PRELIMINARY GEOLOGIC AND HYDROLOGIC EVALUATION REPORT
Idled Gas Storage Field Conversion Project

Matrix Oil Corporation
Los Angeles County
La Habra Heights, California

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This report was prepared by the staff of AMEC under the supervision of the Engineer(s) and/or Geologist(s) whose seal(s) and signature(s) appear hereon.

The findings, recommendations, specifications, or professional opinions are presented within the limits described by the client, in accordance with generally accepted professional engineering and geologic practice. No warranty is expressed or implied.

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1.0 INTRODUCTION

AMEC Environment and Infrastructure, Inc. (AMEC), has prepared this report for Oakview Engineering and Matrix Oil Corp (Matrix) to summarize the results of geologic and hydrologic evaluations for the proposed conversion of the idled gas storage field (the site) located southeast of the intersection of Cerquita and Peterson Drives in the City of La Habra Heights to an oil and gas producing property. We understand that Matrix has requested the evaluations to support California Environmental Quality Act (CEQA) project review being performed by the City of La Habra Heights. We further understand that Matrix intends to submit a Negative Declaration in its efforts to secure a Conditional Use Permit for the proposed property use. The scope of this evaluation was described in our proposal dated December 12, 2011.

2.0 PROJECT DESCRIPTION

The subject property (the site) is approximately 69 acres and is located southeast of the intersection of Cerquita and Peterson Drives in the City of La Habra Heights, California (Figure 1). On the site are nine existing oil and gas recovery wells, four well pads (identified as well pads #1, #2A, #2B, and #3), and asphaltic paved roads (Figure 2). We understand that site operations are idled and that Matrix intends to reenter and deepen three existing wells for testing of deeper resources for oil and gas production, and that additional existing wells will be reentered and deepened or recompleted, and new wells will be drilled. Recovered emulsion of oil and water will be piped to a Central Processing Facility to produce marketable crude oil and produced water. A truck loading facility will be constructed to transport crude oil to market. Produced water and natural gas will be reinjected back into the reservoir. A Gas Plant will be built to treat or process (upgrade) natural gas to pipeline quality standards. Depending on economic viability, pipelines may be built to deliver crude oil to refineries and/or upgraded natural gas to Southern California Gas Company. Additional ancillary facilities will be constructed to support project operations. It is our understanding construction of new facilities will be completed on existing pads and roads and that no new grading or road work is planned for the site.

3.0 GEOLOGY AND SOILS

This section provides a discussion of the regional and site geology, unconsolidated materials, and associated hazards.

3.1 REGIONAL AND SITE GEOLOGY

The site is located in the northeast part of the Los Angeles basin in the Puente Hills area of the United States Geological Survey (USGS) La Habra 7½-minute topographic quadrangle map. The Puente Hills are part of the Transverse Ranges, which are a series of east-west trending mountain ranges that formed due to the interaction of the Pacific Plate and the North American Plate. The site is located east of downtown Los Angeles in the City of La Habra Heights in the southwest margin of the Puente Hills. The Puente Hills rise to an elevation of around 1,000 feet above mean sea level (msl) with the maximum height being 1,428 feet msl (Yerkes, 1972). The site is situated in hilly terrain with ridges separated by steep-sided drainages. Topographic relief across the project area is approximately 250 feet, with elevations ranging from approximately 800 feet msl near Well Pad #1 to an approximate elevation of 550 feet msl below the proposed location of the Central Processing Facility. The steepest slope surrounding the building pad that will be used for the Central Processing Facility is a natural slope to the west and has an inclination of approximately 34 degrees (1.5:1).

The major bedrock units south of the Whittier fault in the Puente Hills are Pliocene age marine deposits comprised of the La Habra, San Pedro, and Fernando Formations. The project site, as mapped by Yerkes (USGS, 1972), is underlain by the upper member of the Fernando Formation. The upper member of the Fernando Formation is divided into three parts; the lower, middle, and upper units. The lower unit is approximately 650 feet thick and consists of sandstone with thin partings of siltstone, a massive, pebbly sandstone, and a massive pebble conglomerate at its base. The middle unit is approximately 1,935 feet thick and consists of massive silty sandstone with thin beds of silt and localized scattered pebbles and limey concretions. The upper unit is approximately 825 feet thick and consists of a massive friable sandstone and pebbly sandstone. The predominant dip direction of the bedrock units beneath the site is to the southwest. During a site visit conducted by AMEC on December 19, 2011, outcrops of slightly weathered, friable, silty sandstone were exposed at the site

