PRELIMINARY PROJECT DESCRIPTION (PRE-FEED STAGE)

CO_2 ENHANCED OIL RECOVERY AT THE ELK HILLS OIL FIELD

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1 Introduction and Project Overview

Occidental of Elk Hills, Inc. (OEHI) operates a large, mature oil production field in the Elk Hills Unit near Bakersfield, California. The boundaries of the Elk Hills Unit are depicted in Figure 1-1 OEHI is proposing to extend its existing Enhanced Oil Recovery (EOR) operations by utilizing carbon dioxide (CO_2) from the proposed Hydrogen Energy California (HECA) project to facilitate oil production from its Elk Hills operations (hereinafter referred to as the "OEHI CO_2 EOR Project"). The HECA Project, which will be located approximately 4 miles north of the Elk Hills Unit, will generate CO_2 from an Integrated Gasification Combined Cycle (IGCC) power plant.

This Project Description has been prepared based on information available to OEHI from a Class 3 Preliminary Front End Engineering Design (Pre-FEED) analysis. The Project Description will be updated as the HECA Project is further detailed and in accordance with results from a final FEED analysis.

In CO_2 EOR, the injected CO_2 moves through the reservoir, encountering residual droplets of crude oil, becoming miscible with the oil, and forming a concentrated more mobile oil bank that is swept toward the production wells. The U.S. Department of Energy (DOE) estimates that CO_2 EOR has the potential to increase total U.S. oil reserves by 45 to 85 billion barrels of oil (bbo), which are 2 to 4 times the current U.S. total proven reserves. A significant portion of these potential oil reserves are in California (5 to 6 bbo). (DOE-NETL, 2008)

The OEHI CO_2 EOR Project will have the capacity to utilize all of the CO_2 delivered by the HECA Project, both on an annual basis and over the expected life of the HECA Project. Based on extensive studies of the subsurface at Elk Hills, OEHI has determined that there is more than adequate capacity within the target geological formations to inject and trap the total volume of CO_2 delivered by the HECA Project. The capacity, operational injection volumes and pressures will be reviewed as a part of OEHI's permitting process with California Division of Oil, Gas and Geothermal Resources (DOGGR). DOGGR will be the agency responsible for issuing Class II Underground Injection Control (UIC) permits for the planned operations under provisions of the state Public Resources Code and the federal Safe Drinking Water Act of 1974.

As with oil and gas, CO_2 has been naturally trapped in geologic formations for millions of years. The injection of CO_2 into such formations has been safely practiced on an industrial scale for decades, mostly in conjunction with hydrocarbon production. Further, the U.S. Environmental Protection Agency (EPA) has recognized that oil and gas reservoirs will play a valuable role in the

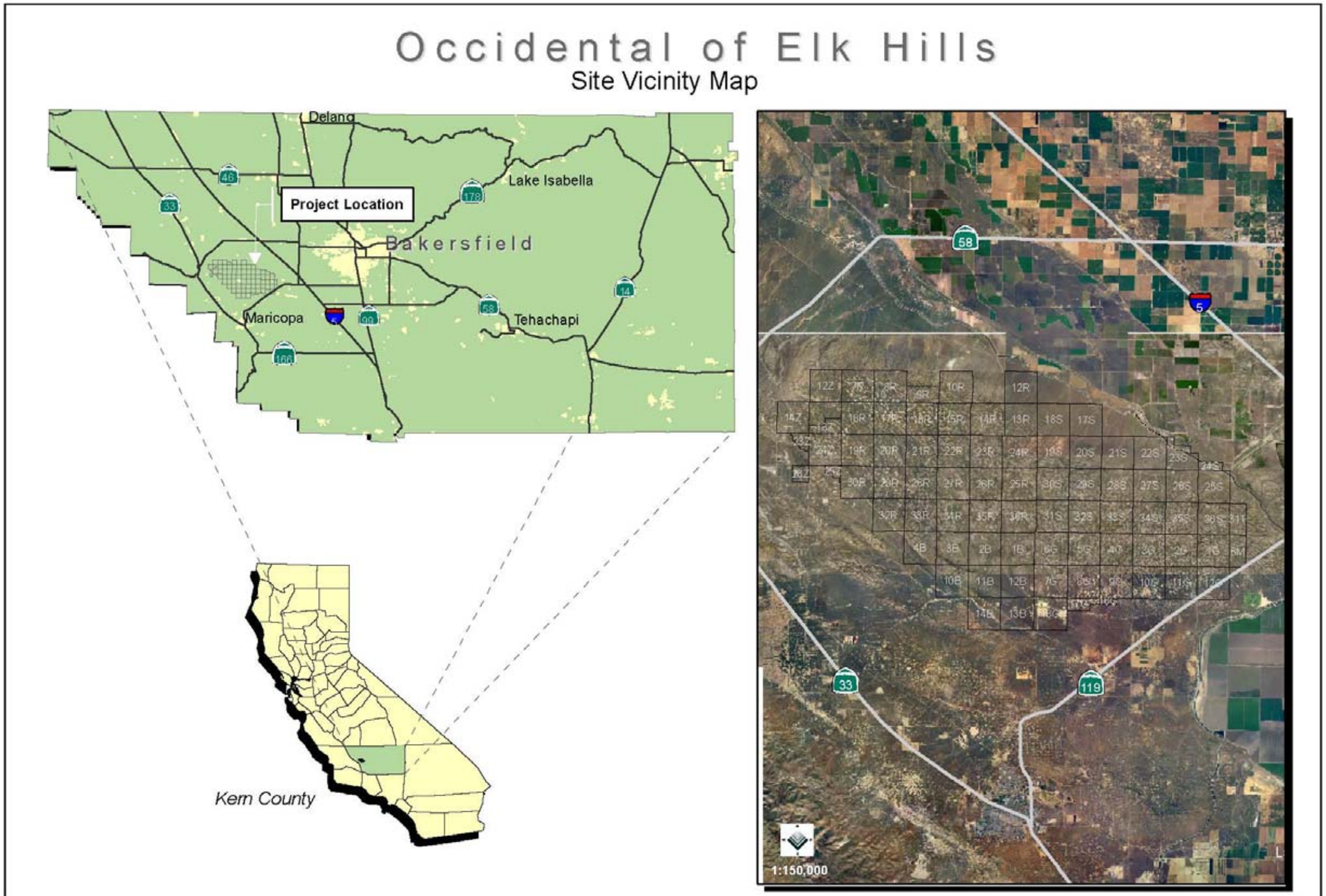

FIGURE 1-1 ELK HILLS OIL FIELD VICINITY MAP

geologic trapping of CO_2. Two of the reasons cited by EPA are: (1) oil and gas reservoirs are natural storage containers that have trapped fluids (both liquid and gaseous) for millions of years; and (2) oil and gas exploration and production activities have created a wealth of knowledge and geologic data that can support the site characterization process for geologic trapping. (See EPA's Proposed Rule: Federal Requirements under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, 73 Fed. Reg. 43492 541, July 25, 2008). In addition, a DOE report (DOE-NETL, 2008) states that oil and gas reservoirs can be ideal candidates for trapping of CO_2 since oil and gas reservoirs have proven capable of storing fluids and gases for millions of years and replacing the extracted oil and hydrocarbon gas with CO_2 is an excellent use of such natural reservoirs. Importantly, not only does trapping of CO_2 occur during active EOR operations, but it continues after EOR operations cease.

The OEHI CO_2 EOR Project would become part of OEHI's Elk Hills operations. The general location and extent of the Elk Hills Unit is illustrated in Figure 1-1. The structure and stratigraphy of the Elk Hills oil field (EHOF) has been exhaustively studied and is ideally suited for the injection of CO_2. The Stevens Reservoirs, which are prominent and long-producing geological structures located approximately 1 mile below the surface, provide excellent EOR targets and ample capacity for long-term CO_2 geologic trapping. Between the surface and the Stevens Reservoirs, there exists naturally occurring dense and thick overlying shales that serve as excellent seals and have proven capable of containing fluids and gases for millions of years. While faults are present within the EHOF, these faults are non-transmissive as indicated by variable oil-water contacts, pressures and temperatures within individual Stevens Reservoirs. Consequently, there are no natural pathways from the subsurface injection zones to the surface. Therefore, CO_2 leakage to the surface and atmosphere is highly improbable.

The EOR process begins when CO_2 is injected into reservoirs at a pressure to dissolve into the oil reservoir, but below a pressure that would fracture the confining geologic zone. Under appropriate conditions, CO_2 and crude oil are miscible, meaning they are capable of mixing in any ratio and becoming a single homogeneous solution. Due to the induced pressure gradient caused from the injection of the CO_2, the CO_2 will flow away from the injection well (Figure 1-2) and become miscible with the reservoir oil. The resulting miscible fluid has the favorable properties of lower viscosity, enhanced mobility, and lower interfacial tension as compared to reservoir oil without dissolved CO_2. In effect, this process mobilizes and recovers oil that would otherwise be trapped within the rock. Water injection will be alternated with CO_2 injection to sweep the miscible CO_2-oil mixture to production wells and to control the movement of CO_2 through the oil.

