6.6 GEOLOGIC HAZARDS AND RESOURCES

This section discusses the VV2 Project's potential effects on geologic resources and the potential geologic hazards that may be encountered by the Project.

6.6.1 LORS Compliance

This section addresses the LORS applicable to geologic hazards and resources that are relevant to the VV2 Project. Table 6.6-1 summarizes the LORS that are expected to apply to the Project.

Table 6.6-1
LORS Applicable to Geological Resources and Hazards

LORS	Applicability	Where Discussed in AFC
Federal:		
Uniform Building Code	The Uniform Building Code specifies acceptable design criteria for structures and excavations with respect to seismic design and load bearing capacity.	Section 6.6.4
State:		
California Building Code	Specifies acceptable design criteria for structures and excavations with respect to seismic design and load bearing capacity.	Section 6.6.5
Alquist-Priolo Earthquake Fault Zoning Act	Identifies areas subject to surface rupture from active faults.	Section 6.6.5
Local:		
City of Victorville Building Code enforcement	The City of Victorville is responsible for issuing building permits	Section 6.6.6

6.6.1.1 Federal LORS

The Uniform Building Code specifies acceptable design criteria for structures with respect to seismic design. The State has adopted these provisions in the California Building Code (CBC).

6.6.1.2 State LORS

The Project is subject to the applicable sections of the CBC. The City of Victorville is responsible for implementing the CBC for the VV2 Project.

Although the Project is subject to the Alquist-Priolo Earthquake Fault Zoning Act, the Project features are not located within areas identified as subject to surface rupture from active faults.

6.6.1.3 Local LORS

The Project is subject to the City of Victorville's requirements for grading and building permits.

6.6.1.4 Involved Agencies

The agency and person to contact for building and grading permits are identified in Table 6.6-2.

Table 6.6-2
Agencies and Agency Contacts

Agency	Contact	Permit/Issue
Victorville Building Department 14343 Civic Drive Victorville, CA 92393	Scott Webb, Assistant Planner (760) 955-5101 Main Office	Grading Permit for earthmoving activities exceeding 50 cubic yards

6.6.1.5 Required Permits and Permit Schedule

Building and grading permits are required by the City of Victorville. Applications are required at least 30 days prior to construction.

6.6.2 Affected Environment

This section discusses the existing geologic environment potentially affected by the VV2 Project. Underlying geologic structures, seismicity, and geologic hazards are discussed.

6.6.2.1 Geology

Regional. The VV2 Project site and offsite linear facility routes are within the southern portion of the Mojave Desert Geomorphic Province of California. The Mojave Desert is

bounded on the north and northwest by the Tehachapi Mountains, on the west by the Garlock fault, on the east by the Colorado River, and on the south and southwest by the San Andreas Fault. The Mojave Desert Province is characterized by broad alluvial basins of Cenozoic sedimentary and volcanic materials overlying older plutonic and metamorphic rocks (Dibblee, 1980). The plutonic and metamorphic rocks are exposed as eroded hills throughout the region. The alluvial basins are up to several thousand feet thick.

Structurally the Project is located on a large alluvial fan adjacent to metamorphosed sediments that have been intruded by masses of quartz monzonite. The alluvial deposits are classified as Younger Alluvium by Dibblee (1960) and consist of interbedded sand and gravel with lesser amounts of silt and clay. Caliche deposits, composed primarily of calcium carbonate, are present within the upper few feet. The sand and gravel deposits are generally unconsolidated to weakly consolidated sediments. The alluvium was derived from erosion of the San Gabriel and San Bernardino Mountains to the south.

The Mojave River channel and associated tributaries have dissected the alluvium and continue to deposit younger alluvium in active channels. Regionally, the ground surface slopes gently downward in a northwest direction at a gradient of less than two percent.

The Project site is in the Upper Mojave River Groundwater Basin. The groundwater aquifers are recharged primarily from infiltration within the Mojave River channel, approximately 0.9 miles to the east of the site. The depth to groundwater in the vicinity of the site is variable, but is estimated to be approximately 220 feet or deeper below the ground surface (bgs) (DWR, 1967).

Plant Site Vicinity (Two-Mile Radius). The Project site is relatively flat with a very gentle slope to the north-northwest. Surface elevations range from approximately 2,770 feet msl in the northwest corner of the site to approximately 2,800 feet msl in the site's southeastern quarter. Topography slopes gently to moderately along the eastern edges of the site with the steepest area in the east-central portion of the site. Topography in this east-central area slopes to the southeast down to an elevation of approximately 2,740 feet msl. It is underlain by Quaternary Alluvium (Figure 6.6-1) predominately composed of sand, silty sand, and sand with silt.

There are no bodies of water located on the Project site. As noted above, the Mojave River is the nearest body of water and is located approximately 0.5 mile east of the site at its closest point. Although regionally, groundwater is estimated to be approximately 220 feet bgs or deeper as stated above, a 2006 preliminary geotechnical study of the Project site by Kleinfelder, Inc. (see AFC Appendix C), estimated groundwater at the site itself to

be approximately 150 feet or deeper bgs. Drainage across the Project site occurs as sheet flow.

Offsite Linear Facility Routes. The topography of the Project's offsite linear facility routes is relatively flat with elevations ranging between approximately 2,800 feet msl where the linear facility routes leave the Project site to 3,740 feet msl at the Lugo substation at the southern terminus of transmission line Segment 3 (Figure 6.6-1). These Project features are underlain by Quaternary Alluvium composed of sand, silty sand, and sand with silt (Figure 6.6-2).

6.6.2.2 Seismicity

Major Faults. The VV2 Project site is located in seismically active Southern California, a region that has experienced numerous earthquakes in the past. The Alquist-Priolo Special Studies Zones Act specifies that an area termed an "Earthquake Fault Zone" is to be delineated if surrounding faults that are deemed "sufficiently active" or "well defined" after a review of seismic records and geological studies. This legislation was passed to prohibit the location of most structures for human occupancy across the traces of active faults and to mitigate the hazard of earthquake-induced ground rupture. Cities and counties affected by the Earthquake Fault Zones must regulate certain existing and development projects within the zones by permitting and building code enforcement.

The major faults within 30 miles of the Project site include the Helendale-South Lockhardt, North Frontal, Lenwood-Lockhart-Old Woman Springs, Cleghorn, San Andreas, Cucamonga, San Jacinto, and Gravel Hills-Harper Lake faults (Figure 6.6-3). With the exception of the North Frontal and Cleghorn faults, most of these faults trend northwest to southeast. Movement along the faults is predominantly strike slip and/or dip slip. Table 6.6-3 lists the active and potentially active faults in a radius of 60 miles around the VV2 Project (Blake, 2000). This table presents the approximate distance to the faults, the maximum credible event for each of the faults, and the estimated peak horizontal acceleration at the Project site for that maximum credible event.

6.6.2.3 Geologic Hazards in Plant Site Vicinity (Two-Mile Radius)

Seismic Groundshaking. The Project is located in a seismically active area and therefore will likely be subjected to ground shaking from movement along one or more of the active or potentially active faults in the region. The estimated Peak Horizontal Ground Acceleration (PGA) at the VV2 Project site with 10 percent probability of being exceeded in 50 years is 0.35g for alluvial soil conditions (California Geologic Survey 2006). This PGA would most-likely be the result of movement along the Helendale-S.

Lockhart fault. As shown in Table 6.6-3, movement along the Helendale – S. Lockhart (9.2 miles to the northeast) could potentially generate a maximum estimated site intensity of IX. This intensity is based on the Modified Mercalli (MM), a scale which qualitatively measures the shaking effects of earthquakes. A rating of IX on the MM scale would suggest violent shaking and heavy damage to structures.

Ground Rupture. Although located in an acknowledged seismically active area (see Table 6.6-3), the Project site and associated linear facilities corridors are not located on a fault trace as designated by mapping and site investigations conducted as part of the Alquist-Priolo Earthquake Fault Zoning Act.

Table 6.6-3
Active and Potentially Active Faults Within 60 Miles

Abbreviated Fault Name	Approx. Distance mi (km)	Estimated Maximum Credible Magnitude	Estimated Peak Site (Acc. g)*	Estimated Site Intensity. (MM)*
Helendale – S. Lockhardt	9.2 (14.8)	7.1	0.33	IX
North Frontal Fault Zone (West)	20.7 (33.3)	7.0	0.17	VIII
Lenwood-Lockhart-Old Woman Springs	22.7 (36.6)	7.3	0.15	VIII
Cleghorn	23.3 (37.5)	6.5	0.08	VII
San Andreas – 1857 Rupture	24.4 (39.2)	7.8	0.20	VIII
San Andreas – Mojave	24.4 (39.2)	7.1	0.12	VII
San Andreas – Southern	24.7 (39.8)	7.4	0.15	VIII
San Andreas – San Bernardino	24.7 (39.8)	7.3	0.14	VIII
Cucamonga	25.4 (40.8)	7.0	0.13	VIII
San Jacinto – San Bernardino	28.3 (45.6)	6.7	0.08	VII
Gravel Hills – Harper Lake	29.1 (46.9)	6.9	0.08	VII
Landers	31.8 (51.1)	7.3	0.10	VII
Blackwater	33.5 (53.9)	6.9	0.07	VI
Sierra Madre	34.5 (55.5)	7.0	0.09	VII
Calico – Hidalgo	35.5 (57.2)	7.1	0.08	VII
Clamshell-Sawpit	37.8 (60.9)	6.5	0.05	VI
Johnson Valley (Northern)	38.8 (62.5)	6.7	0.05	VI
North Frontal Fault Zone (East)	39.6 (63.7)	6.7	0.06	VI