The closest active fault is the Whittier fault, which is located approximately 0.25 miles (1,400 feet) north of the site (Figure 3, Yerkes, 1972). In addition to the Whittier fault, the more recently discovered Puente Hills Thrust system, which is comprised of the Coyote Hills, Santa Fe Springs, and Los Angeles blind thrust faults, begins near the western Puente Hills and runs through downtown Los Angeles to Beverly Hills (Olson, 2005). The exact trace of the Puente Hills Thrust is uncertain as it is a blind thrust with no surface expression.

The Whittier fault controls the major geologic structure of the Puente Hills and extends along the southern margin of the Puente Hills approximately 25 miles northwest to the Northwestern end of the Puente Hills. Movement along the Whittier fault initiated during the Miocene and continues into recent times. The Whittier fault is considered seismically active by the California Geological Survey (formerly the State Mining and Geology Board [Hart, 1994]). Approximately 19 miles of right lateral movement of Paleocene sediments has been postulated along the Whittier fault (Lamar, 1961). Yerkes (1972) estimated approximately three miles of right-oblique offset based on vertical separation of Miocene sediments and stream channel deflections.

At the northwestern end of the Puente Hills, the Whittier fault (zone) is joined by two other North-trending faults, the Workman Hill and Whittier Heights faults. These faults are typically near vertical and display normal dip slip movement, with some evidence for lateral movement. The Workman Hill and Whittier Heights faults are not considered active by the California Geological Survey (Hart, 1994).

Oil and gas exploration and production began in the Puente Hills in 1880 (Yerkes, 1972). Since that time, several oil fields have been discovered in the area including the Puente Hills, Brea-Olinda, Sansinena, Whittier, Rideout Heights, Santa Fe Springs, and East and West Coyote oil fields (Yerkes, 1972). While many oil fields in the area have been abandoned, oil production continues in the Puente Hills.

3.2 UNCONSOLIDATED MATERIAL

Unconsolidated material observed at the site during AMEC's reconnaissance is limited to young alluvial deposits at the base of small ephemeral streams and colluvium along the lower parts of slopes. Exposures along roadcuts observed during AMEC's site reconnaissance indicated there is a thin veneer (on the order of several inches) of soil overlying the silty sandstone bedrock. It is not known if there are currently fill materials at the site. Observation of the roads and pad areas indicate these were placed on cut bedrock materials. The roads and pads appear to be in good condition with little to no cracking. Cracks were observed in the road along the western margin of the proposed Central Processing Area (Figure 2). These cracks appear to be related to creep along the edge of the slope. A geotechnical assessment of the subsurface conditions should be conducted prior to construction of new facilities at the site.

3.3 GEOLOGIC HAZARDS

This section discusses geologic hazards including active faults, surface rupture hazard, ground shaking, liquefaction, and landslides.

3.3.1 Active Faults

Based on the record of historic earthquakes and position within the broad deforming boundary between the North American and Pacific plates, the Southern California region is considered to be one of the most seismically active regions of the world. During the recent historic period (approximately 200 years), faults within the region have produced numerous moderate- to large-magnitude earthquakes (i.e., magnitude >6). In 1971, the magnitude 6.6 San Fernando Earthquake ruptured the northwestern portion of the Sierra Madre fault and created Modified Mercalli shaking intensities of VI at the site (NEIC, 2011a).

The Puente Hills Blind Thrust is thought to be responsible for the Whittier-Narrows earthquake, which occurred on October 1, 1987 and had a magnitude of 5.9M with an epicenter in the northwest portion of the Puente Hills (Dolan, 2003). The Whittier Narrows earthquake created shaking intensities of VII to VIII at the site (NEIC, 2011b). For reference, during intensity VIII shaking, damage is considerable in ordinary substantial buildings and great in poorly-built structures, chimneys and walls collapse, and heavy furniture is moved (NEIC, 2011b). As recently as March 16, 2010, a magnitude 4.4 earthquake was centered in Pico Rivera, to the west of Whittier. Extensive petroleum-industry seismic reflection data have allowed paleoseismologists to estimate that the Puente Hills Thrust has produced four earthquakes of magnitude 7.2 to 7.5 during the past 11,000 years (Dolan, 2003). The return period for large earthquakes on the Puente Hills Thrust is thought to be significantly longer than on other major earthquake producing faults in Southern California, such as the Garlock fault (Dawson, 2003).