As part of the continuous EOR process, the CO_2 is separated from the produced hydrocarbons at the surface and reinjected to the reservoir using a closed loop operating system to recover additional hydrocarbons. The surface facilities will be designed to prevent releases of CO_2 to the atmosphere. As CO_2 is a valuable commodity, all of OEHI's EOR surface facilities are designed to contain, recover and recycle CO_2 used in the EOR process. The injected CO_2 is monitored closely through each stage of the process. The closed-loop system consists of surface and subsurface facilities for injection, production, processing, separation, compression and reinjection of CO_2. With each pass of the CO_2 stream through the oil reservoir, a portion, typically 30 to 50 percent, of the injected CO_2 becomes trapped in the reservoir. The balance is recovered, recycled, and blended with additional CO_2 purchased from the HECA Project before being injected. Ultimately, all of the injected CO_2 becomes trapped in the formation and is sequestered. Thus, sequestration is an inevitable consequence of EOR, and, for the purposes of this document, the term "sequestration" will be used interchangeably with the term "trapping."

As it relates to the HECA Project, the CO_2 EOR process will be subject to monitoring, measurement, and verification (MMV) requirements. A site-specific MMV Plan will be developed with the objective of demonstrating trapping of HECA-provided CO_2. The MMV Plan will include consideration of the existing detailed subsurface, seismic, geochemical characterization and wellbore construction details that have been generated from the extensive data covering the EHOF. Selection of the appropriate suite of tools to satisfy the MMV objectives will be based on an assessment of the potential risks, taking into account the unique characteristics of the EHOF and the performance expectations at the site.

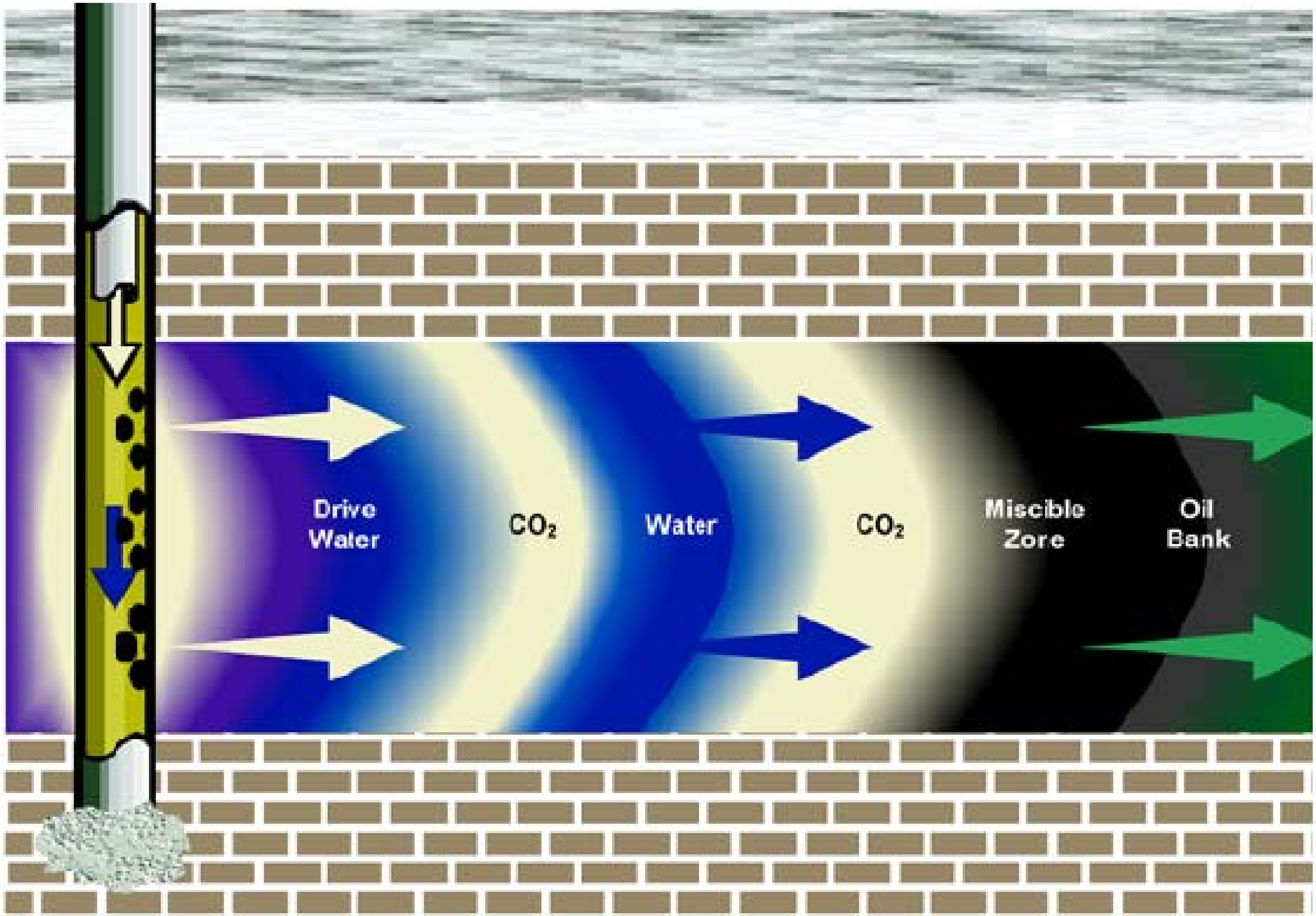

FIGURE 1-2 CO_2 EOR SCHEMATIC

1.1 Project Benefits

The OEHI CO_2 EOR Project will provide a variety of benefits at the local, state, regional, national and global levels. Among these benefits are the following:

- Extension and Enhancement of Production from Elk Hills Unit. Occidental's experience with EOR at Elk Hills and its world-leading expertise in CO_2 EOR will allow the OEHI CO_2 EOR Project to extend production at Elk Hills Unit.

- Reduction in Dependence on Foreign Oil. CO_2 EOR at Elk Hills Unit will extend production from a valuable domestic oil field for many years, partially alleviating the dependence of California and the United States on foreign oil supplies.

- Reduction in CO_2 Emissions. As a user of CO_2 from the nearby HECA Project, the OEHI CO_2 EOR Project will, as a co-benefit to the enhancement of oil recovery, act as a mitigation measure for the HECA Project by allowing for the sequestration of CO_2 emissions from the HECA operations and promote the siting of a valuable power generation resource in California.

- Minimizing Sensitive Habitat Disturbance. The OEHI CO_2 EOR Project will use much of the existing infrastructure such as roads, pipelines pathways and storage and processing facilities to extend recovery of oil and gas while minimizing impacts on the environment. In addition, the OEHI CO_2 EOR Project provides significant net environmental and economic benefits in habitat conservation and the efficient use of existing infrastructure.

- Economic Benefit. The OEHI CO_2 EOR Project will boost the local and California economy with jobs associated with construction and operations, as well as extend the life of the Elk Hills Unit where 345 employees and 2,650 contractors currently work.

1.2 Project Objectives

Project objectives are summarized as follows:

- Extend and enhance the useful and productive life of the Elk Hills Unit.

- Increase California and domestic energy supplies and enhance energy security by maximizing production of petroleum reserves.

- Economically maximize oil recovery within the Elk Hills Unit and safely sequester CO_2 in accordance with all county, state, and federal safety and environmental rules and regulations.

- Provide a mechanism to mitigate CO_2 emission impacts from the nearby HECA Project.

- Minimize environmental impacts associated with the construction and operation of the OEHI CO_2 EOR Project through choice of technology, project design and implementation of feasible and appropriate mitigation measures.

- Ensure the economic viability of the OEHI CO_2 EOR Project by minimizing costs while achieving other Project objectives.

1.3 Project Ownership

OEHI is the majority owner (78 percent) of the Elk Hills Unit and Chevron owns the remaining 22 percent. OEHI operates the Elk Hills Unit on behalf of Occidental and Chevron.

1.4 Proposed Project Schedule

Permitting activities	Ongoing
Start of construction	Spring 2012
Completion of construction	End of year 2014
Commissioning and initial startup	Spring 2015
Commercial operation of the Project	Summer 2015

1.5 Location

The Elk Hills Unit is located 26 miles (42 kilometers [km]) southwest of Bakersfield in western Kern County, California. The entire Elk Hills Unit (approximately 48,000 acres) includes land distributed across all or part of 81 sections within the following townships: T.30S, R.22E; T.30S, R23E; T.30S, R.24E; T.30S, R.25E; T.31S, R.25E; and T.31S, R.24E, Mount Diablo Baseline and Meridian (MDB&M).

The Elk Hills oil field was originally developed as part of the federal Naval Petroleum Reserves, and was designated as “NPR-1.” The U.S. Navy, the original operator of the field, did not use the customary cadastral survey conventions to refer to the location of a particular section. Instead, it employed a “short cut” method in which each distinct Township/Range was identified by a letter designation. Under the cadastral survey method, each township is comprised of 36 one-mile square sections, numbered

1 through 36; each section is referred to by section, township and range designations. Under the Navy's shortcut method, however, each section at the Elk Hills oil field was identified simply by its section number and the township/range letters. Thus, what would normally be described as "Section 7 of Township 30 South, Range 23 East" was described by the Navy simply as "Section 7R." The Navy's convention has persisted and, therefore, all sections within and adjacent to the Elk Hills oil field are still commonly referred to by this shortcut method, which is used in this document (Figure 1-3).

