a brown Sani-Clor bleach bottle base and clear soda bottle fragments with Owens Illinois year code 8 and plant code 23 (Los Angeles, c. 1956).

P-33-17694, CA-RIV-9141 (EAGLE MOUNTAIN 3)

The site consists of a small, discreet historic trash dump, consisting of metal cans, glass fragments, ceramic fragments, and metal scraps (Figure 4.10). The site sits on a slight rise between the two washes, and measures approximately 5 m east-west by 3 m north-south. Two creosote bushes define the dump boundary. Dry washes bound the east and west ends of the site. The site is subjected to natural erosion through alluvial processes. An old dirt road trending east west is between 5 and 10 m south of the site.

Identified artifacts appear to date to the late 1940s to 1950s, and include over 100 brown and clear bottle glass fragments, at least five straw-colored milk bottle glass fragments, over 20 brown medicine bottle glass fragments, approximately five pink baking dish glass fragments, more than 20 glazed ceramic vessel fragments, at least five metal mason jar lids, and various rusted metal scraps, in addition to crimped machine-soldered-seam flat top ($n > 20$), sanitary ($n > 10$), and hole-in-top tin cans ($n = 2$). One Owens Illinois glass bottle base displayed a plant code of 12 (Gas City, Indiana).

Figure 4.9 Western overview of P-33-17694, CA-RIV-9141 (Eagle Mountain 2) Concentration 1, with the archeologist standing in the background at Concentration 2.

Figure 4 [illegible] ountain 2) viewed from the south.

P-33-17645, CA-RIV-9142 (EAGLE MOUNTAIN 4)

Eagle Mountain 4 is a small (5-x-3-m), north-south trending historic trash dump, consisting of metal cans, glass fragments, ceramic fragments, and metal scraps. The site sits on a slight rise between the two drainages and clusters around a creosote bush (Figure 4.11). Intermittent drainages bound the east and west sides of the site. Artifacts from the site are eroding down the associated drainages. A modern trash pile containing tires, milled lumber, rebar, cable, and chain-link fencing lies approximately 20 m northwest of the site. An old dirt road contours the drainage west of the site.

Historic artifacts identified at the site appear to date from the late 1940s to the 1950s and include over 20 sanitary cans, six hole-in-top cans, more than 30 brown bottle glass fragments, at least 20 clear bottle glass fragments, a glass pipette fragment, approximately five white transfer-print ceramic fragments, and various metal scraps and screen. All of the tin cans identified at the site display crimped machine-soldered seams, with rotary, internal-friction, and P38 openings on sanitary cans and punched holes and key-strip-opened hole-in-top cans. Diagnostic glass artifacts include a clear Best Foods Mayonnaise jar base fragment with an Owens Illinois year code of 0 and Clorox Bleach brown bottle glass fragments.

Figure 4.11 Southeastern view of cans clustered around creosote bush at P-33-17645, CA-RIV-9142 (Eagle Mountain 4).

P-33-17646, CA-RIV-9143 (EAGLE MOUNTAIN 5)

Three discreet historic refuse dumps consisting of tin cans and bottle glass comprise the site, with washed-out cans among and between the three concentrations. The site lies on an alluvial fan, sparsely covered with mesquite, creosote, and low lying brush. Dry washes border the site's east and west ends, and bisect the site. Artifacts are eroding out of the concentrations through alluvial activity. An old dirt road runs along a north-south trending drainage between Concentration 1 and 2, intersecting with an east-west-trending dirt road running through the center of the site (Figure 4.12). Modern debris is dispersed across the site.

Concentration 1 is approximately 5 m in diameter, and contains over 200 glass fragments, including clear, green, brown, and cobalt bottle glass fragments, mason jars, medicine bottles, and glassware (Figure 4.13). One brown glass alcohol bottle base fragment is embossed with "ONE/QUART" and contains the mark "MG" (possibly Maywood Glass Co., Compton, California). Tin cans from the concentration (n > 50) all display crimped machine-soldered seams, and include rotary-opened sanitary cans, hole-in-top cans with punched hole openings, meat tins, and tobacco tins.