The Whittier fault is located approximately 0.25 miles north of the site. It is a right-lateral strike slip fault with a significant component of vertical displacement creating a cumulative right-oblique net slip with a slip rate of 2.5 to 3.5 millimeters per year (Yerkes, 1972; California Department of Conservation, 2011). The most recent surface rupture along the Whittier fault was between 1,400 and 2,200 years ago and had an estimated magnitude of 7.15, based on paleoseismic data (Dolan 2007). While no evidence of large earthquakes on the Whittier fault was found in recent history, it is thought to be capable of producing an earthquake with a magnitude as high as 6.8 (California Department of Conservation, 2011).

3.3.2 Surface Rupture Hazard

The site is not located within a currently established Alquist-Priolo Earthquake Fault Zone and no known faults are mapped or were observed on site. The closest active fault is the Whittier fault, which lies approximately 0.25 miles to the north. The position of the Whittier fault is well known in this area. The risk due to surface rupture at the site is considered low.

3.3.3 Ground Shaking

The California Department of Conservation estimates that the Whittier fault is capable of producing an earthquake of magnitude 6.8 (California Department of Conservation, 2011). In addition, the nearby Puente Hills Thrust has been shown to be able to produce a magnitude 7.2 to 7.5 earthquake (Dolan, 2003). Earthquakes of these magnitudes near the site would cause intense ground shaking at the site. The peak horizontal ground accelerations that have a 10 percent chance of being exceeded once in 50 years at the site have been evaluated by referring to California Division of Mines and Geology's (CDMG) Seismic Shaking Hazard Evaluation of the La Habra 7.5-Minute Quadrangle (CDMG, 2000). A 10 percent probability of exceedance in 50 years corresponds to an earthquake return period of 475 years. The CDMG indicates that peak horizontal ground accelerations (PHGA) for the 475-year return period for earthquakes at the site are approximately 0.44g. This PHGA is for soft rock conditions. In addition, the design PHGA for the site based on the 2010 California Building Code (CBC, 2010) is approximately 0.55g. The CBC (2010) PHGA is also intended to approximately represent an earthquake return period of 475 years, similar to CDMG (2000). The approximate PHGAs from both CDMG (2000) and CBC (2010) are for level sites and do not include any topographic effects such as what could be present at the site. All structures on site should be built according to the Uniform Building Code and any local requirements. A detailed evaluation of ground shaking should be performed during the design of the project.

3.3.4 Liquefaction Potential

Liquefaction is a soil behavior phenomenon in which a loose saturated soil located below the groundwater surface loses a substantial amount of strength due to strong earthquake ground shaking. Some types of loose to medium dense soils tend to compact during earthquake shaking, inducing excess pore water pressure in the saturated soil, which in turn causes a reduction in strength. Recently deposited (i.e., geologically young) and relatively loose natural soils, and uncompacted or poorly compacted fills, are potentially susceptible to liquefaction. While silty, sandy, and gravelly soils typically have potential for liquefaction, clayey soils and bedrock generally are not susceptible to liquefaction. The site is located on sedimentary bedrock and although there may be localized zones of perched groundwater, we anticipate groundwater is relatively deep (discussed below in Section 4.0) and thus risk of liquefaction is remote. In addition, the seismic hazard map prepared by CDMG does not consider the site to be in an area at risk for liquefaction (CDMG, 1997).

3.3.5 Landsliding

The Puente Hills contain areas of relatively steep relief that are prone to landslides. Bedding attitudes mapped at the site are to the southwest and several south-facing slopes are located within the subject property. AMEC reviewed geologic and seismic hazard zone maps for the site vicinity. No known landslides are mapped within the subject property. The La Habra

Seismic Hazard Zone map shows areas on site to the south of Well Pad #2B, north of Well Pad #3, and west of the building pad for the Central Processing Facility that are at a higher risk for seismically induced landslides (CDMG, 1997).