Table 6.6-3
Active and Potentially Active Faults Within 60 Miles

Abbreviated Fault Name	Approx. Distance mi (km)	Estimated Maximum Credible Magnitude	Estimated Peak Site (Acc. g)*	Estimated Site Intensity. (MM)*
San Jose	40.3 (64.9)	6.5	0.05	VI
San Jacinto – San Jacinto Valley	43.7 (70.3)	6.9	0.05	VI
Chino-Central Ave. (Elsinore)	47.7 (76.8)	6.7	0.05	VI
Emerson So. – Copper Mtn.	48.0 (77.2)	6.9	0.05	VI
Raymond	48.5 (78.0)	6.5	0.04	V
Verdugo	49.8 (80.1)	6.7	0.04	VI
Pisgah-Bullion Mtn. – Mesquite Lake	51.9 (83.6)	7.1	0.05	VI
Pinto Mountain	54.6 (87.8)	7.0	0.04	V
Elysian Park Thrust	54.7 (88.1)	6.7	0.04	VI
Sierra Madre (San Fernando)	55.7 (89.7)	6.7	0.04	V
Whittier	55.9 (89.9)	6.8	0.03	V
San Gabriel	56.2 (90.5)	7.0	0.04	V
Elsinore-Glen Ivy	56.3 (90.6)	6.8	0.03	V
Garlock (West)	56.7 (91.3)	7.1	0.04	VI
Garlock (East)	57.7 (92.8)	7.1	0.05	VI
Hollywood	59.7 (96.1)	6.4	0.03	V

mi (km) = miles (kilometers)
Acc. g. = Acceleration in gravity
MM = Modified Mercalli, a scale which qualitatively measures the shaking effects of earthquakes.
Source: Blake, 2000, EQFAULT

Liquefaction. Liquefaction is a soil condition in which seismically induced ground motion causes an increase in soil water pressure in saturated, loose, sandy soils, resulting in loss of soil shear strength. Liquefaction can lead to near-surface ground failure, which may result in loss of foundation support and/or differential ground settlement. Sandy deposits deeper than 50 feet below ground surface usually are not prone to causing surface damage. In addition, soils above the groundwater table, that is soils that are not saturated, will not liquefy. As noted earlier, groundwater at the Project site is reported to be deeper than 150 feet, and thus, liquefaction is considered unlikely.

Slope Stability. The majority of the site consists of generally flat terrain which is not prone to significant mass wasting or slope stability problems. However, the eastern portion of the Project site is located at the top of a slope that descends into an intermittent stream valley. Moderately steep slopes currently exist in the east-central portion of the Project site near its eastern boundary, although Project grading as part of site preparation activities will eliminate these slopes and thus reduce landslide risks.

Subsidence. Subsidence due to groundwater withdrawal has been documented in various regions of the Mojave Desert, such as in the area around Lancaster in Los Angeles County and in the southern portion of San Bernardino County. According to Jay Cass of the Lahontan Regional Water Quality Control Board (RWQCB), there are no reports of subsidence at or near the Project site (Cass 2006). RWQCB staff indicate that two domestic water wells (not related to the Project) are located northwest of the Project site and several production wells are located to the east of the site along the Mojave River (Cass 2006). Pumping of these wells is not expected to affect the aquifer sufficiently to cause subsidence in the Project vicinity. In addition, subsidence is not considered an issue in the Project vicinity because the VVWRA treatment plant and the City of Adelanto recharge water into the local aquifer. Based on the information provided by RWQCB staff, subsidence due to groundwater withdrawal in the Project area is considered unlikely.

Alluvial soils in arid and semi-arid environments have the tendency to possess characteristics that make them prone to collapse with increase in moisture content. The Project is located in an area were the potential exists for collapsible soils. Based on the Project's preliminary geotechnical report, the upper 20 feet of soils at the plant site have a low to moderate potential for collapse (Kleinfelder, 2006).

Expansive Soils. Expansive soil consists of fine-grained clay which occurs naturally. It is generally found in areas that were historically a flood plain or lake area, but can occur in hillside areas also. Expansive soil is subject to swelling and shrinkage, varying in proportion to the amount of moisture present in the soil. As water is initially introduced into the soil (by rainfall or watering), an expansion takes place. If dried out, the soil will contract, often leaving small fissures or cracks. Excessive drying and wetting of the soil can progressively deteriorate structures over the years because it can lead to differential settlement within buildings and other improvements.

Soils at the VV2 Project site are composed mainly of sands, silty sands, and sand with silt. For that reason, the expansion potential of the soil is generally low, as indicated in the Soil Conservation Survey of San Bernardino County (U.S. Department of Agriculture Soil Conservation Service, 1986). There are some clay horizons in the subsurface that

exhibit moderate expansion potential, but these areas are relatively deep and would not be expected to pose significant expansive soil issues for Project facilities (see Section 6.2, Agriculture and Soils).

Erosion. Erosion is the displacement of solids (soil, mud, rock, and other particles) by wind, water or ice and by downward or down-slope movement in response to gravity. Due to the generally flat terrain of the vast majority of the Project site (~ 95 percent), it is not prone to significant mass wasting at present. Areas at the top of the slope along the eastern site boundary have a potential for mass wasting at present, although grading as part of Project site preparation will eliminate these slopes and reduce this erosion potential. Soil characteristics at the Project site allow for the potential for wind and water erosion (see Section 6.2, Agriculture and Soils).

6.6.2.4 Geologic Hazards Along Linear Facility Routes

Seismic Groundshaking. As with the proposed plant site, the Project's linear facility routes are located in seismically active areas and therefore will likely be subjected to ground shaking from movement along one or more of the active or potentially active faults in the region. The estimated PGA for the soils beneath Segment 1 and the northern portions of Segment 2 of the Project transmission line routes with 10 percent probability of being exceeded in 50 years is between 0.35g and 0.38g for alluvial soil conditions (California Geological Society 2006). These PGAs would most likely be the result of movement along the Helendale-S. Lockhart fault which is located approximately 9.2 miles northeast of the VV2 Project site. The remainder of Segment 2 and all of Segment 3 of the transmission route has an estimated PGA of 0.40g to 0.58g for alluvial soil conditions. These PGAs would also most-likely be the result of movement along the Helendale-S. Lockhart fault. The maximum estimated site intensity based on the Modified Mercalli (MM), is IX (Blake, 2000).

Ground Rupture. Although the linear facility routes are located within a seismically active area, no historically active faults have been identified along the routes themselves.

Liquefaction. Detailed groundwater studies have not been performed for the Project's linear facilities routes, but the preliminary geotechnical investigation at the Project site indicated that groundwater is estimated to be approximately 150 feet or deeper. Because soil conditions and topography in the areas along the linear corridors are similar to the soils and topography at the Project site, groundwater levels along the linear facility routes are expected also to be between 100 and 150 feet bgs. In areas where intermittent streams are crossed, groundwater would be expected to be encountered at more shallow

depths. Soils that are above the groundwater table and not saturated will not liquefy; thus, liquefaction in these areas is considered unlikely.

Slope Stability. With the exception of a number of locations where the transmission line route crosses intermittent stream channels, the majority of the off-site linear facility routes traverse terrain that is generally flat. Significant mass wasting or slope stability problems in the flat areas are unlikely, as are mass movements such as landslides although there is some potential for slope instability in areas where stream channels are crossed. Regionally, landslides and mass movements could occur along the slopes that border the Mojave River channel. Portions of the Segment 1 and Segment 2 transmission lines are located along the slope of the Mojave River channel and thus are potentially subject to mass wasting or slope stability problems. However; careful selection of the locations of the power poles along this segment (e.g., placing them in areas with the shallowest slopes and avoiding stream channels) and appropriate construction procedures and adherence to construction SWPPP procedures during pole installation activities is expected to reduce the potential for unstable slopes to less than significant. The reclaimed water supply line extending between the VWRA treatment plant and the VV2 plant site will be located along relatively flat terrain along much of the route, but the northern portion of the route will traverse gentle slopes of the Mojave River channel. The southern portion of the Sanitary Waste Water Pipeline also traverses the slope of the Mojave River channel. Therefore, there is a potential for unstable slopes along these pipeline routes, particularly during construction. Careful route selection to minimize the slopes encountered, adherence to the construction phase SWPPP to minimize storm water runoff impacts, and the temporary nature of the construction indicate that impacts will be less than significant.

Slope stability is not expected to be a major issue along Segment 2 and Segment 3 of the transmission route because the topography is generally flat, the Segment 2 transmission lines largely will be strung on existing towers and new towers will be constructed adjacent to existing towers (several under-crossing towers in Segment 2 and throughout most of Segment 3).

Subsidence. Geologic and soils conditions along the linear routes are generally similar to those of the plant site**.** The geotechnical investigation performed on the VV2 plant site indicates that the soils at the site have a low to moderate potential for collapse (Kleinfelder, 2006). Soils along the linear facility routes are expected to have the same low to moderate potential for collapse of the natural soil deposits within the upper 5 feet. Site-specific geotechnical reviews will be conducted prior to construction at each transmission structure location in order to ensure that the structures/foundations are properly located and designed to accommodate the site-specific conditions.

Expansive Soils. Soils beneath the linear facility routes are composed mainly of sands, silty sands, and sand with silt. For that reason, the expansion potential of the soil is generally low, as indicated in the Soil Conservation Survey of San Bernardino County (U.S. Department of Agriculture Soil Conservation Service, 1986). There are, however, some clay horizons in the subsurface that exhibit moderate expansion potential (see Section 6.2, Soils and Agriculture).

Erosion. As noted above, over most of the linear facility routes, the terrain is generally flat and thus, these areas are not prone to significant mass wasting. Although portions of Segment 1 and Segment 2 (roughly between mileposts 3.00 and 5.00) of the Project transmission lines are located along the slope of the Mojave River channel and cross a number of ephemeral drainages, careful power pole placement will avoid areas of steeper terrain and thus the potential for erosion will be less than significant. Erosion potential is not considered significant for most of Segment 2 and all of Segment 3 of the Project transmission lines because of the generally flat terrain. Soil characteristics beneath the linear facility routes allow for the potential for wind and water erosion. This information is presented in Table 6.2-3 (Section 6.2, Soils and Agriculture).

6.6.2.5 Geologic Resources

Mineral deposits within the Mojave Desert region include ores within bedrock deposits, lake bottom evaporates, and sand and gravel deposits within the alluvial basins (Dibblee, 1980). Figure 6.6-4 shows quarry and prospect locations within two miles of the Project in the areas east of the Mojave River Channel (Mineral Resources Data System, 2006). Resources mined include sand and gravel, limestone, calcium, granite, stone, silica, sphalerite and galena, and gold. No mineral deposits were identified at the VV2 Project site and along the linear facility routes.