Concentration 2 measures approximately 20 x 10 m, and includes more than 100 clear, aqua, brown, green, and milk glass fragments representing beer and other beverage bottles, cold cream jars, bleach bottles, condiment bottles, and glassware. Identified bottles include a Purex bleach bottle base, Old Quaker whisky flask, and a possible Orange Crush bottle. The concentration also includes over 30 tin cans, primarily P38 opened sanitary cans with crimped machine-soldered seams, tobacco tins (Figure 4.14) and one flat-top interlocked machine-soldered-seam can with a church-key opening. Modern debris, including bottle glass and corrugated metal, is interspersed within the concentration.

Concentration 3 is less than 50 cm in diameter and contains over 20 clear, green, and milk glass fragments from beverage bottles and cold cream jars. The concentration also includes at least six unidentifiable tin cans embedded within the sediment.

P-33-17647, AC-RIV-9144 (EAGLE MOUNTAIN 6)

A discreet refuse dump containing historic household and construction debris characterizes this site (Figure 4.15). The site sits on a small rise surrounded by intermittent drainages (Figure 4.16). Mesquite, creosote, and small, ground-level brush cover portions of the rise. Dry washes surround the landform containing the site. Artifacts from the site are washing into the surrounding washes.

Artifacts identified at the site include over 100 wire nails, metal hooks, hinges, nuts, and bottle caps, as well as wire, light bulbs, two tin cans, and over 50 clear, brown, aqua, and milk glass bottle fragments. The tin cans from the site both represent crimped machine-soldered-seam sanitary cans with rotary openings.