During our site reconnaissance, evidence of localized slope creep and/or shallow slumps was observed on slopes adjacent to road cuts within the site. These areas were limited in extent and likely the result of weathering and erosion. No obvious signs of landsliding or adverse slope conditions were observed during our site reconnaissance. In addition, AMEC observed an area where approximately 20-foot high, near vertical cut slopes had been excavated for an alternative building pad. Historic aerial photos reviewed by AMEC show these slopes were cut at least 18 years ago and appear to remain relatively unchanged, suggesting these slopes are grossly stable. Slope stability could be affected if site use changes and/or the slopes become saturated or altered by excavation or surface water runoff. As Matrix plans to utilize the existing roads and building pads and a water conveyance system is in place, the landslide threat is considered low.

4.0 HYDROLOGY AND WATER QUALITY

This section provides a brief discussion of the regional and site hydrogeology, site hydrology, and associated hazards.

4.1 REGIONAL AND SITE HYDROGEOLOGY

The site is located north of the La Habra groundwater basin in the Puente Hills. The La Habra Basin is located between the Central Basin of Los Angeles and the Orange County Basin. It is comprised of a shallow alluvial depression bounded on the north by the Puente Hills and the south by the Coyote Hills (OCWD, 2004; WRD, 2004). Little groundwater production occurs in the La Habra Basin due to low transmissivity and poor water quality (high total dissolved solids). Potable groundwater production in the basin has been about 1,200 acre-feet per year (MWDOC, 2007). According to hydrogeologic studies, between 2,200 and 5,500 acre-feet of groundwater per year flows westerly into the Central Basin or southerly into the Orange County Basin (OCWD, 2004).

Due to the relatively steep topographic relief of the Puente Hills, precipitation that falls on the hills will be carried either by overland flow or groundwater flow to the La Habra Basin. Due to the lack of water wells, groundwater levels near the site are unknown. The presence of groundwater in hilly terrain is highly variable and localized, however, and zones of shallow perched water may be present in some areas. The Whittier Landfill is located approximately 2.5 miles northwest of the site in the Puente Hills. Groundwater was first encountered at depths between 200 and 250 feet below ground surface (bgs) during drilling for monitoring wells at the Whittier Landfill (Whittier, 2011). Static water levels in these wells were measured at 136.33, 149.90, and 165.42 feet bgs in July 2011 (Whittier, 2011). Based on the relatively similar geomorphic features and geologic conditions at the landfill and the site, depth to groundwater may be similar beneath the site. Groundwater is not expected to be encountered near the surface except where siltstone layers within the Fernando Formation may create localized perched zones.

4.2 HYDROLOGY

While no surface water was observed during the site visit, the topography indicates that surface water generally flows from the northeast to the southwest across the site. Surface water on the roads and drilling pads is conveyed to catch basins that divert surface water off site to the surrounding natural drainage system. The likely headwaters of an ephemeral stream are located in an incised canyon to the west of the Central Processing Facility. The site is located near the top of the Puente Hills and thus has a relatively small watershed above it to capture precipitation and the relatively steep topography around the site is expected to shed water quickly.

4.3 HYDROLOGY AND WATER QUALITY HAZARDS

This section discusses hydrologic hazards and their potential impact to the site including water quality violations, groundwater depletion, alteration of existing drainage, site flooding, and tsunamis and seiches.

4.3.1 Water Quality

It is our understanding that operations at the site will be conducted according to regulations and in a manner that will prevent drilling fluids and produced liquids from infiltrating into the ground or drainage system. If appropriate regulations are followed and best management practices are emplaced, there should not be an impact to water quality.

4.3.2 Groundwater Depletion

It is our understanding that site operations will not include utilization of groundwater and that additional oil and/or gas wells will be installed in accordance with state and local regulations, which will include provisions for protection of underlying groundwater resources. The site will utilize existing roads and building pads and therefore proposed construction on the existing pads should not significantly affect existing groundwater recharge.

4.3.3 Alteration of Existing Drainage

The proposed site operations will utilize existing roads and building pads and will not alter the existing drainage system. There is no anticipated increase in erosion, siltation, or run off due to the proposed site activities.