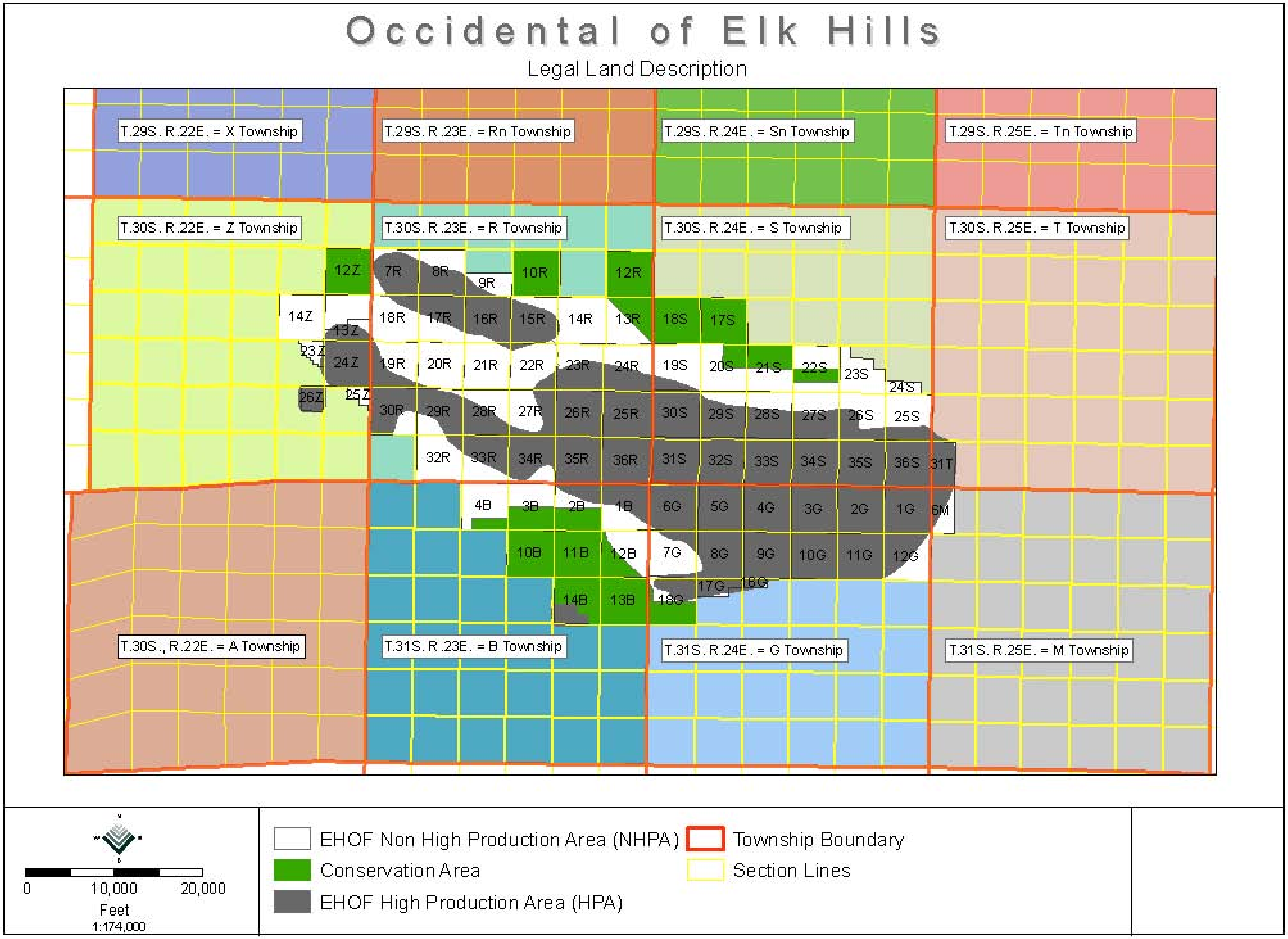

FIGURE 1-3 ELK HILLS OIL FIELD TOWNSHIP/RANGE NAMING CONVENTIONS SCHEMATIC

The Elk Hills Unit is located along the southwest edge of the San Joaquin Valley. This area is situated immediately south of, and contiguous with, the Lokern Area of Critical Environmental Concern (ACEC),[1] a part of which (3,110 acres) is controlled by the Bureau of Land Management (BLM). Portions of this surrounding area (2,050 acres) are managed by the Center for Natural Lands Management (CNLM) and OEHI (formerly Plains Exploration and Production Company and Nuevo Energy Company) Habitat Management Lands (200 acres) as conservation areas. The remainder is owned by Chevron Corporation and others. The City of Buttonwillow is located directly to the north.

McKittrick Valley and portions of Buena Vista Valley with Highway 33 running NW-SE are to the west. The cities of McKittrick and Derby Acres are located along Highway 33. Approximately 10 miles to the west and across the Temblor Range is the Carrizo Plain National Monument (also an ACEC; 199,030 acres).

To the south of the Elk Hills Unit is the Buena Vista Valley, the majority of which is within another oil field, NPR-2, which was recently transferred from the DOE ownership to the BLM. The City of Taft is located approximately 7 miles to the south. Mostly undeveloped areas are located along Highway 119 to the southeast of Elk Hills Unit.

Lands to the immediate east include Coles Levee Ecological Preserve (CLEP; 6,059 acres), Kern Water Bank Authority (19,900 acres), Tule Elk Reserve State Park and the Kern River. The California Aqueduct and the West Side Canal converge and flow along the north and eastern boundary of Elk Hills Unit, as does the Kern River. The Buena Vista Lake Bed is located immediately southeast of Highway 119. Bakersfield is approximately 26 miles to the northeast. The Elk Hills Unit is circumscribed by Highway 5 to the north and east, Highways 119 and 33 to the south, Highway 33 to the west and Highway 58 to the north. Elk Hills Road runs north and south and bisects the project area. Figure 1-4 provides an overview of the Elk Hills Unit with a regional context.

[1] This ACEC designation is authorized by Section 202(c) (3) of the Federal Land Policy and Land Management Act of 1976 (FLPMA, P.L. 94-579). ACEC include public lands where special management attention and direction is needed to protect and prevent irreparable damage to important historic, cultural and scenic values, fish, or wildlife resources or other natural systems or processes or to protect human life and safety from natural hazards. ACEC designation indicates BLM recognizes the significant values of the area and intends to implement management to protect and enhance the resource values.

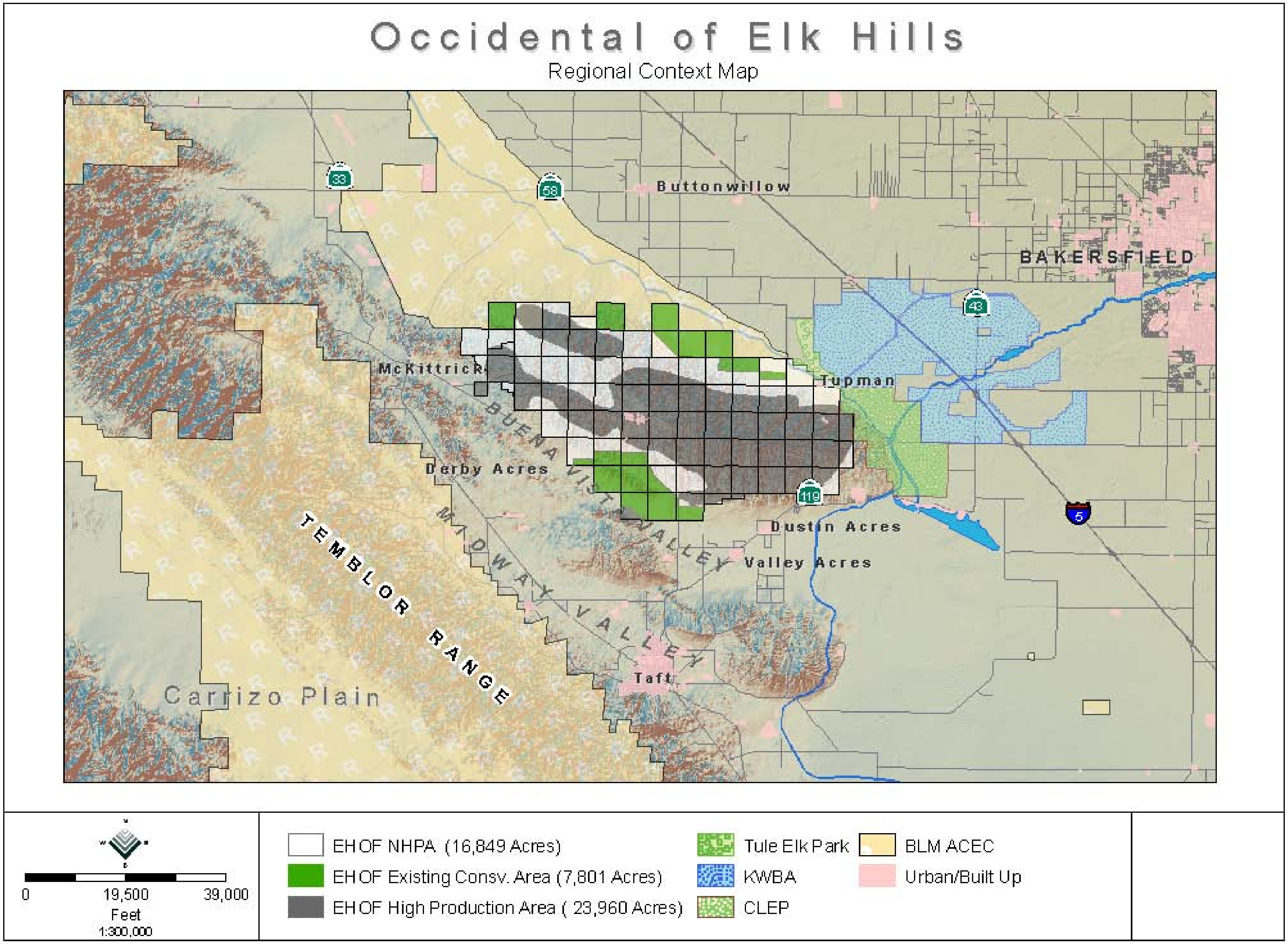

FIGURE 1-4 ELK HILLS OIL FIELD IN THE REGIONAL CONTEXT

1.6 Project Components

The OEHI CO_2 EOR Project components are listed below and described further in Sections 2 and 3.