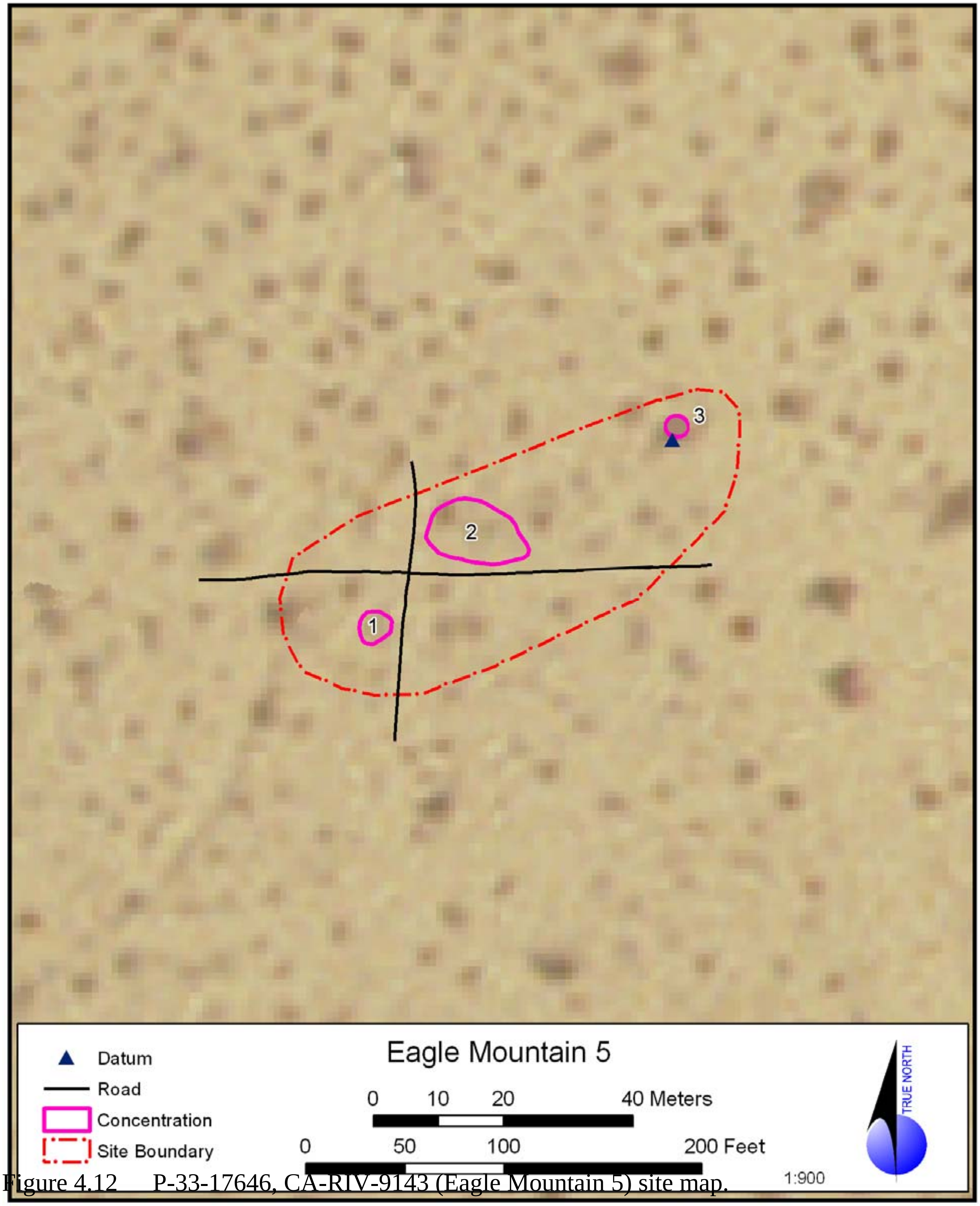

Figure 4.12 P-33-17646, CA-RIV-9143 (Eagle Mountain 5) site map.

Figure 4.13 Southern overview of P-33-17646, CA-RIV-9143 (Eagle Mountain 5) Concentration 1.

Figure 4.14 Example of tobacco tins identified within P-33-17646, CA-RIV-9143 (Eagle Mountain 5) Concentration 2.