Based on the Mineral and Land Classification of Concrete Aggregate Resources in the Barstow-Victorville Area, the VV2 Project (including linear facility routes) are within mineral resource zone designation MRZ-3a (CDMG, 1993) (Figure 6.6-4). This designation is classified as: “Areas containing known mineral occurrences of undetermined mineral resource significance.” Widespread areas of desert are classified as MRZ-3a. The area within the Mojave River channel is classified as mineral resource zone MRZ-2b, which is defined as areas where significant aggregate deposits exist or where there is a high likelihood of significant aggregate deposits to occur (CDMG, 1993).

Based on a search of State recreation-related websites (California State Parks and Recreation.gov, 2006), there are no known recreational geologic resources associated

with the proposed VV2 site. Recreational geologic resources typically include rock or mineral collecting, surface hydrothermal features, or surface expression of geologic features unique enough to generate recreational interests of the general public (natural bridges, caves, waterfalls, etc.).

6.6.3 Environmental Impacts

Significance criteria were developed based on CEQA Guidelines and evaluated using professional judgment. The significance criteria used in evaluating potential geologic-related impacts are shown below. Impacts would be considered significant if:

- Surface rupture occurred as a result of faulting or due to mass movements or settlement from seismic shaking;
- Liquefaction occurred as a result of shallow groundwater and/or seismic shaking;
- Subsidence occurred as a result of existing soil conditions or seismic shaking;
- Mass wasting occurred as a result of landsliding and soil creep; and
- Construction of the Project interfered with access to mineral resources.

Water-related seismic hazards, such as a tsunami or seiche, are not discussed because the proposed Project site is not near any large bodies of water.

6.6.3.1 Construction

Construction-related impacts to the geologic environment primarily are related to terrain modification (cuts, fills, and drainage diversion measures) and dust generation. No major unique geologic or physical features have been identified in the Project areas. Project construction will not require cut and fill activities on the site and grading will not require import or export of earthen materials to/from the site. Thus, significant impacts are not expected on geologic hazards or resources during construction. No evidence of ground subsidence caused by groundwater extraction has been noted at the VV2 Project site or offsite linear facility routes. Subsurface soils show low to moderate potential to collapse.

The Project site is in the seismically active area southern California region and thus the Project areas are subject to groundshaking from earthquakes along faults in the region. The potential for earthquake-related impacts would begin during Project construction. However, seismic impacts would be of greater concern during long-term Project operation than during the limited duration of the Project construction phase and these impacts are discussed immediately below.

6.6.3.2 Operations

Regional and local geologic conditions will not be altered significantly by the long-term operation of the VV2 Project. No major unique geologic or physical features have been identified at the Project site or along the linear facility routes. The Project areas may be underlain by deposits of sand and gravel, and these resources could not be recovered and used during the active life of the Project. No other impacts to the geologic environment were identified.

The Project area is subject to ground shaking from nearby and distant earthquakes. Ground accelerations up to 0.35g may be experienced at the VV2 plant site and up to 0.58g along the Project's linear facility routes, which represent the potential for moderate to severe shaking. According to the California Uniform Building Code (UBC, Section 2312), the site is located in Seismic Zone 4, the zone with the highest potential for seismic ground shaking. Project structures will be designed to meet the seismic design standards appropriate for Seismic Zone 4. No faults have been identified with a ground rupture potential at the Project site and thus, no impacts resulting from fault rupture at the Project site are anticipated. Due to the depth to groundwater (150 feet or more), liquefaction is not expected to occur.

No evidence of ground subsidence caused by groundwater extraction has been noted at the VV2 Project site (including linear facilities routes). The potential for local settlement due to groundwater withdrawal may be present at the Project site if the regional groundwater table were to be lowered significantly. However, the VV2 Project will not utilize significant groundwater resources and the potential for settlement due to groundwater withdrawal at the Project locations is considered minimal, due in part to the aquifer recharge activities conducted by the City of Adelanto and the VVWRA treatment plant. Soils at the VV2 plant site and along the linear routes show a low to moderate collapse potential. To ensure that collapse potential is minimized, all foundations for plant facilities will be designed in accordance with preliminary and subsequent geotechnical investigations, including overexcavation and recompaction where necessary.

In summary, the only identified potential geologic hazards at the Project site are ground shaking from earthquakes and the potential for localized soil collapse. Construction of facilities in accordance with the mitigation measures identified below will ensure that earthquake-related impacts and impacts from potential soil collapse are minimized. VV2 Project impacts are considered less than significant.

6.6.3.3 Cumulative Impacts

The VV2 Project will be designed and constructed to meet UBC/CBC requirements for industrial facilities located in Seismic Zone 4 and will adhere to sound professional practices and appropriate regulatory requirements related to geologic hazards (e.g., grading, slope stability). For these reasons, the Project is expected to have no significant impacts on geologic hazards or resources. Other projects in the same vicinity also would be expected to adhere to the appropriate professional standards and regulatory requirements. As such, the VV2 Project would not be expected to contribute to significant cumulative effects on geologic resources and hazards during either construction or operation.

6.6.4 Mitigation Measures

Geologic impacts associated with the construction and operation of the VV2 Project are expected to be less than significant. Moreover, site-specific geotechnical and seismic conditions will be appropriately addressed in the detailed design and construction of Project facilities and equipment. The following mitigation measures are proposed to ensure that impacts are less than significant.

GEOL–1. Power plant structures and equipment as well as Project offsite linear facilities (natural gas, reclaimed water supply and sanitary wastewater pipelines; transmission lines) will be designed in accordance with Seismic Zone 4 requirements.

GEOL-2. Project foundations will be designed in accordance with recommendations (e.g., overexcavation and recompaction beneath Project structures and paved areas) provided in the Project's preliminary geotechnical report (AFC Appendix C), as amended by future geotechnical investigations, with respect to collapsible soil conditions at the Project site and along linear facilities routes.

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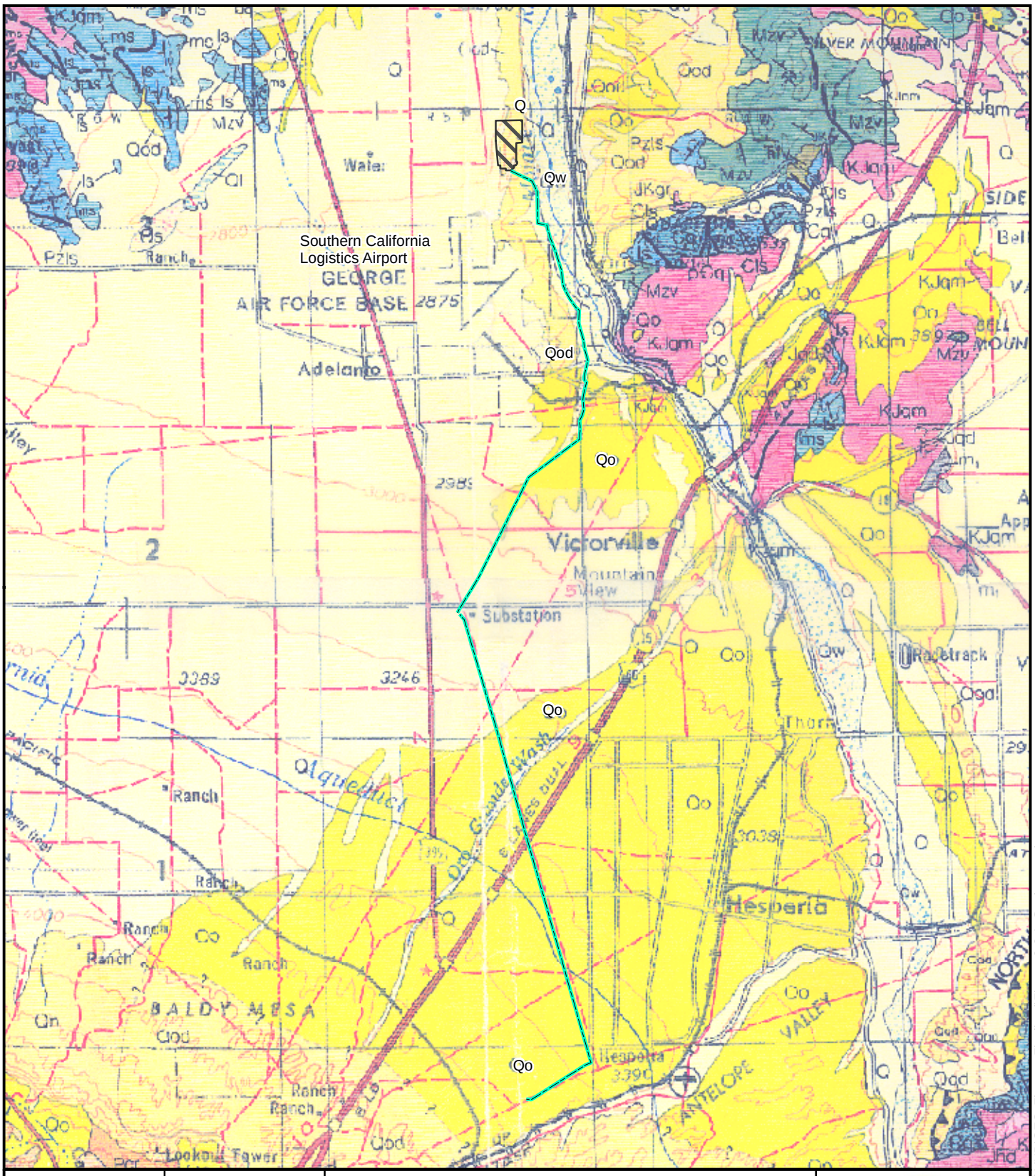

Locus Map

Index Map

Geology Map

Victorville 2 Hybrid Power Project

Project Transmission Line

Project Site

Data:California Geological Survey

Note: Legend of Geologic Units on separate page

Scale: 1:170,000

0 2 4 6 8 Miles

Inland Energy, Inc.