4.3.4 Site Flooding and Erosion

The project is situated near the top of the Puente Hills and there are no significant rivers or flooding hazards nearby. The site has a limited watershed above it that could capture rainfall. Even in heavy precipitation, the steep relief around the site will likely quickly convey water away from the site through the existing drainages. Erosion is not considered a significant risk because only existing drilling pads and roads will be utilized and the hillsides around the site are vegetated. The surface conditions have been graded to convey surface water to collection points that discharge to the natural drainage system surrounding the site.

4.3.5 Tsunamis and Seiches

The project site is located over 17 miles inland from the Pacific Ocean at an approximate elevation range of 550 to 800 feet msl. Consequently, earthquake-induced tsunamis are not considered a hazard at the site. Since there are no permanent bodies of water within several miles of the site, seiches also are not considered a hazard.

5.0 DISCUSSION OF FINDINGS

The active Whittier fault is located approximately 0.25 miles north of the site and the Puente Hills Blind Thrust has caused large earthquakes nearby, which is thought to be capable of producing an earthquake of magnitude 7.2 to 7.5. Although there are no active faults mapped at the site, the site may experience significant ground shaking during the life of the facility. All buildings and facilities should be constructed after appropriate location-specific geotechnical studies are performed and in accordance with UBC and local building codes.

Landslides are not considered a significant threat to the site; however, cut slopes may be prone to localized shallow slumping or erosion, which could impact surface drainage systems. These conditions can be mitigated by on-going maintenance at the site.

Groundwater beneath the site is believed to be relatively deep. Site operations should be conducted in a manner to prevent the infiltration or runoff of drilling fluids and produced liquids to prevent potential surface or groundwater impacts.

Our study found no other evidence of unusual or significant soil conditions or geologic hazards that might affect the proposed facility conversion. The proposed project will not change the hydrology, hydrogeology, surface topography, or geologic hazards if conducted according to applicable regulations. However, prior to construction of new facilities or buildings on the existing pads, a geotechnical assessment of the soil and bedrock conditions should be conducted.

6.0 LIMITATIONS

The recommendations made in this report are based on the assumption that subsurface conditions at the project site do not deviate appreciably from those described herein and encountered during our reconnaissance. If any variations or undesirable conditions are encountered during construction, AMEC should evaluate the effects these conditions may have on our recommendations and, if necessary, develop supplemental recommendations. Recommendations are made for specific improvements described in this report. Changes in design of the project should be evaluated for their effects on these recommendations.

In the performance of our professional services, AMEC, its employees, and its agents comply with the standards of care and skill ordinarily exercised by members of our profession practicing in the same or similar localities. This report may not provide all the subsurface and geologic information that may be needed by a contractor to construct the project. No warranty, either expressed or implied, is made or intended in connection with the work performed by AMEC, or by the proposal for consulting or other services or by the furnishing of oral or written reports or findings. We are responsible for the recommendations contained in this report, which are based on data related only to the specific project and location discussed herein. In the event conclusions or recommendations based on these data are made by others, such conclusions and recommendations are not our responsibility unless we have been given an opportunity to review and concur with such conclusions or recommendations in writing.