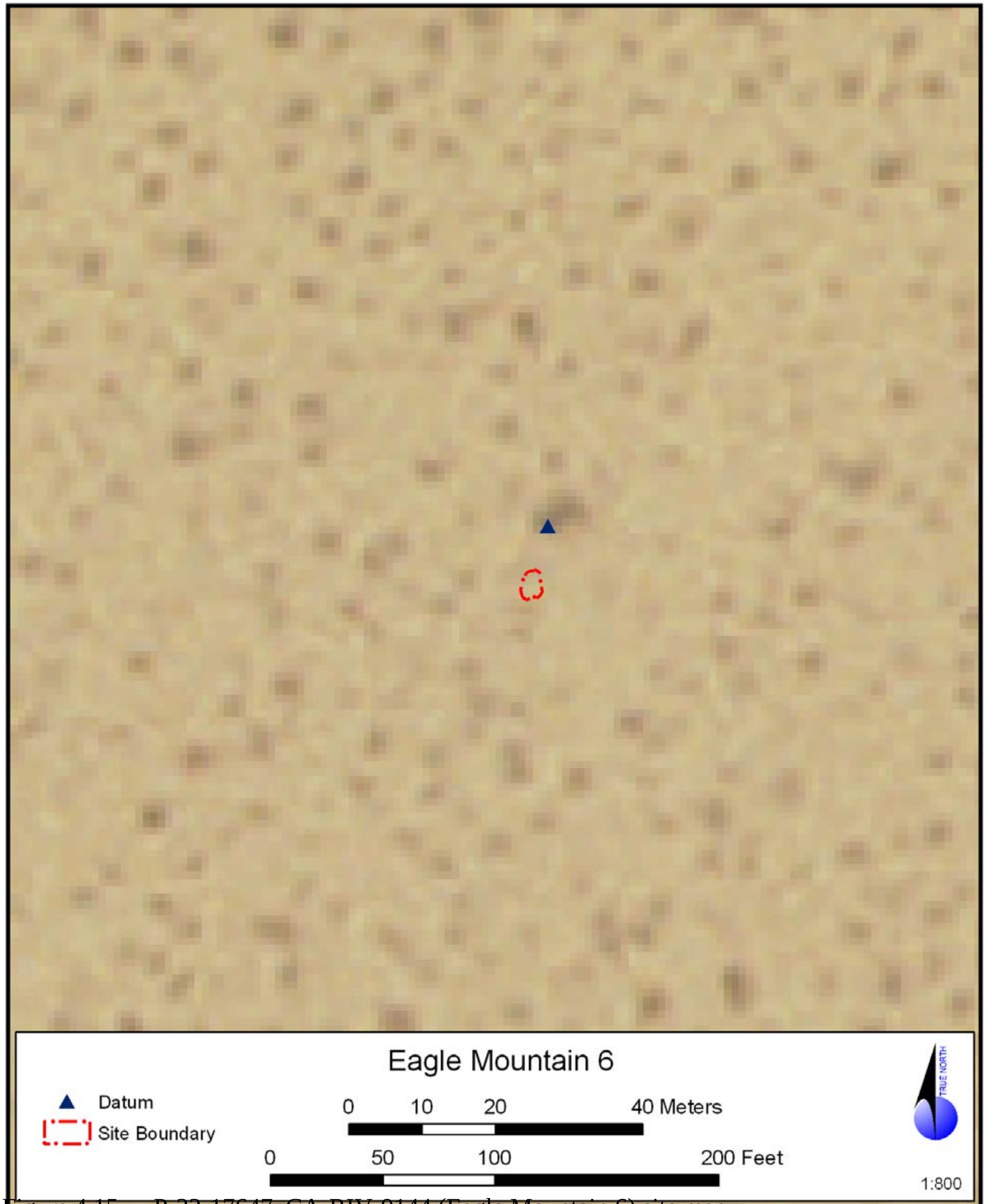

Figure 4.15 P-33-17647, CA-RIV-9144 (Eagle Mountain 6) site map.

Figure 4.16 Southern overview of P-33-17647, CA-RIV-9144 (Eagle Mountain 6).

(P-33-17648) ISOLATE 1

The isolate consists of a concrete post embedded in the ground with a “C” inscribed on its eastern end, representing a California highway right-of-way monument (Figure 4.17). It was recorded as an “isolate” on a DPR Primary Record but could also be interpreted as an “object” An abandoned dirt road trending east west off of Ragsdale Road runs north of the marker. The marker is embedded in a compact desert pavement, with at least four aqua bottle glass fragments from the same vessel scattered on the ground surface east of the isolate. Such monuments were used between 1914 and 1934. This one may date to a survey for the Mecca-Blythe road and predate the 1925 relocation of the route 1.25 miles to the south as U.S. Highway 60.

Figure 4.17 East side of California Highway marker, P-33-17648 (Isolate 1) with aqua bottle glass in foreground.

5. CONCLUSIONS AND RECOMMENDATIONS

The following sections provide a brief discussion regarding the results of the archaeological survey, evaluations for eligibility to the NRHP, and recommendations for future management of cultural resources identified within the areas surveyed for the proposed Eagle Mountain Pumped Storage Project.

CRITERIA FOR EVALUATION

Section 106 of the NHPA directs Federal agencies to consider the effects of undertakings on historic properties that are eligible to be listed in the NRHP. To be eligible for listing the NRHP, a resource must satisfy the following criteria:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> **A.** That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> **B.** That are associated with the lives of persons significant in our past; or
>
> **C.** That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> **D.** That have yielded or may be likely to yield, information important in prehistory or history (36 CFR 60.4).

DISCUSSION

ASM surveyed approximately 33 linear miles, including the Proposed and withdrawn Alternative Transmission Lines, Water Lines, in addition to a Proposed and withdrawn Alternative 25-acre Interconnection Collection Substation locations and four potential Water Supply Well locations. ASM was unable to survey the northern ends of the Proposed Transmission and Water Lines due to access issues at the Kaiser Mine. In any event, the Mine and Townsite have been previously recorded as site P-33-6913 for the proposed Eagle Mountain Landfill Project. In regard to that project the State Historic Preservation Officer on concurred with the BLM determination that the 429-acre Eagle Mountain Townsite and the Eagle Mountain Mine were not eligible for listing in the NRHP because neither were more than 50 years old and neither exhibited exceptional significance (Letter from Cherilyn Widell to Henri R. Bisson, District Manager, BLM California Desert District, Dec. 12, 1996) (Appendix B).