ENSR | AECOM

Figure: 6.6-1

Date: February 2007

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ABBREVIATED EXPLANATION

Approximate stratigraphic relationships only; see Geologic Map Explanation for more accurate age determinations and unit descriptions.

CENOZOIC

QUATERNARY

Holocene

- Q — Alluvium *(Undifferentiated)*
- Qw — Wash deposits *(Alluvial deposits of modern washes)*
- Qow — Older wash deposits *(Alluvial deposits of abandoned washes)*
- Qls — Landslide deposits
- Qs — Wind-blown sand
- Qyf — Younger fan deposits
- Qf — Fan deposits
- Qya — Younger alluvium
- Ql — Lake deposits

Pleistocene

- Qof — Older fan deposits
- Qo — Older alluvium *(Undifferentiated)*
- Qg — Glacial till and outwash
- Qod — Well dissected alluvial fans
- Qh — Harold Formation and Shoemaker Gravel *(Fine- to coarse-grained sediments, nonmarine)*
- Qol — Older lake deposits

TERTIARY

- QT — Continental deposits *(Undifferentiated; fluvial gravel, sand, silt, and clay)*
- QTst — San Timoteo Formation *(Nonmarine sandstone, siltstone, conglomerate, and shale)*

Pliocene

- Pj — Juniper Hills Formation *(Nonmarine sandstone, conglomerate, siltstone, and shale)*
- Pow — Old Woman Sandstone *(Arkosic sandstone and conglomerate; nonmarine)*
- Pcr — Crowder Formation *(Nonmarine arkosic sandstone and conglomerate)*
- Pa — Anaverde Formation *(Nonmarine sandstone and shale)*
- Pf — Fernando Formation *(Siltstone, sandstone, conglomerate; marine)*
- Ppb — Punchbowl Formation *(Nonmarine cobbly to pebbly sandstone)*

? — ?

- Mp — Potato Sandstone
- Msa — Santa Ana Sandstone *(Nonmarine)*

Miocene

- Mcf — Coachella Fanglomerate *(Boulder, cobble, and pebble fanglomerate)*
- Mpe — Puente Formation *(Marine siltstone, sandstone, and shale)*
- Mb ∑ Mbᵛ — Barstow Formation *(Nonmarine sandstone, siltstone, conglomerate, and tuff)*; Mbᵛ-volcanic rocks
- Mcv — Punchbowl (?) Formation of Cajon Valley *(Nonmarine arkosic conglomerate and sandstone)*
- Mtp — Topanga Formation *(Marine sandstone and conglomerate)*
- Mt — Tropico Group *(Conglomerate, arkosic sandstone, siltstone, tuff, shale and limestone)*
- Mc ∑ Mcls — Unnamed Miocene continental deposits *(Poorly sorted sandstone and conglomerate)*; Mcls-limestone and claystone
- Mph — Pickhandle and Jackhammer Formations *(Nonmarine tuff, agglomerate, sandstone, and mudflows)*
- Mh — Hector Formation *(Nonmarine volcaniclastic sediments)*
- Mvq — Vaqueros (?) Formation *(Marine arkosic sandstone, siltstone, and conglomerate)*

Oligocene

Paleocene

- Tsf — San Francisquito Formation *(Massive marine sandstone)*
- TKsf — San Francisquito (?) Formation *(Marine sandstone and siltstone)*

MESOZOIC

- ps — Pelona Schist *(Feldspar-quartz-mica schist)*
- Mzq — Mesozoic quartzite
- Mzv — Mesozoic metavolcanic rocks
- Tfv — Fairview Valley Formation *(Limestone, calcareous sandstone and siltstone)*

PALEOZOIC

- Pzls — Upper Paleozoic limestone and marble
- wg — Waterman Gneiss
- ms ∑ ls — Metasedimentary rocks of uncertain age *(Quartzite, phyllite, and schist)*; ls - limestone and marble
- Cls, Cq — Cambrian and uppermost Precambrian metasedimentary rocks; €ls - Crystalline limestone; €q - Quartzite

PRECAMBRIAN

- p€s ∑ p€q — Late Precambrian metasedimentary rocks; p€s - undivided; p€q - quartzite
- p€b — Baldwin Gneiss

- Cv — Basalt; *Cinder cone*
- MPv — Miocene–Pliocene volcanic rocks *(b-basalt; t-rhyolite tuff)*
- Mi — Miocene shallow intrusive rocks *(a-andesitic; d-dacitic and rhyolitic; b-basaltic)*
- Mgv — Glendora Volcanics *(a-andesite; b-basalt; r-rhyolite)*
- Mv — Miocene volcanic rocks *(a-andesite; b-basalt; d-dacite; p-pyroclastic rocks)*
- Tgr — Tertiary granitic rocks
- Φvz — Vasquez Formation, volcanic member *(Andesite, dacite, and tuff)*
- Φm — Mountain Meadows Biotite, Dacite Porphyry

MESOZOIC PLUTONIC ROCKS

- Kgr — Cretaceous granitic rocks
- Kgb — Gabbroic and dioritic rocks
- JKgr — Jurassic or Cretaceous granite
- Jqd — Jurassic quartz diorite
- J?mz — Jurassic ? monzonite
- Tigd — Mt. Lowe Granodiorite
- gb — Gabbro of Pleasant View Ridge
- Kqd — Cretaceous quartz diorite
- KJqm — Cretaceous or Jurassic quartz monzonite; Quartz Monzonite of Pleasant View Ridge
- JKgd — Jurassic or Cretaceous granodiorite
- Jhd — Jurassic hornblende diorite and minor gabbro
- Trmz — Triassic monzonite

m₁ m₂ m₃ m₄

Sheared and deformed metamorphic rocks (age uncertain)

- m_1 - Gneiss
- m_2 - Mylonite of Vincent Thrust
- m_3 - "Black Belt" Mylonite
- m_4 - High-grade metamorphic rocks

} Locally contain undeformed to slightly deformed plutonic rocks.

MAP SYMBOLS

Contact

Observed or approximately located; queried where gradational or inferred.

Fault

Solid where well located; dashed where approximately located or inferred; queried where continuation or existance is uncertain; dotted where concealed by younger rocks. Arrows show relative or apparent direction of movement. U, upthrown side and D, downthrown side (relative or apparent).

Thrust fault - barbs on the upper plate. Generally dips less than 45°, but locally may have been subsequently steepened. Dashed where approximately located or inferred; dotted where concealed by younger rocks; queried where continuation or existance is uncertain.

Anticlinal fold

Dashed where inferred; dotted where concealed by younger rocks.

Synclinal fold

Dashed where inferred; dotted where concealed by younger rocks.

Overturned fold

Dashed where inferred; dotted where concealed by younger rocks.

Strike and dip of beds

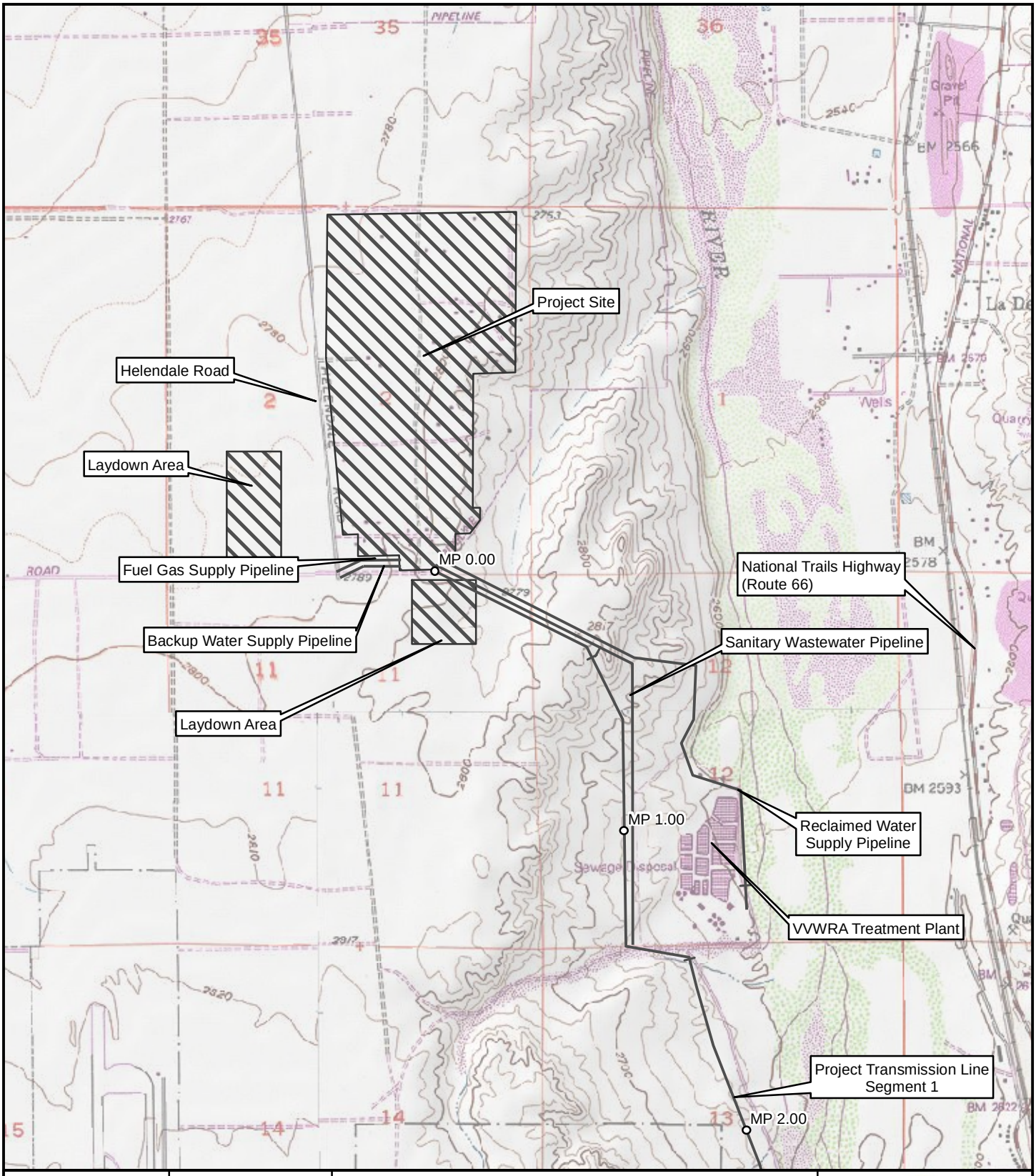
General strike and dip of stratified rocks.