7.0 REFERENCES

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FIGURES

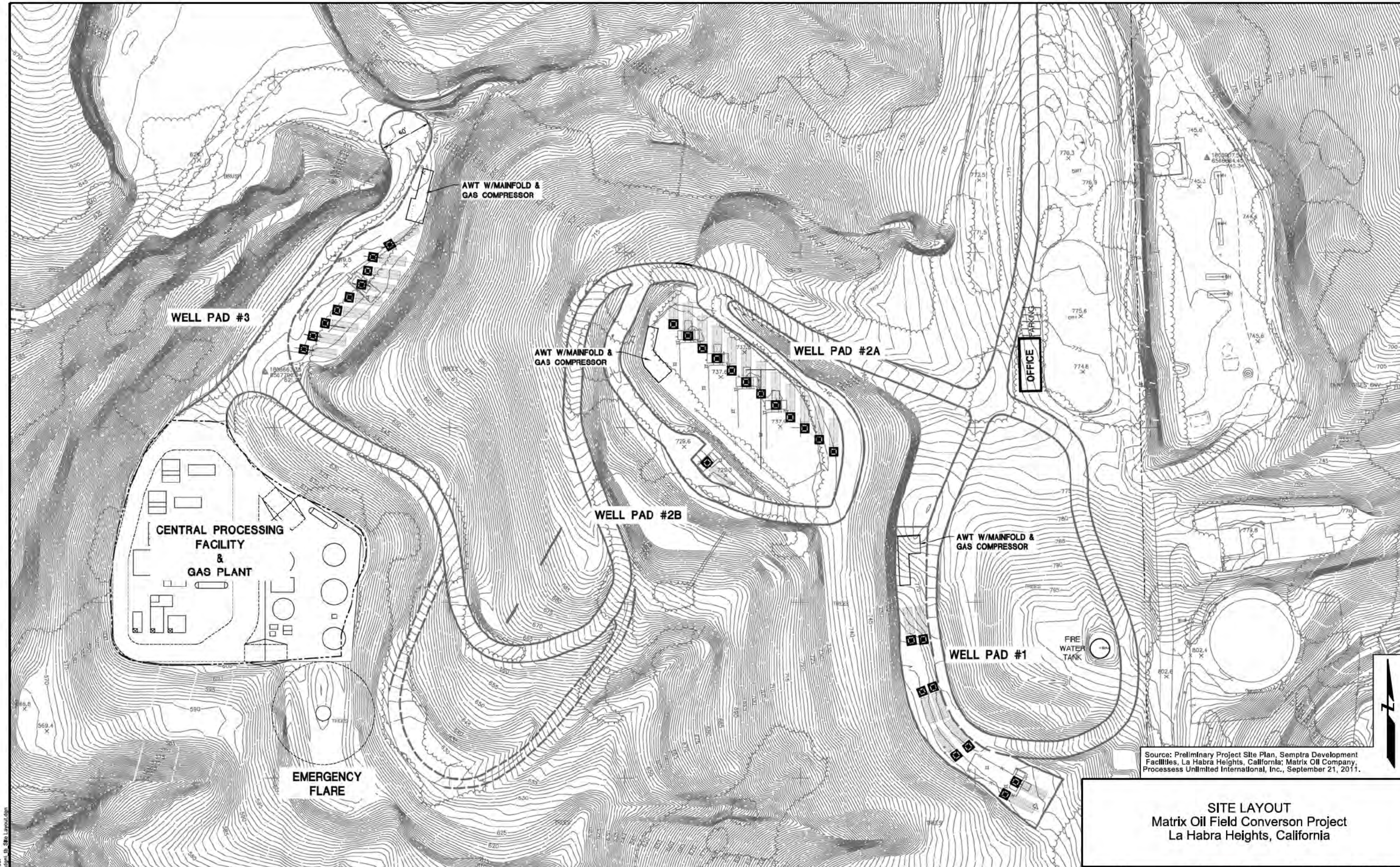
0 2,000 4,000
Approximate Scale in Feet

Basemap modified from Bing Maps (Microsoft Corporation© 2011 and Digital Globe©, 2010).

SITE LOCATION MAP
Matrix Oil Field Conversion Project
La Habra Heights, California