- CO_2 Injection and Recovery Equipment
  - CO_2 Supply System
  - Satellite Gathering Stations
  - Infield Gathering and Injection Distribution Pipelines
- Recovered CO_2 Purification and Compression
  - Central Tank Battery (CTB)
  - Reinjection Compression Facility (RCF)
  - CO_2 Recovery Plant (CRP)
  - Water Treating and Injection Plant
- Backup CO_2 Injection Facility
- CO_2 Sequestration Monitoring and Verification
- Supporting Process Systems
  - Hazardous Material Management
  - Hazardous Waste Management
  - Stormwater Management
  - Fire Protection
  - Control Systems
  - Utilities
  - Project Buildings/Facilities
  - Security Systems
  - CO_2, Monitoring, Measurement, Verification and Closure

All temporary construction areas, including construction parking, offices, and construction laydown areas, will be located within the OEHI's existing operations.

The disturbed acreage associated with the OEHI CO_2 EOR Project will be estimated in more detail when the project moves to the FEED stage. The following general information regarding disturbed acreage is available:

- A significant portion of the development will occur in areas where disturbance has already occurred. OEHI will design project components to utilize existing disturbed acreage to the extent feasible.

- The CO_2 Facility and the 13 satellites are expected to occupy approximately 100 acres; however, until the FEED is completed, it is not possible to determine the extent of newly disturbed acreage. Newly disturbed acreage will be minimized to the extent feasible.
- The estimated total length of all new pipelines is 550 miles, much of which will be located in existing pipeline corridors that are already sited on disturbed acreage. Total disturbed acreage for the new pipelines and drilling pads will not be available until completion of the FEED. OEHI will utilize existing pipeline corridors, Rights of Way (ROWs) and disturbed acreage to the extent feasible.
- OEHI will design project components to minimize disturbed footprint during construction, as appropriate. Additionally, OEHI will restore temporarily disturbed acreage.
- The current estimated number of producing and injection wells is approximately 550. OEHI will attempt to use as many existing wells and drilling pads and locate new drilling pads in disturbed acreage as much as possible.

Table 1-1 summarizes site meteorology and other characteristics upon which the design will be based.

TABLE 1-1 SITE CHARACTERISTICS

Elevation	General site elevation varies from 250 – 1,325 feet above msl	
Design Ambient Temperature and Humidity	Dry Bulb °F	Relative Humidity (%)
Average Ambient	65°	55
Summer Design	97°	20
Winter	39°	82
Extreme Minimum Ambient	20°	85
Extreme Maximum Ambient	115°	15
Design Ambient Barometric Pressure		14.54 psia
Average Precipitation per year		5.7 inches (average. 2000 – 2006)
24-hour Max Precipitation (50-year storm)		1.8 inches

Source: Computed from Annual and Monthly Summaries (year span) of Bakersfield, California Meteorological Data, NOAA, National Climate Data Center, Asheville, North Carolina.

Notes:

ºF = degrees Fahrenheit
% = percent
msl = mean sea level
psia = pounds per square inch absolute

1.7 Site Plan

Figure 1-5 presents an overall site plan for the OEHI CO_2 EOR Project, including:

- Planned pipeline alignment from the HECA Project to OEHI operations
- Approximate location of injection wells, associated equipment and piping over the project life
- Location of the CO_2 Facility including Recovery Plant & Reinjection Compression Facility
- Alignment of piping to Backup CO_2 Injection Facility
- Location of Backup CO_2 Injection Facility

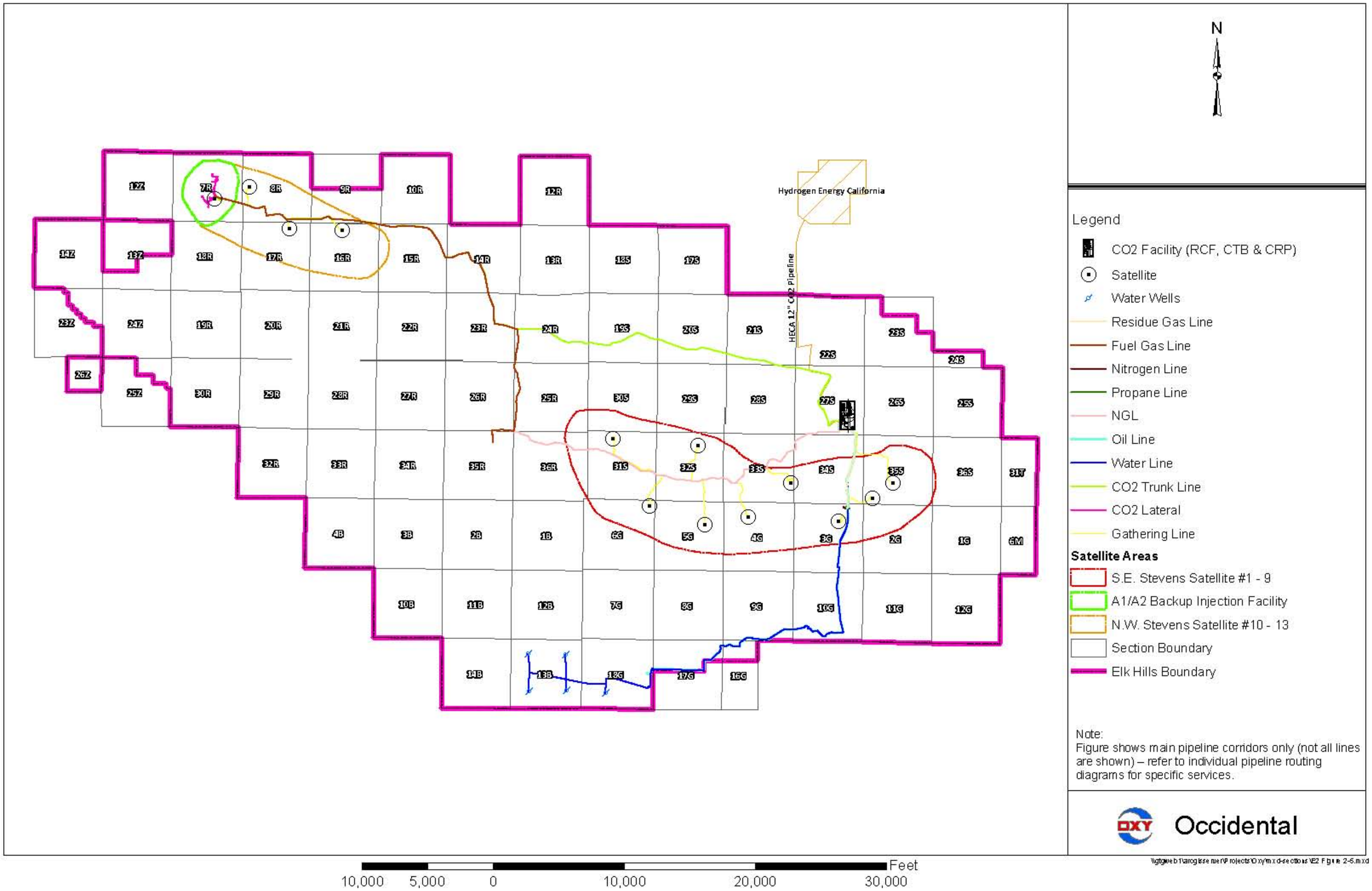

FIGURE 1-5 CONCEPTUAL PLOT PLAN

2 CO_2 Enhanced Oil Recovery

High volume CO_2 injection for EOR, similar to the volumes anticipated for the OEHI CO_2 EOR Project, began in West Texas in the early 1970s. CO_2 EOR has proven capable of increasing oil production and extending the life of mature oil fields. CO_2 injection in the targeted zones of the Stevens Reservoirs has the potential to significantly increase recoverable oil reserves and extend the productive life of the Elk Hills Unit. The CO_2 EOR process involves the injection, recovery, processing and reinjection of CO_2 to allow trapped oil to flow more readily through the reservoir, thereby improving recovery. During the process, injected CO_2 becomes trapped in the reservoir.

The OEHI CO_2 EOR Project will utilize CO_2 generated by the proposed HECA Project. According to the HECA Project siting application, the HECA Project intends to utilize technology capable of capturing over 90 percent of the CO_2 produced during HECA facility operations. The OEHI CO_2 EOR Project is expected to receive an annual average rate of 107 million standard cubic feet per day (mmscfd) of CO_2 (approximately 2 million tonnes per year). This CO_2 will be compressed and delivered via pipeline to OEHI's CO2 Facility. The planned injection volumes and pressures will be reviewed as a part of the OEHI permitting process with DOGGR. During all phases of this project, OEHI will comply with UIC Class II regulations enforced by DOGGR.