Most conspicuous foliation strike and dip

Joints

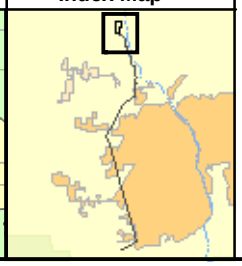
Selected areas of prominently jointed plutonic rocks

Dikes



Locus Map

Index Map



Topographic Map
Victorville 2 Hybrid Power Project

Mile Post (MP)

Half-Mile Hatch

Base Imagery: USGS 24K Topo Quadrangle(s)
Scale: 1:24,000

0 1,000 2,000 3,000 4,000 5,000 Feet

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Mapsheet 1 of 7

Figure: 6.6-2

Date: February 2007

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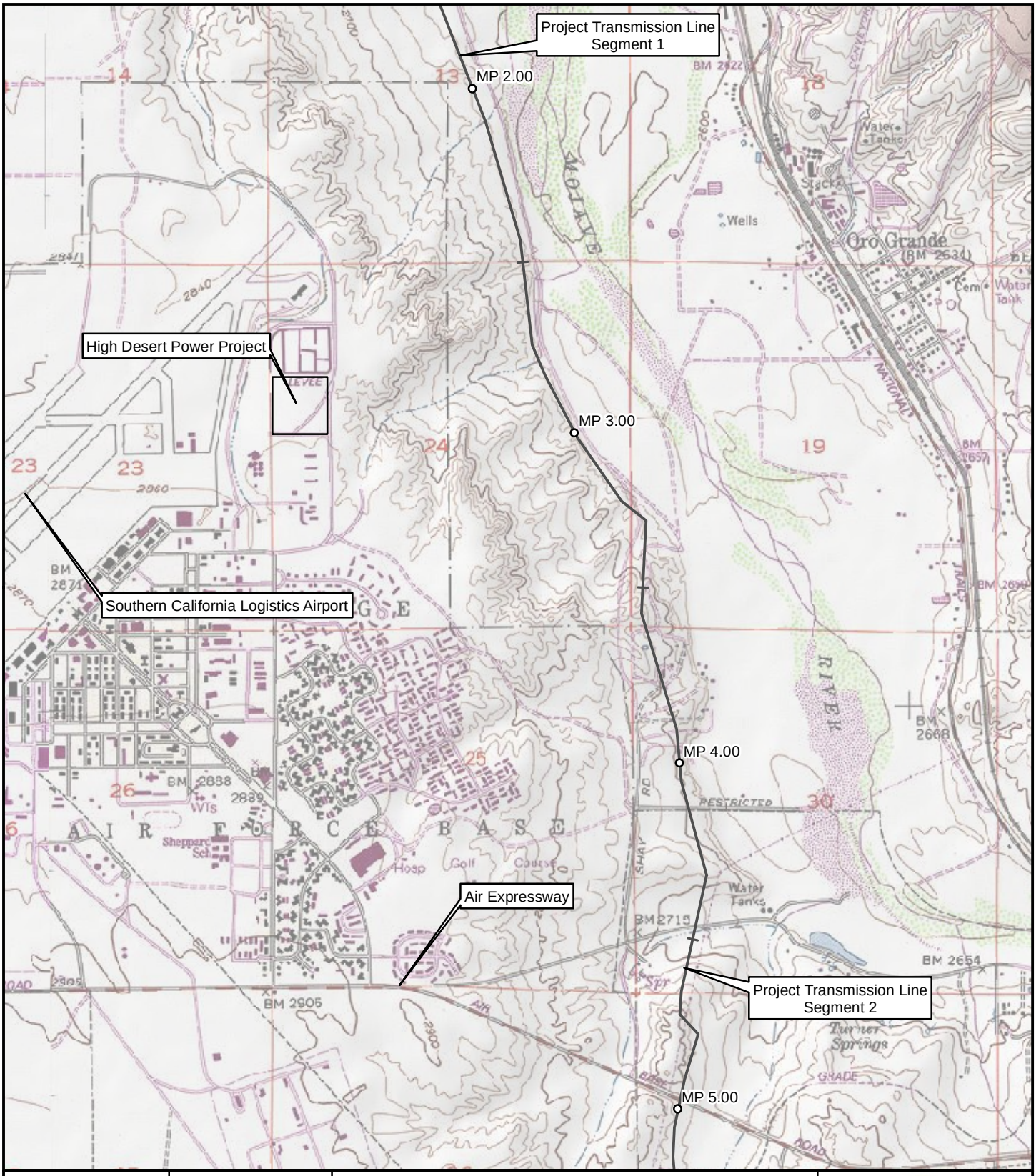

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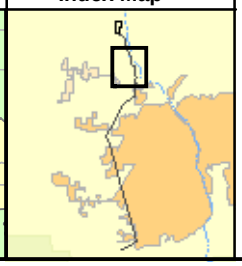

Topographic Map
Victorville 2 Hybrid Power Project

Mile Post (MP)

Half-Mile Hatch

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Mapsheet 2 of 7

Figure: 6.6-2

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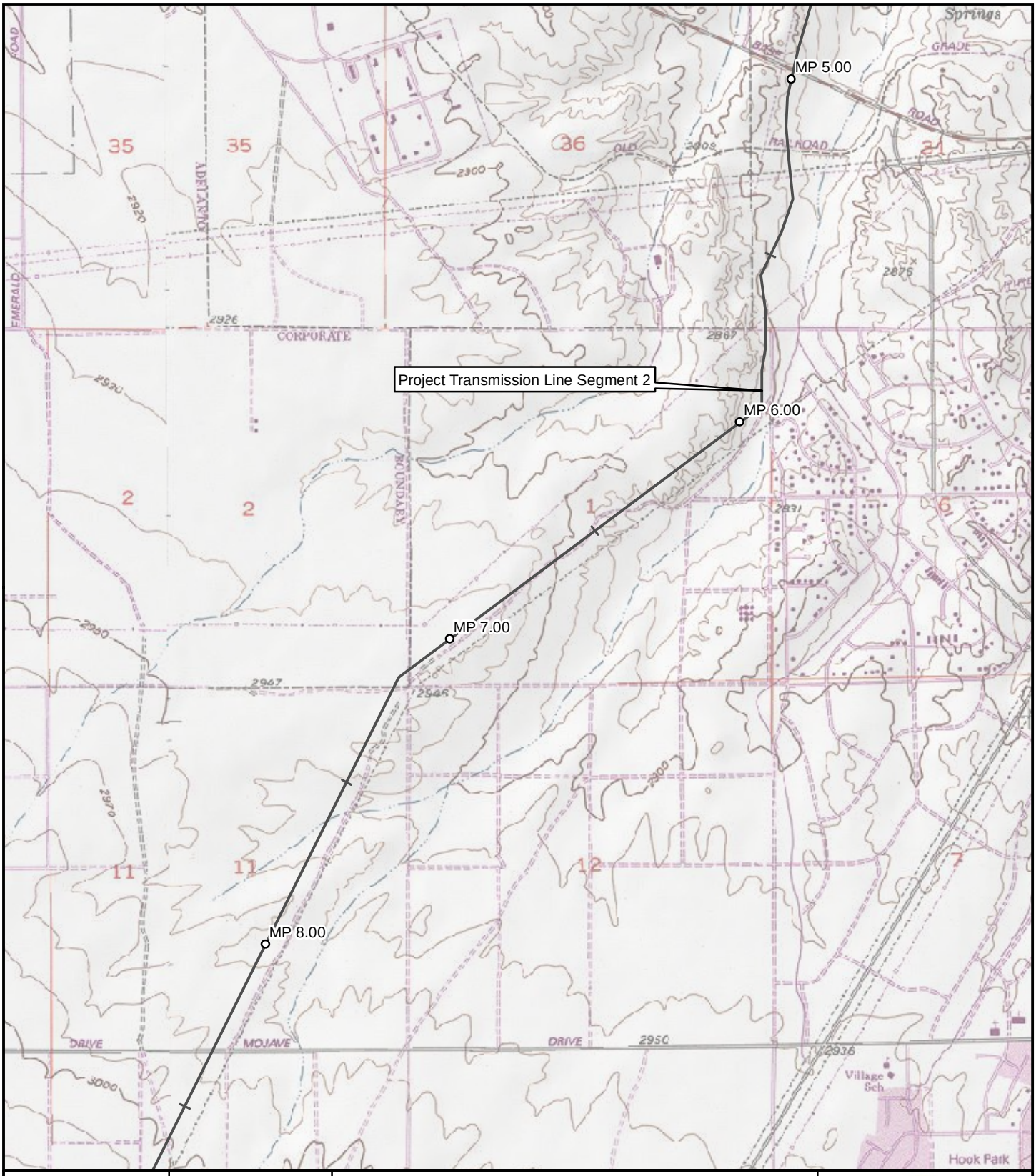

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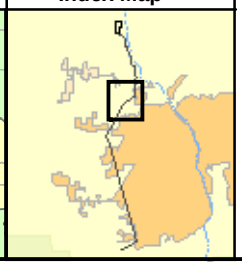

Topographic Map
Victorville 2 Hybrid Power Project

Mile Post (MP)