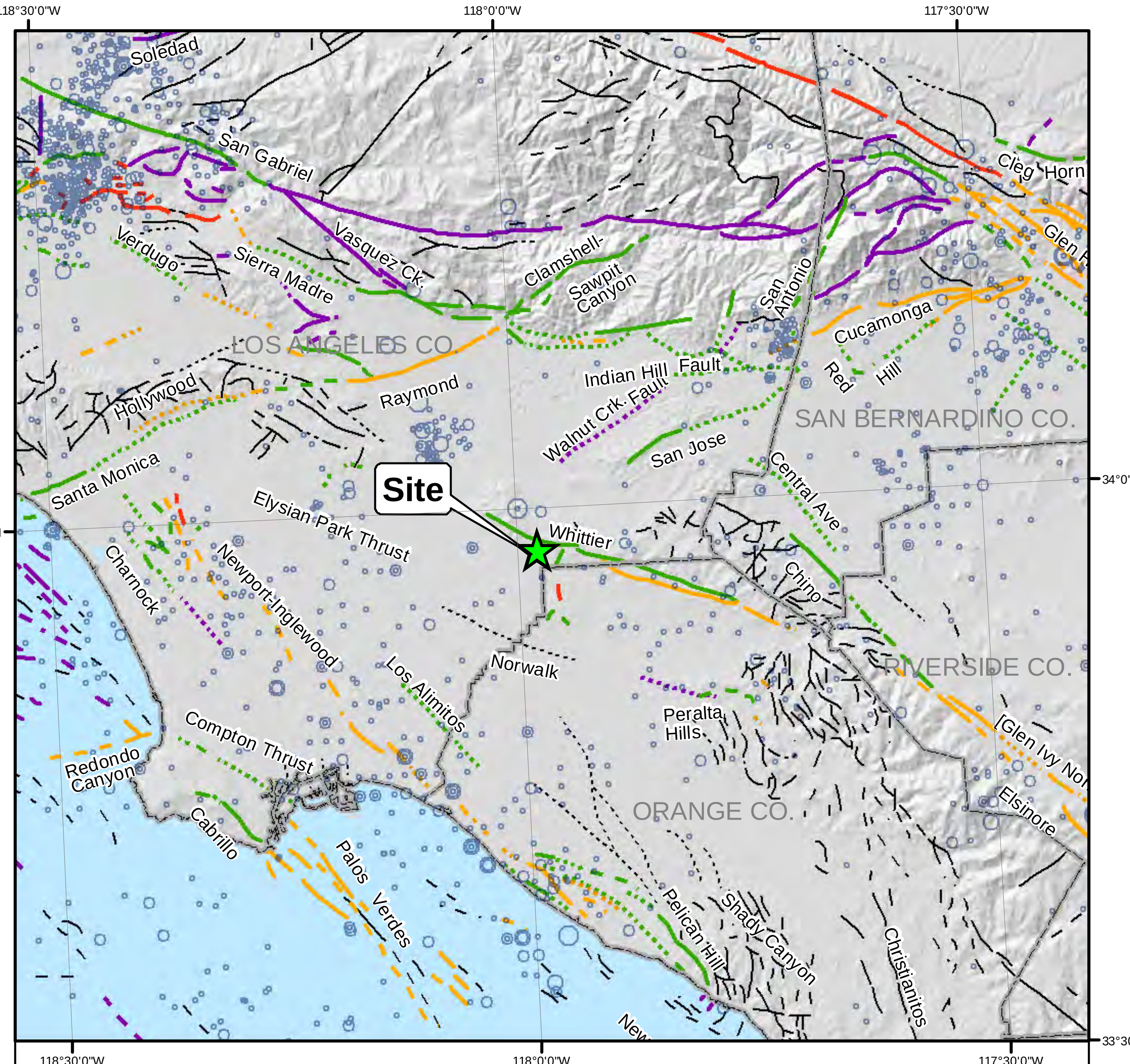
By: pah	Date:03/07/12	Project No. IRV12162090
amec		Figure 1

Path: Y:\IRV12162090\esri\bing_aerial_site_location_V2.mxd



SITE LAYOUT
Matrix Oil Field Converson Project
La Habra Heights, California

By: pah	Date: 03/07/12	Project No: IRV12162090
	amec	Figure 2



Explanation

Fault Recency Classification (Jennings, 1994)

- Faults with historic surface rupture or creep
- Faults that displace Holocene (~10 ka) deposits or geomorphic surfaces
- Faults that displace late Quaternary (~700 ka) deposits or geomorphic surfaces
- Quaternary faults; show evidence for displacement within past 1.6 Million years
- Pre-Quaternary faults
- **[Anza]** Fault Segments

Note: See text of report for description of seismicity catalog.

10 5 0 10
Miles

20 10 0 20
Kilometers

Historic earthquakes, 1769-2003

Magnitude

- 3.0 to < 4.0
- 4.0 to < 5.0
- 5.0 to < 6.0
- 6.0 to < 7.0
- 7.0 or greater

N

Path: Y:\IRV12162090\esri\Vicinity Fault Map.mxd

FAULT MAP OF SITE VICINITY
Matrix Oil Field Conversion Project
La Habra Heights, California

By: pah	Date:03/07/12	Project No. IRV12162090
amec		Figure 3