ASM did not encounter the recorded portion of the Colorado River Aqueduct (P-33-6726) as crossing the Proposed Transmission and Water Lines, as this site is a subsurface tunnel where the proposed line crosses, but ASM did encounter portions of the Eagle Mountain Industrial Railroad in the northern end of the Proposed Transmission Line. The Colorado River Aqueduct (P-33--6726) is very likely to be eligible listing in the NRHP based on its historical significance under Criteria “A” and “C” (Schaefer 2009). In 1998 the Historic American Engineering Record of the National Park Service formally recorded the Aqueduct for the Metropolitan Water District. The U.S. Army Corps of Engineers may have previously determined it to be NRHP-eligible (Cristopher Dalu, BLM, Palm Springs/South Coastal Field Office 2009, personal communication). It is recommended as eligible for listing in the NRHP under Criteria “A” and “C” on the regional and national levels. The Proposed Transmission Line and Waterline, however, span buried portions of the aqueduct of which only a road and earthern berm are indicators of its alignment. Little or no impacts to integrity of setting, feeling, or materials are therefore expected from the proposed project.

The Eagle Mountain Industrial Railroad lacks integrity of materials and only its original alignment remains. Even though it is now over 50 years old, it is recommended that it also be evaluated as not eligible for listing in the NRHP, along with the Eagle Mountain Townsite and Mine. All of the materials have been replaced in the 1960s and 1970s and the proposed Eagle Mountain Landfill project calls for its reuse.

The survey resulted in the recordation of six previously unidentified historic archaeological sites and one historic period isolate. Site P-33-17642, CA-RIV-9139 (Eagle Mountain 1), located in the northern end of the Alternative Transmission Line, consists of a series of tent pads and related features constructed from locally occurring cobbles, representing military operations associated with the World War II Desert Training Center (DTC) initially commanded by General George S. Patton. The DTC/C-AMA operated between 1942 and 1944, and represents a relatively significant period in Southern California history. The site may characterize a portion of the evacuation hospital complex at camp Desert Center, or possibly troop activities associated with Camp Desert Center or other installations of the DTC/C-AMA, such as Camp Young or Camp Coxcomb. It appears likely that the trash scatters identified on the site surface represent deposition both prior and subsequent to military occupation of the area. Buried trash deposits from the time of DTC/C-AMA might likely occur within the site boundaries, however. It is recommended to be eligible for listing in the NRHP under Criterion “A” and possibly Criterion “D” at the local, regional, and national level due to its association with the World War II mobilization effort (Bischoff 2000). Although additional survey would be necessary to determine what other DTC/C-AMA facilities are in the immediate facility, it is recommended for consideration on a multiple resource nomination, at the very least. Site P-33-17642, CA-RIV-9139 (Eagle Mountain 1), however, lies outside the current APE and therefore no further consideration or treatment is warranted for Section 106 compliance. BLM, however, may want to consider some protection from continued use of Eagle Mountain Road.

The remaining recorded cultural resources, sites P-33-17643-17647, CA-RIV-9140-9144 (Eagle Mountain 2-6) are all located within the Proposed Interconnection Collection Substation location. All are evaluated as not eligible for listing in the NRHP. The historic-period sites within the Substation location all appear to represent the disposal of household refuse along a dirt road during the late 1940s or 1950s, most likely from the community of Desert Center via Ragsdale Road. Because of their spatial dislocation from specific Desert Center households or enterprises proper, these sites are not associated with known persons or specific activities or time periods with historic significance. Additionally, the artifacts associated with the site, while retaining integrity of location and in some cases condition, do not signify resources that would lead to a greater understanding of the time period in the Desert Center area. In comparison, trash deposits from the 1920s that were associated with "Desert Steve" Ragsdale's homestead at Gruendike Well or his initial move to Desert Center might have greater significance at a local level.