Half-Mile Hatch

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Mapsheet 3 of 7

Figure: 6.6-2

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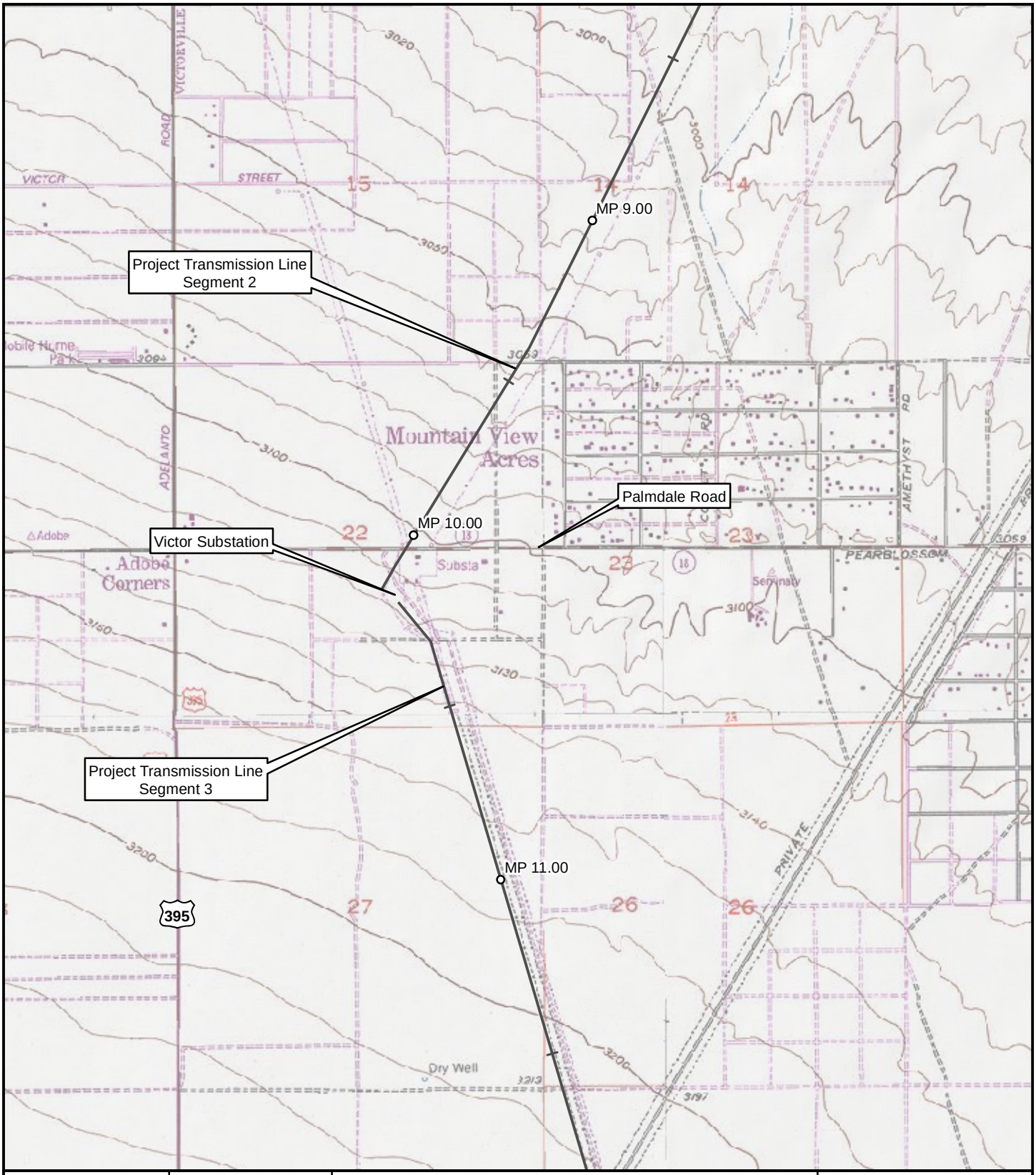

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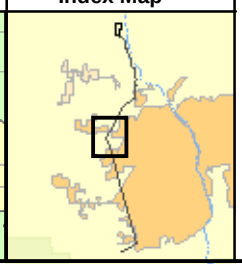

Topographic Map
Victorville 2 Hybrid Power Project

Mile Post (MP)

Half-Mile Hatch

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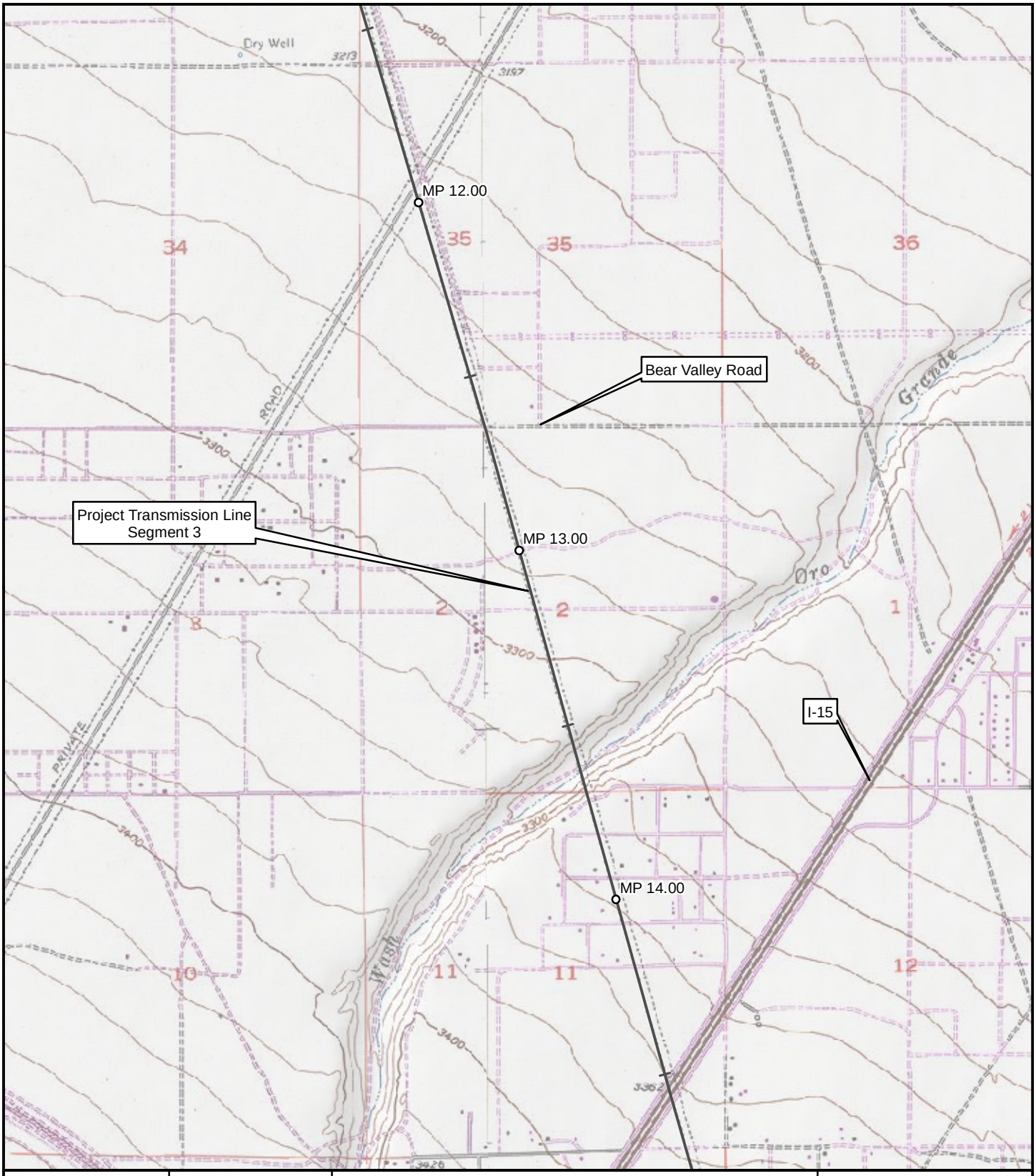

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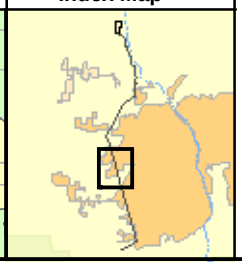

Topographic Map
Victorville 2 Hybrid Power Project

Mile Post (MP)

Half-Mile Hatch

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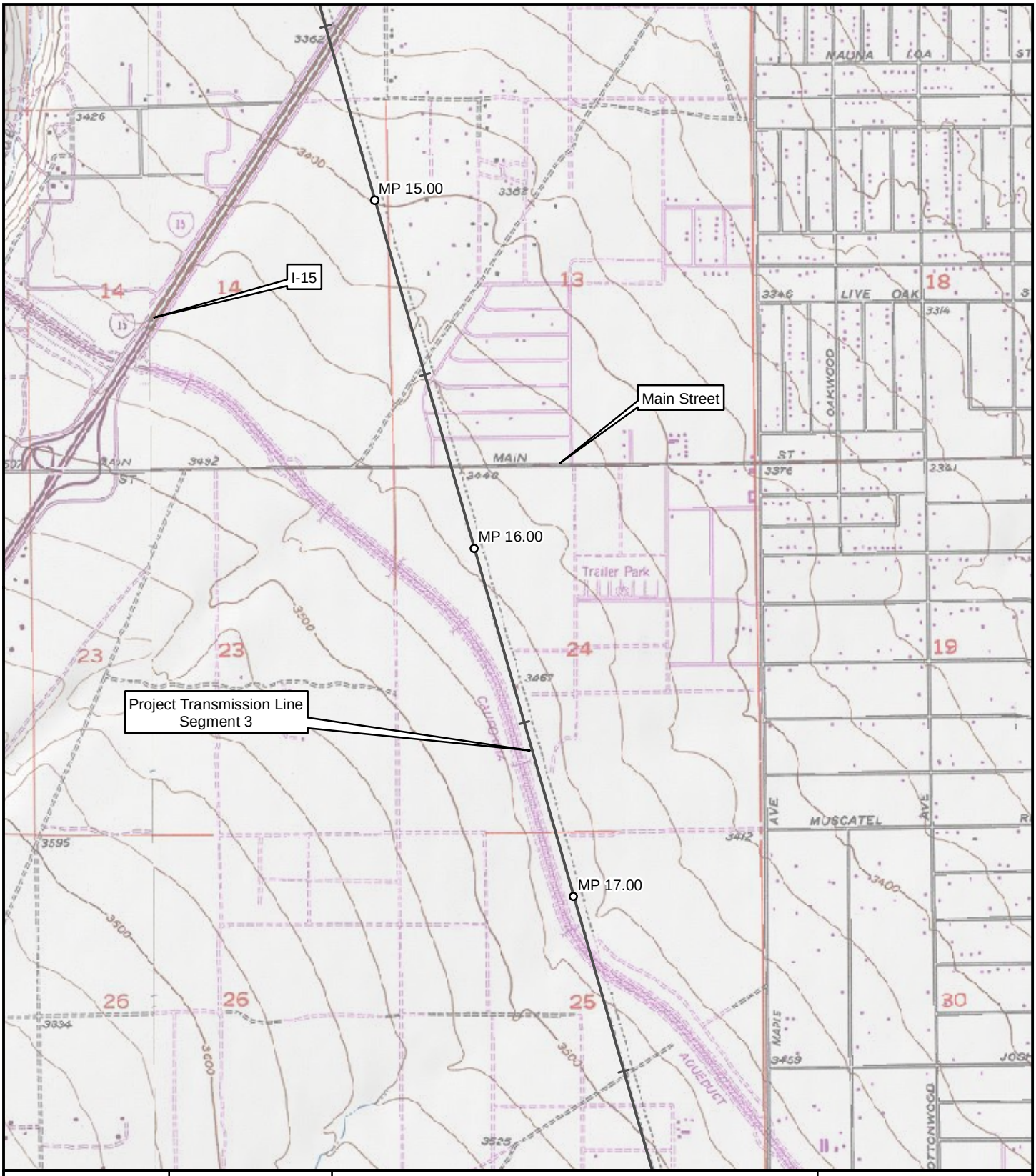