As with oil and gas, CO_2 has been naturally trapped in geologic formations for millions of years. The injection of CO_2 into such formations has been safely practiced on an industrial scale for decades, mostly in conjunction with hydrocarbon production. Further, the EPA has recognized that oil and gas reservoirs will play a valuable role in the geologic trapping of CO_2. Two of the reasons cited by EPA are: (1) oil and gas reservoirs are natural storage containers that have trapped fluid (both liquid and gaseous) for millions of years; and (2) oil and gas exploration and production activities have created a wealth of knowledge and geologic data that can support the site characterization process for geologic trapping. (See EPA's Proposed Rule: Federal Requirements under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, 73 Fed. Reg. 43492 541, July 25, 2008). In addition, a DOE report (DOE-NETL, 2008) states that oil and gas reservoirs can be ideal candidates for trapping of CO_2 since oil and gas reservoirs have proven capable of storing fluids and gases for millions of years; and replacing the extracted oil and hydrocarbon gas with CO_2 is an excellent use of such natural reservoirs. Importantly, not only does trapping of CO_2 occur during active EOR operations, but it continues after EOR operations cease.

In 2005, the Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988, released a report entitled "Carbon Dioxide Capture and

Sequestration" (the "IPCC Report"). The IPCC is charged with providing relevant advice to policymakers on all aspects of climate change. The IPCC Report was written by 125 contributing authors, and was extensively reviewed by over 200 others, including technical experts and government representatives from around the world. The IPCC Report carefully weighs the technologies and the potential risk of CCS and concludes that, with appropriately selected and managed sites, CO_2 may be sequestered by injection into suitable geologic formations including oil and gas reservoirs. The IPCC Report notes that the early commercial scale CCS projects will probably employ CO_2 sequestration with EOR as their basis of design, which will extensively inform the technical development and safe deployment of CCS projects in other types of geologic formations.[2]

The EHOF reservoirs have the advantage of being well studied and provide a uniquely suited setting for large-scale geologic sequestration of CO_2, building on 100 years of oil and gas field operating experience in the EHOF and the oil industry's more than 35 years of CO_2 EOR operations. The appropriateness of using CO_2 EOR in any given oil field or reservoir cannot be determined until the geologic setting is evaluated to enable informed decisions in terms of reservoir management, safety, and carbon sequestration potential. As a result of thousands of wells being installed over the operational history of the EHOF, a significant database has been developed and utilized to model the proposed OEHI CO_2 EOR Project. This extensive database was transferred to OEHI when Elk Hills was acquired from the federal government in 1998. As a result, OEHI is in the unique position of possessing all of the subsurface information that has been accumulated over the nearly 100-year life of the field. As described in Section 2.1.1 and 2.2.2, the EHOF has been found to be an ideal candidate for CO_2 EOR.

2.1 CO_2 EOR Process Overview

The CO_2 EOR process can be described in two parts: subsurface process and aboveground CO_2 handling process.

2.1.1 Subsurface Process Overview

In CO_2 EOR operations, highly compressed CO_2 (which has the characteristics of a liquid) is injected into an oil reservoir through injection wells designed for CO_2 injection. Injection occurs at high pressure to maintain liquid-like state, facilitate transfer of the desired volume of CO_2 into the reservoir, and promote miscibility. Injection occurs at pressures below levels that could fracture the confining geologic

[2] Notably, it is estimated that site characterization of saline reservoirs will likely cost tens of millions of dollars and it would take a decade or more to develop one large-scale commercial saline storage reservoir project exceeding 2 million tons/year of CO2.

zones or compromise the integrity of the reservoir. As a result of the pressure difference between the injection well and the reservoir, the CO_2 flows from the injection well (see Figure 2-1) and dissolves in the oil (CO_2 and oil are miscible under these reservoir conditions and form a single-phase solution). The miscibility of the CO_2 and the oil is dependent on the characteristics of both the oil reservoir, including pressure and temperature, and the chemical composition of the reservoir fluids. CO_2 EOR alters the oil properties, resulting in lower viscosity, enhanced mobility and lower interfacial tension when compared to oil extraction without CO_2 EOR. CO_2 EOR helps to mobilize oil naturally trapped in the rock, facilitating oil production. In order to enhance EOR performance, a technique of alternating cycles of water injection with cycles of CO_2 injection may be used (referred to as “Water Alternating Gas” or “WAG”). The introduction of water periodically behind the CO_2-oil miscible solution facilitates the “sweeping” of the CO_2-oil solution to production wells and further enhances oil recovery.

The current development of the Elk Hills Unit uses a mature pattern of water flood with over 200 water injection wells and an average injection rate for each well of nearly 900 barrels of water per day (bwpd) of water produced from the Elk Hills Unit. OEHI proposes to convert the reservoirs from the current application of water flood to a miscible-CO_2 EOR flood. During this process, many of the water injectors will be converted to CO_2 injectors, with estimated average injection rates between 2 and 20 mmscfd per injection well.

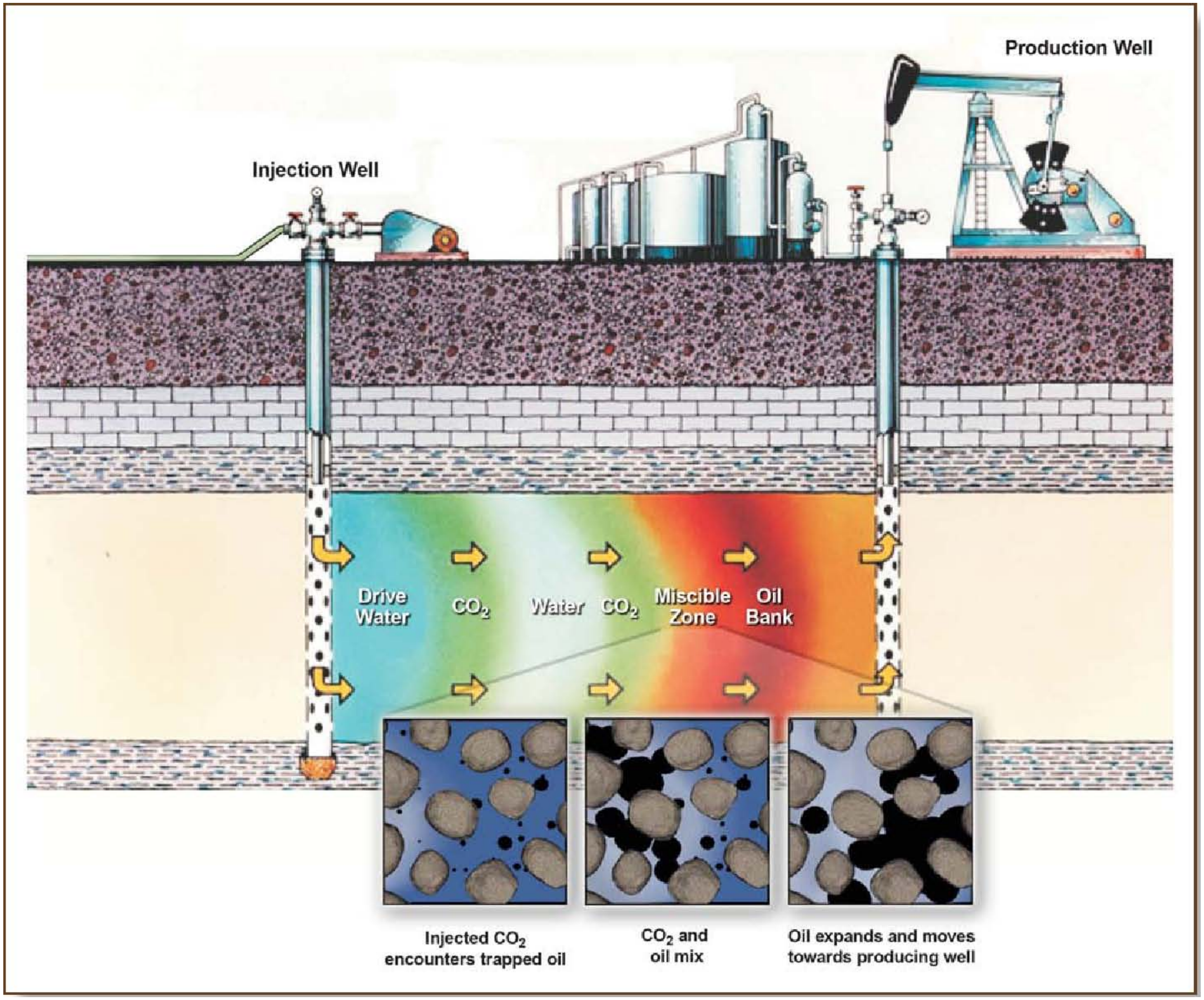

FIGURE 2-1 SCHEMATIC OF MISCIBLE-CO_2 FLOOD (DOE-NETL, 2008)

Production operations are designed to make the most efficient use of CO_2 from the HECA Project to maximize oil recovery and production. This is done by separating the CO_2 from the recovered hydrocarbons at the surface and recycling the CO_2 within a closed system for reinjection into the reservoir as part of the continuous EOR process. Injected and recycled quantities of CO_2 are monitored closely, as CO_2 is a valuable commodity that is purchased by OEHI from the HECA Project. However, trapping of CO_2 within the formation is inevitable with each injection cycle, necessitating the introduction of additional amounts of purchased CO_2 to continue the EOR operation.

The reservoir geological environment will determine the extent to which CO_2 will be immobilized, trapped and retained in the reservoir, making it difficult to predict the recovery (and trapped) fractions for each pass of CO_2 through the reservoir. Occidental's extensive experience as a world-wide leader in operating CO_2 EOR indicates that approximately 30 to 50 percent of the injected CO_2 mass remains trapped in the reservoir and is unrecoverable. Regardless of the fraction of CO_2 trapped during a cycle, all CO_2 injected eventually becomes trapped in the reservoir.