A concrete California Highway marker (P-33-17648), potentially installed in the late 1920s to the 1930s, characterizes the historic period isolated find. Isolates are generally not eligible for listing in the NRHP because they lack sufficient information to be important to history. The California Highway marker likewise does not contribute to the historic record of the general area or of the region as a whole. Hence, it is unlikely that any of these sites or the isolate represent significant cultural resources.

RECOMMENDATIONS

The final section of this report provides brief management recommendations concerning each of the sites recorded during the current survey. Avoidance of archaeological sites is the simplest and most cost effective way to mitigate adverse affects to any cultural resources potentially eligible for the National Register of Historic Places (NRHP). However, avoidance is not always feasible, and eligibility evaluations are often necessary. Although the project alignment crosses portions of both the Colorado River Aqueduct (P-33-006726, CA-RIV-6726H) and the Eagle Mountain Industrial Railroad, the project is unlikely to pose significant adverse effects to these sites. While P-33-17643-17647, CA-RIV-9140-9144 (Eagle Mountain Nos. 2-6) are located in the Proposed Interconnection Collection Substation, and are unlikely to be avoided, they do not represent significant cultural resources and are evaluated as not eligible for listing in the NRHP. No further treatment is therefore recommended.

Although P-33-17648 (Isolate No 1), the California Highway monument, is evaluated as not eligible to the NRHP, such objects that were erected between 1914 and 1934 bear witness to early efforts at developing state and national highway transportation infrastructure. They have been previously recorded along state routes such as Route 66 in San Bernardino Counties and Old Highway 80 in Imperial County:
(http://www.goldenstatehwys.net/state/c_block_california.htm). If at all feasible, efforts should be made to avoid impacts to the monument.

P-33-17642, CA-RIV-9139 (Eagle Mountain 1), on the other hand, is associated with a significant period in Southern California and national history and is likely to be NRHP-eligible as a contributor to a multiple resource. It is located outside of the APE, however, and no further treatment is recommended beyond normal avoidance measures associated with the use of Eagle Mountain Road.

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APPENDICES

APPENDIX A

Confidential Site Records

This information is privileged and not for release. It has been redacted from this document and bound under separate cover, titled:

Confidential Cultural Resources - Appendix to the Environmental Impact Report

APPENDIX B

BLM-SHPO consultation letter concerning the Eagle Mountain Mine and Townsite

STATE OF CALIFORNIA — THE RESOURCES AGENCY PETE WILSON, Governor

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
P.O. BOX 942896
SACRAMENTO 94296-0001
(916) 653-6624
FAX: (916) 653-9824

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BUREAU OF LAND MANAGEMENT
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RIVERSIDE, CA

December 12, 1996

REPLY TO: BLM910826A

TO		INIT	DATE
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2	RC&W		
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RETURN TO:

Henri R. Bisson
District Manager
Bureau of Land Management
California Desert District Office
6221 Box Springs Boulevard
RIVERSIDE CA 92507-0714

Dear Mr. Bisson:

RE: EAGLE MOUNTAIN LANDFILL PROJECT

Thank you for notifying me that the BLM is re-opening consultation on the Eagle Mountain Landfill project. Subsequent to our 1991 consultation, the San Diego Superior Court ruled that the Environmental Impact Report for the project should include the Eagle Mountain Townsite, not included in the 1991 APE, in the project description. The APE has now been expanded to include all patented lands that make up the Townsite of Eagle Mountain, approximately 429 acres. The BLM also wishes to consult now on the eligibility of the the Eagle Mountain Mine, located in the earlier APE but not evaluated.

Pursuant to the terms of the Programmatic Agreement regarding the identification, evaluation and treatment of historic properties managed by the BLM in California, you have determined that neither the Eagle Mountain Townsite nor the Eagle Mountain Mine are eligible for inclusion in the National Register of Historic Places. You have documented that both properties are less than 50 years of age and that neither property exhibits exceptional significance under National Register Criteria Exception G. You have further determined that an isolated milling stone artifact (Field No. EM-ISO#1) is not eligible for inclusion in the National Register. I concur with your determinations.

If you have questions, please do not hesitate to contact Lucinda Woodward at (916) 653-9116.

Sincerely,

Cherilyn Widell
State Historic Preservation Officer