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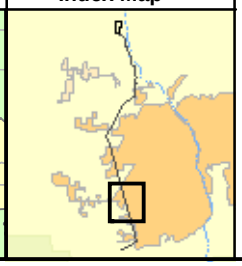

Topographic Map

Victorville 2 Hybrid Power Project

Mile Post (MP)

Half-Mile Hatch

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0 1,000 2,000 3,000 4,000 5,000 Feet

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Mapsheet 6 of 7

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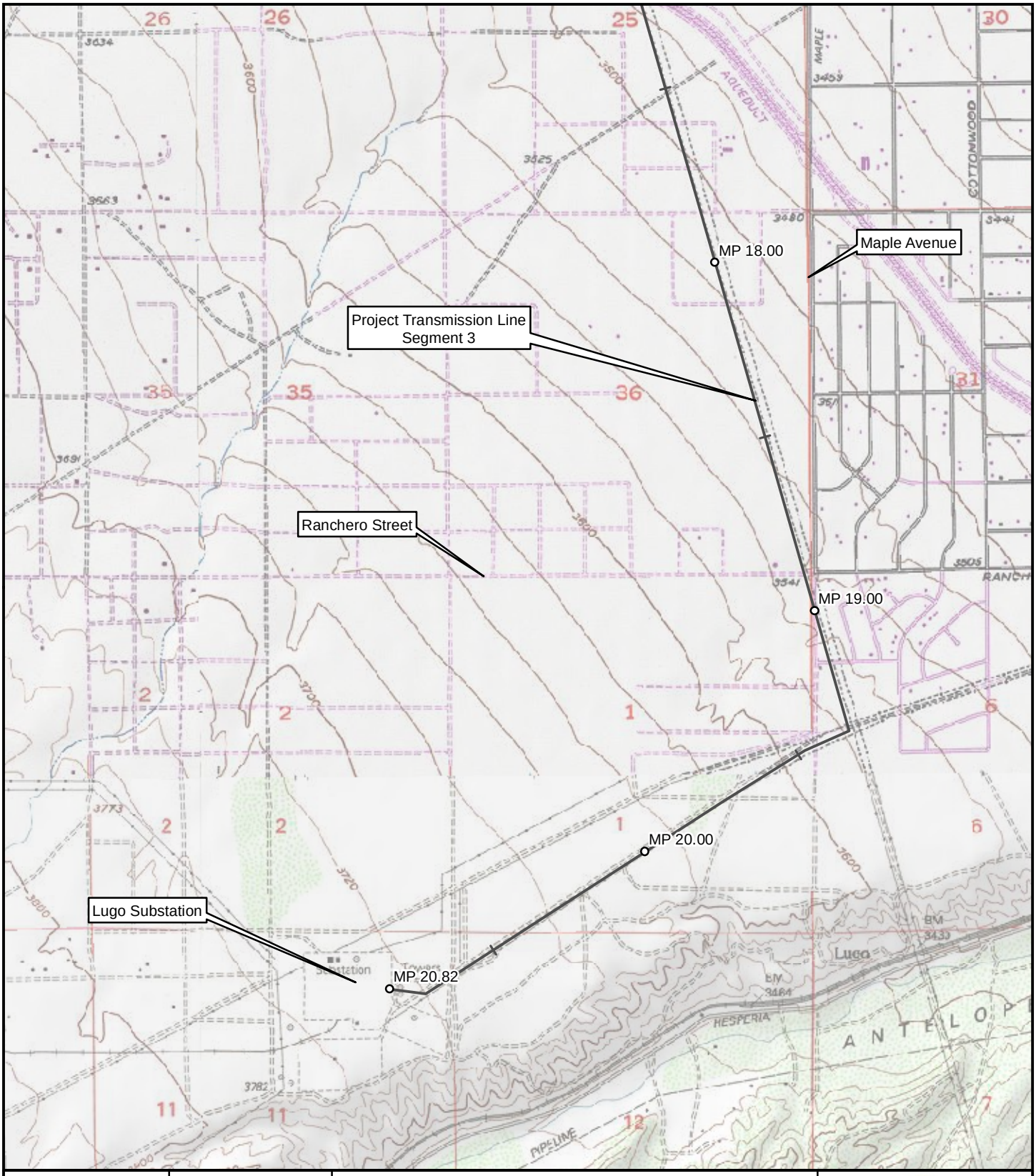

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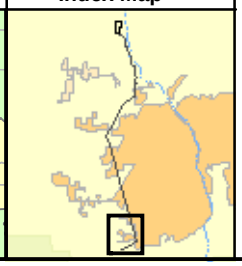

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Victorville 2 Hybrid Power Project

Mile Post (MP)

Half-Mile Hatch

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Mapsheet 7 of 7

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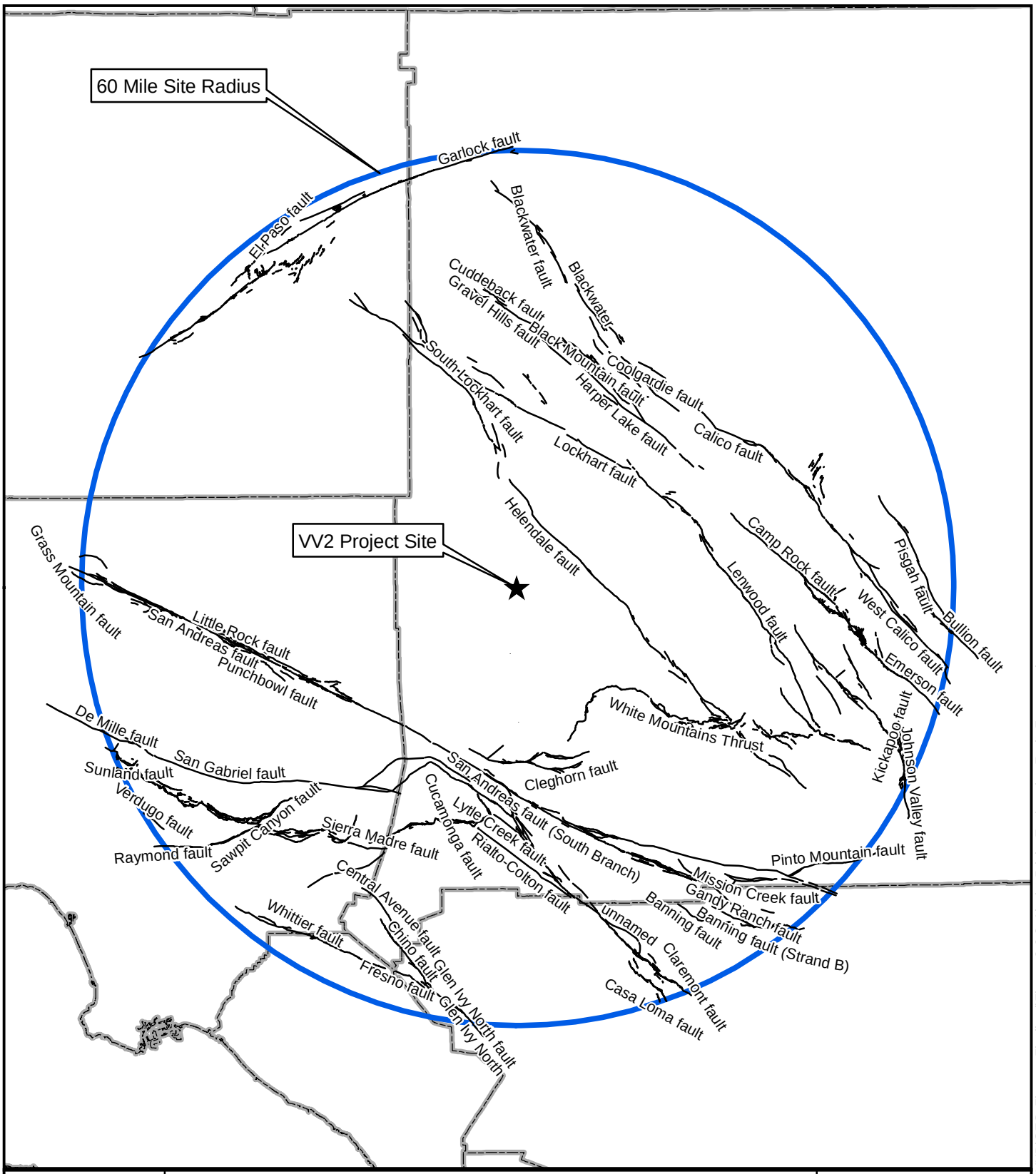