The key CO_2 trapping mechanisms that occur in the subsurface include physical trapping, residual gas trapping and geochemical trapping.

- Physical trapping (and trap filling) retains the CO_2 in the formation using structural and stratigraphic traps with low-permeability formations and faults. Physical trapping of the buoyant CO_2 is provided by the same impermeable "caprock" seal that traps the oil and hydrocarbon gases.
- Residual trapping and dissolution of the liquid or gaseous CO_2 occurs as a result of capillary forces retaining some of the CO_2 as disconnected droplets. Residual trapping is analogous to residual oil saturation (i.e., "trapped" oil) that remains after an oil reservoir is swept with injected water.
- Geochemical trapping describes a series of reactions of CO_2 with natural fluids and minerals in the target formation, principally consisting of CO_2 dissolution in brine (i.e., solubility trapping), CO_2 precipitation as mineral phases (i.e., mineral trapping) and CO_2 sorption onto mineral surfaces. Scientific research is continuing to increase the understanding of the chemical processes involved in geochemical trapping.

These trapping mechanisms operate on different time scales, beginning with initial injection of CO_2 and have different capacities to trap CO_2. The following schematic (Figure 2-2) depicts that over time, the process of physical and residual CO_2 trapping is enhanced by the increasing geochemical processes of solubility trapping and mineral trapping.

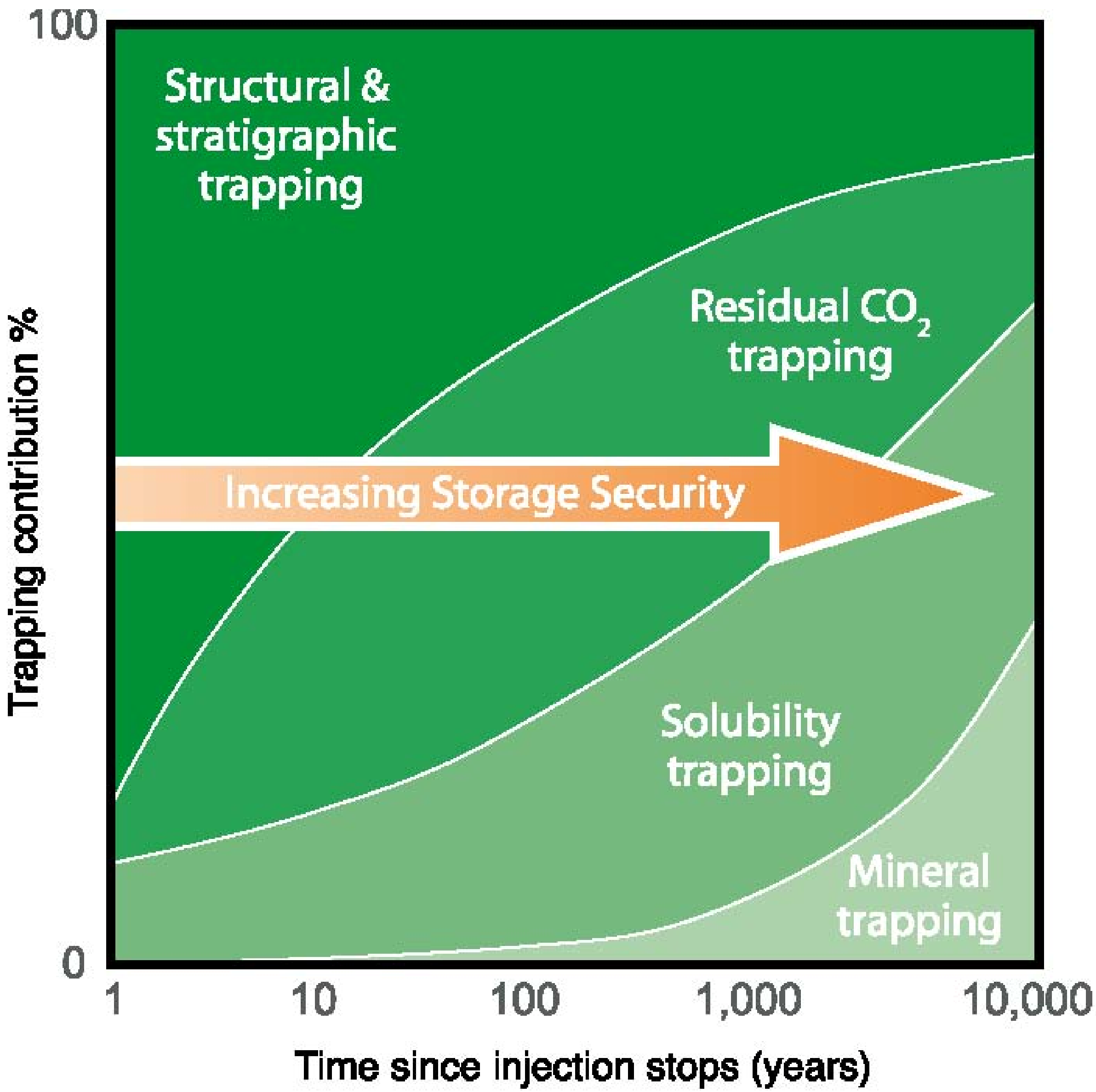

FIGURE 2-2 TYPES AND TIMESCALES OF CO_2 SEQUESTRATION MECHANISMS (IPCC, 2005)

2.1.2 Aboveground CO_2 Handling Process Overview

CO_2 from the HECA Project will be transported via a pipeline to the CO_2 Facility, at which point the CO_2 is distributed to CO_2 injection wells placed in a well pattern designed to optimize the recovery of oil from the reservoir.

There may be three, four or more production wells per injection well where oil and water is pumped to the surface to a centralized collection facility. Typically, these wells are arranged in a consistent geometrical pattern with an injection well in the center and production wells on the perimeter. For example, in a four-spot pattern, there would be four production wells on the four corners of a square geometric pattern, with a single injection well in the center of the pattern. The pattern of injection and production wells will vary with time, and is typically based on predictive computer simulations that model reservoir performance based on reservoir characterization and historical operations. Operational data will be obtained at well manifolds where an individual well's oil, gas and water fractions will be measured, which further helps assess the effectiveness of the CO_2 EOR process.

At the surface, the recovered fluids are transferred to a separator at the CO_2 Facility where the oil and natural gas are separated. The natural gas may include CO_2 as the injected gas begins to break through at the production wells. Separated natural gas enters a pipeline for transport to the existing gas processing facility in Section 35R of the Elk Hills Unit where it is combined with other produced gas from the field for sale to customers. The CO_2 is separated from the produced natural gas to meet sales specifications and the separated CO_2 is recompressed for reinjection along with additional purchased CO_2 from the HECA Project to further optimize the CO_2 EOR process.

A schematic of a typical miscible-CO_2 EOR operation is shown in Figure 2-3 below. The planned OEHI process is described in more detail in Section 2.3.

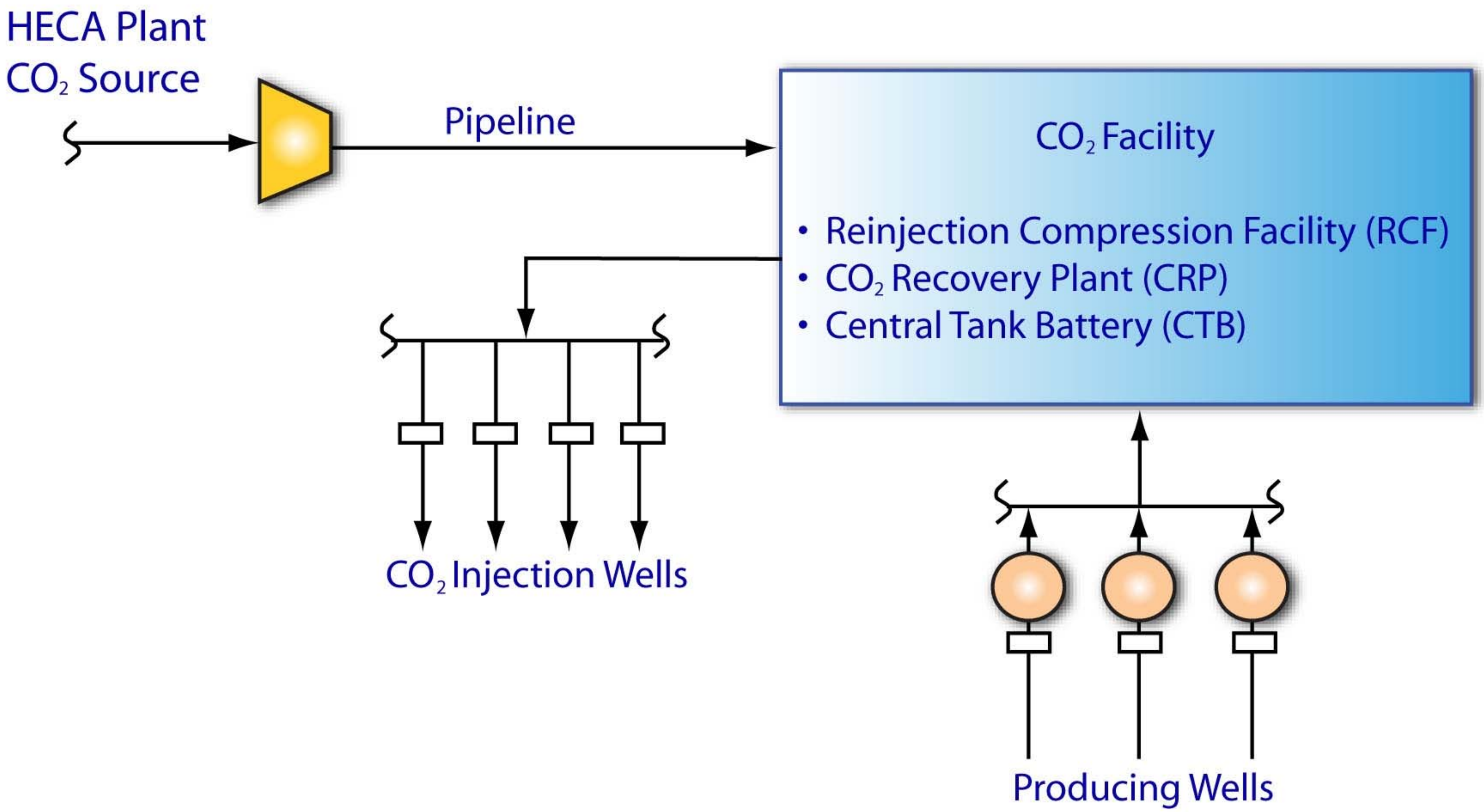

FIGURE 2-3 CO_2 EOR SURFACE PROCESS SCHEMATIC

2.2 Site Selection and Geological Setting

2.2.1 General Elk Hills Structure and Geology

The EHOF produces hydrocarbons (oil and gas) from several vertically-stacked Tertiary-aged (65 to 2 million years ago) coarse-grained clastic reservoirs interlayered with multiple layers of saling fine-grained shale. These layers have been folded and faulted, resulting in anticlinal structures containing hydrocarbons of probable Oligocene and Miocene (approximately 33 to 5 million years ago) source. The hydrocarbons were generated in the deep flanks of the Elk Hills structure and/or migrated into the structure from surrounding subbasins, beginning in the Pliocene, approximately 5 to 2.5 million years ago (Zumberge et al, 2005). The combination of multiple porous and permeable sandstone reservoirs interlayered with multiple impermeable shale seals and large anticlinal structure make the EHOF one of the most suitable locations for the extraction of hydrocarbons and the trapping of CO_2 in North America. The individual structures and geologic horizons within the EHOF are detailed in the following paragraphs.

At the surface, the EHOF presents as a large WNW-ESE trending anticlinal structure, approximately 17 miles long and over 7 miles wide. With increasing depth, the structure sub-divides into three distinct anticlines, separated at depth by high angle reverse faults (Figure 2-4). The anticlines are believed to have formed in a transpressional regime associated with formation of the San Andreas Fault, beginning in the Middle Miocene, which began approximately 16 million years ago (Callaway and Rennie Jr., 1991). The anticlines, labeled 29R, 31S and Northwest Stevens (Figure 2-5), formed bathymetric highpoints on the deep inland marine surface (seafloor), affecting geometry and lithology of the contemporaneously deposited turbidite sands and muds generated as subaqueous debris flows (Figures 2-5 and 2-6).

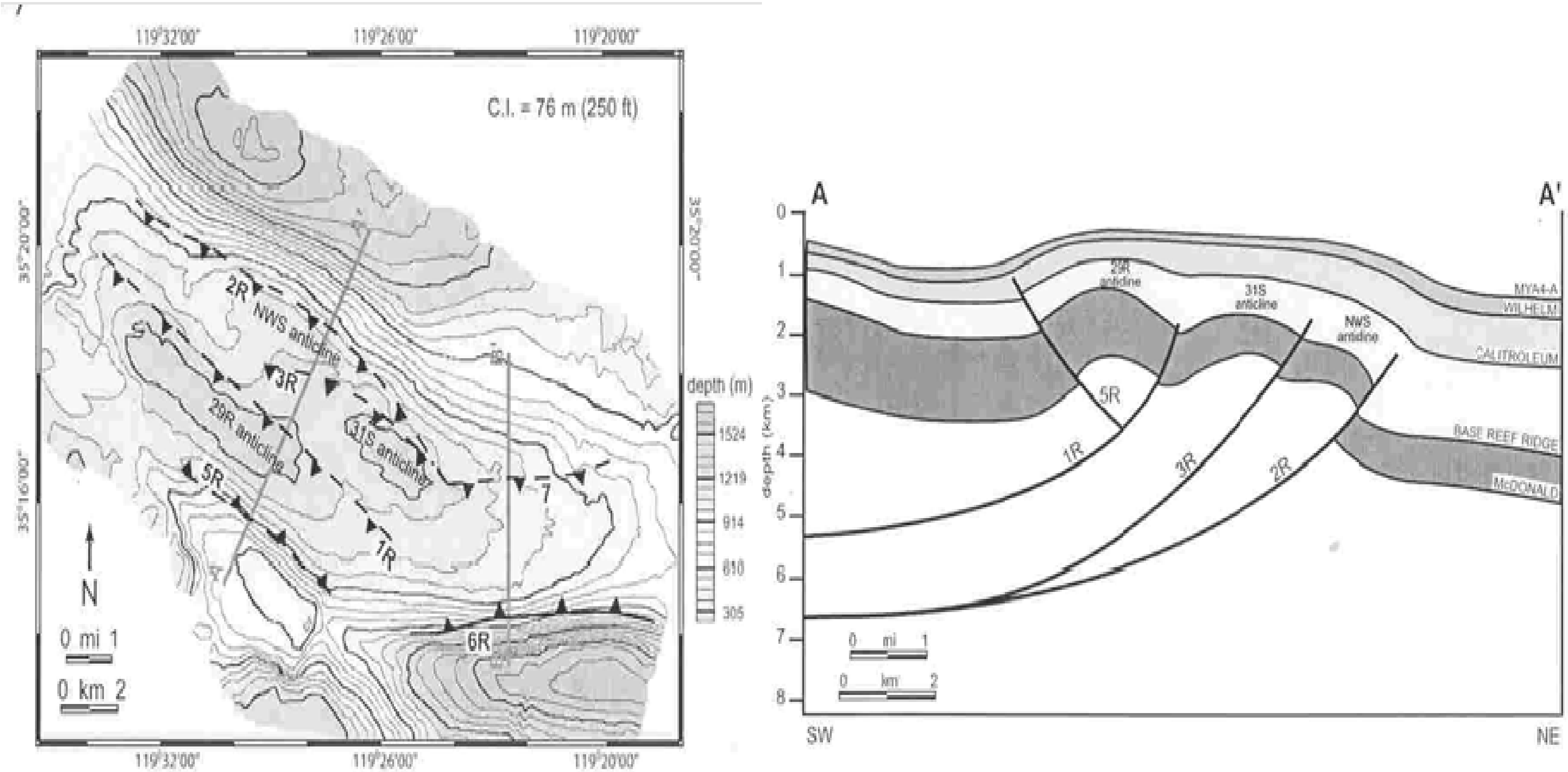

FIGURE 2-4 EHOF STRUCTURE CONTOUR MAP OF UPPER PLIOCENE ROCKS SHOWING FAULTS AND LOCATION OF CROSS SECTION A-A'; CROSS SECTION A-A' SHOWING STRUCTURE OF EHOF ANTICLINES. (FIORE, ET AL. 2007)

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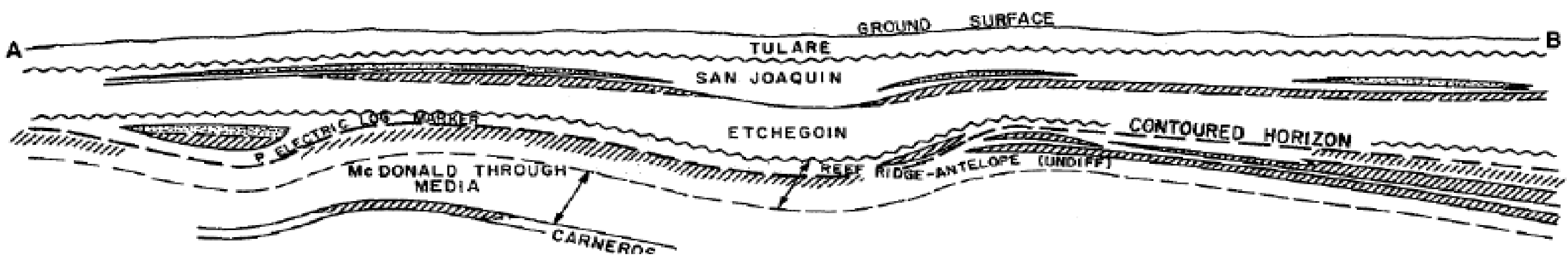

FIGURE 2-5 EHOF STRUCTURE CONTOUR MAP OF THE UPPER MIOCENE AND LOCATIONS OF CROSS SECTIONS A-B AND C-D, BELOW (DOGGR 1998)