Locus Map

Principal Earthquake Fault Zones in the Project Vicinity

Legend

Fault Line

County Boundary

Data: California Geological Survey, Alquist Priolo Earthquake Fault Zones

Scale: 1:1,200,000

0 15 30 45 60 Miles

N S

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Figure: 6.6-3

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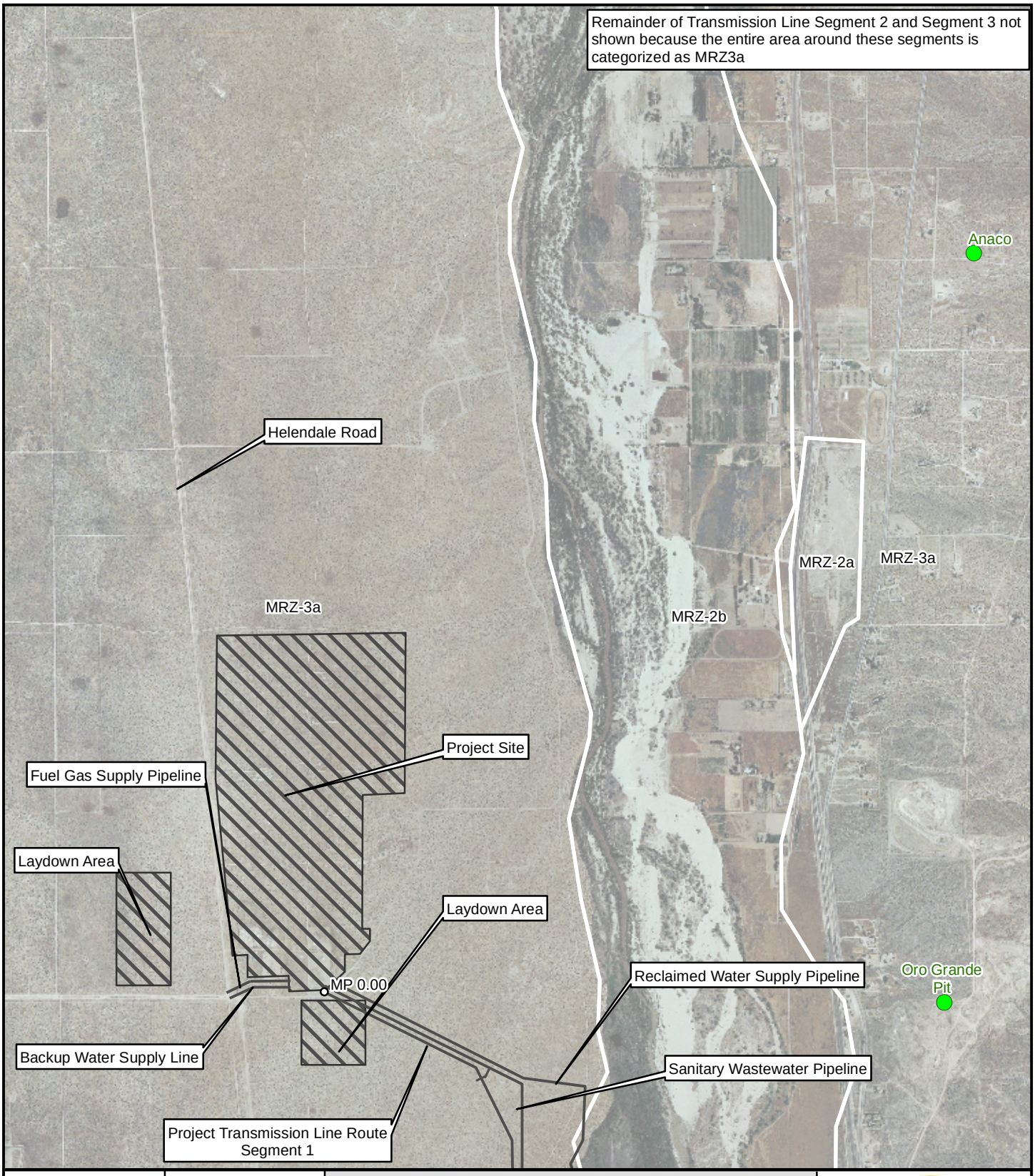

Locus Map

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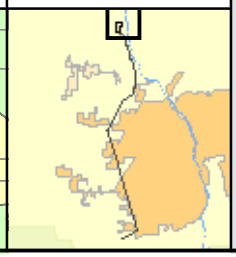

Mineral Resources in the Project Vicinity

Victorville 2 Hybrid Power Project

Mining Pits

Mineral Resources Zone (MRZ)

Mile Post (MP)

Half-Mile Hatch

Imagery: MapMart Aerial Imagery .61 Meter Resolution Circa 2004
Data: USGS Mineral Resources

Scale: 1:24,000

0 1,000 2,000 4,000 6,000 Feet

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Mapsheet 1 of 3

Figure: 6.6-4

Date: January 2007

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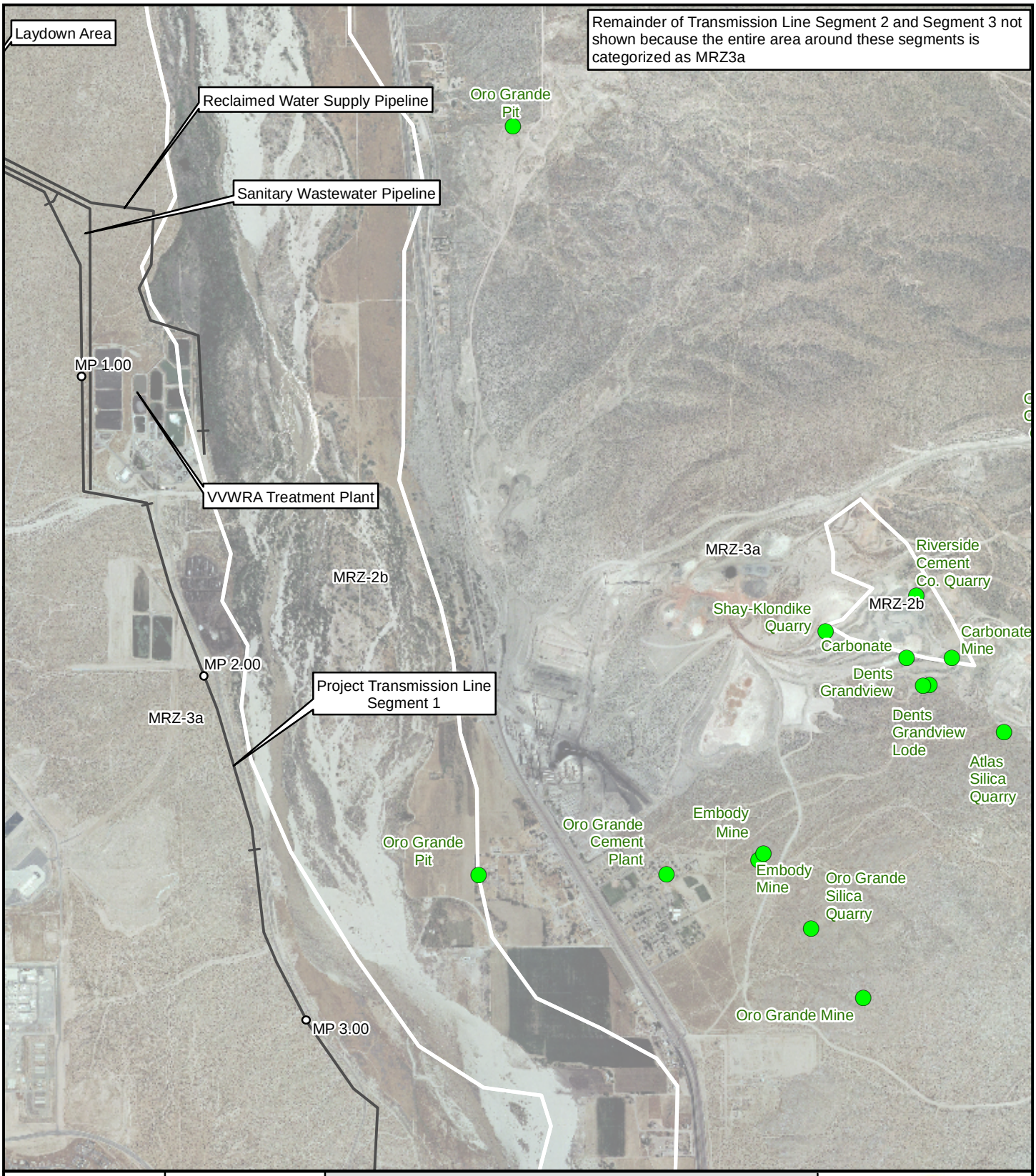

Locus Map

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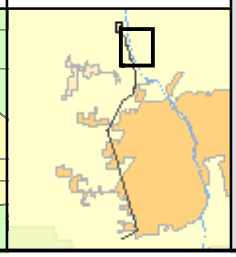

Mineral Resources in the Project Vicinity

Victorville 2 Hybrid Power Project

Mining Pits

Mineral Resources Zone (MRZ)

Mile Post (MP)

Half-Mile Hatch

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Data: USGS Mineral Resources

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0 1,000 2,000 4,000 6,000 Feet

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Mapsheet 2 of 3

Figure: 6.6-4

Date: January 2007

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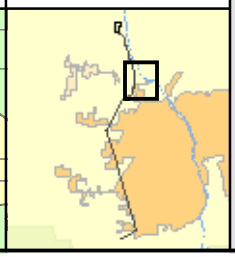
Locus Map

Index Map



Mineral Resources in the Project Vicinty

Victorville 2 Hybrid Power Project

Mining Pits

Mineral Resources Zone (MRZ)

Mile Post (MP)

Half-Mile Hatch

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Mapsheet 3 of 3

Figure: 6.6-4

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