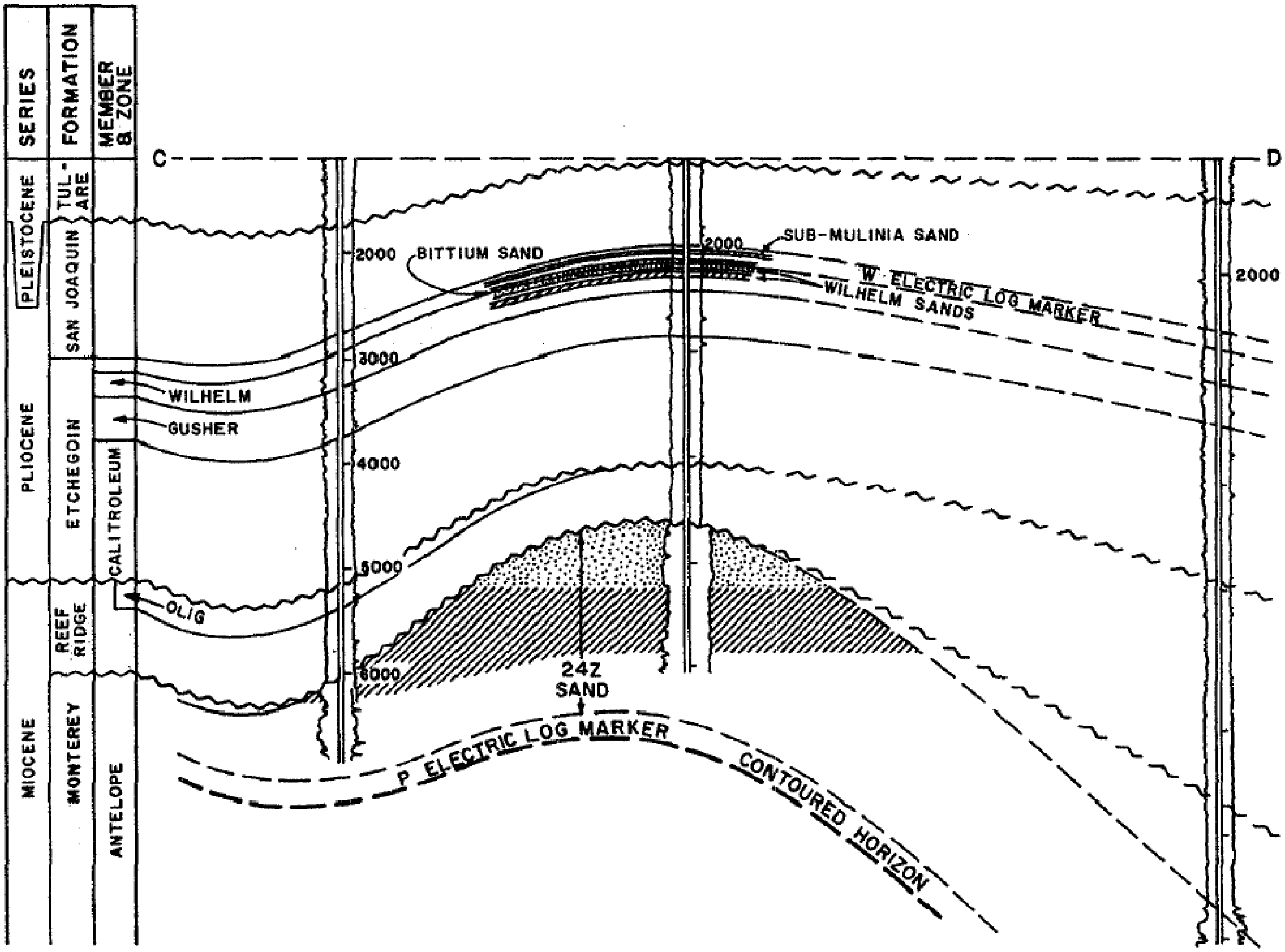

FIGURE 2-6 EHOF CROSS SECTIONS A-B AND C-D; LOCATION SHOWN IN FIGURE 2-5 (DOGGR 1998)

To date, there have been more than 6,000 wells drilled to various depths within the EHOF, creating an extensive library of information compiled within a comprehensive database. The deepest well in the field is the 934 29R, drilled to a total depth of 24,426 feet, bottoming in Mesozoic, Upper Cretaceous age (93 to 65 million years ago) sediments. A schematic diagram of the EHOF area stratigraphy based on well 934-29R is presented (Figure 2-7), as well as the electric log (Figure 2-8). The oldest rocks observed in the field are Upper Cretaceous in age but they are not productive. The Miocene-aged Carneros sandstone member of the Temblor Formation is the lowermost hydrocarbon producing interval in the field, although oil and gas shows have been recorded in deeper Oligocene- and Eocene-aged (55 to 23 million years ago) sediments. Above the Temblor is the Miocene aged Monterey Formation.

The Monterey (approximately 4,500 to 10,000 feet deep) is known locally as the EHOF member and this formation includes the EOR targeted Stevens oil sands that produce from stratigraphic-structural traps on three deep anticlines. Major Stevens Reservoirs include Main Body B ("MBB"), 26R, W31S, 24Z, 2B, A1A6 and T&N pools. The Stevens sands are composed of stacked fining upward turbidite deposits composed of lenticular sheet sands, channels and levee deposits within a submarine fan complex (Reid, 1990). Reservoir properties of the Stevens sands are excellent and have led to decades of hydrocarbon production, with porosities averaging between 20 and 25 percent, permeabilities averaging 150 millidarcy (mD) and net reservoir thicknesses that can exceed 1,000 feet. The uppermost Miocene formation is the Reef Ridge Shale, which is hard and siliceous (Nicholson, 1990) and acts as a stratigraphic trap keeping hydrocarbons below. A number of deep thrust and wrench faults, as well as a series of curvilinear normal faults, intersect the Stevens Reservoirs within the EHOF. These faults are believed to have influenced hydrocarbon migration from deeper source rocks (McJannet, 1996), but faults within the lower productive limits on the anticlinal structures die-out above in the overlying Reef Ridge Shale and Etchegoin Shale. These faults may provide some limited communication between some of the productive sands, though most units are not in communication with one another, having different oil-water contacts. Further, individual anticline sands are compartmentalized, as exhibited by different pressures and temperatures (C&C Resources, 2000).

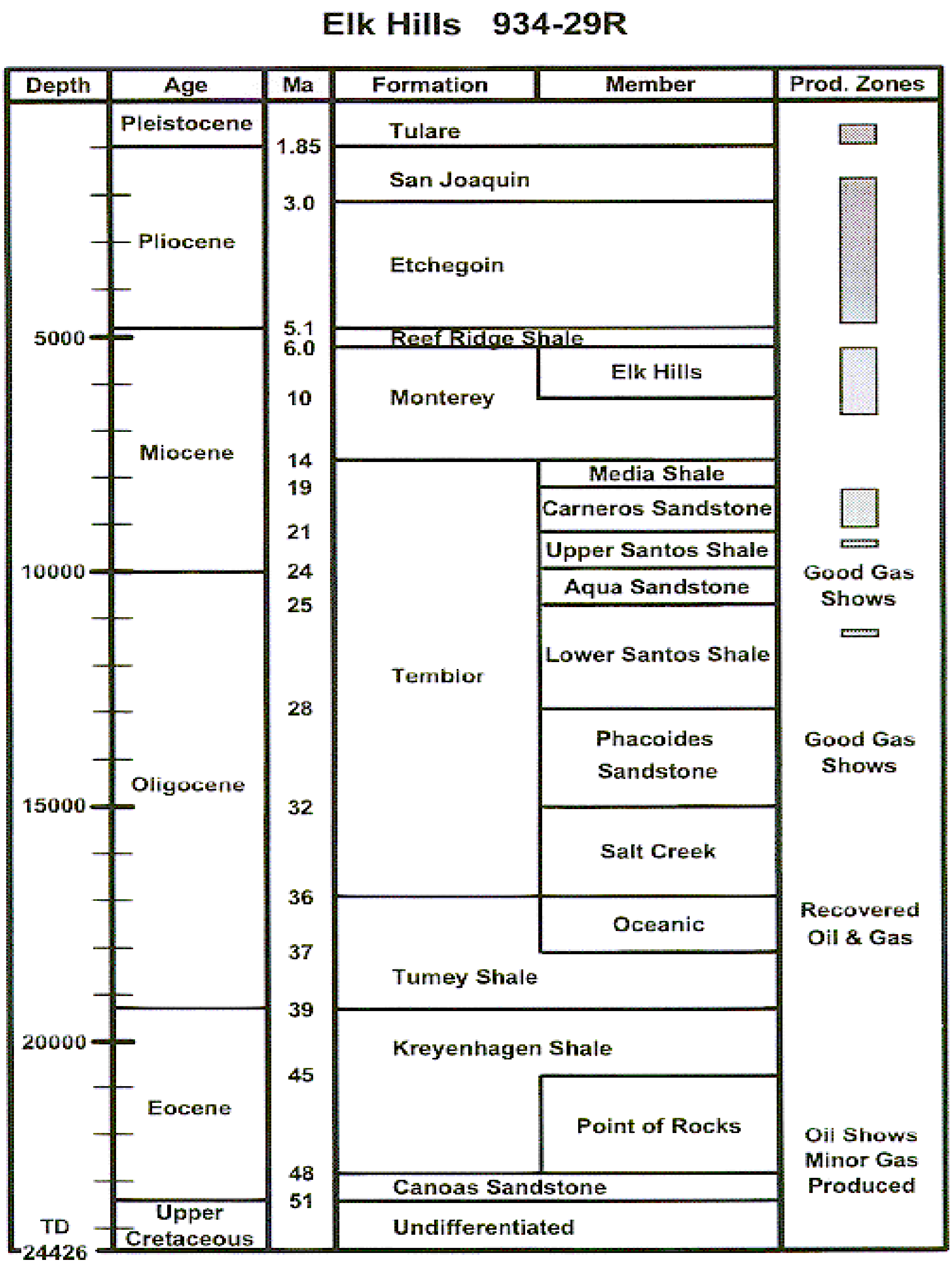

FIGURE 2-7 EHOF STRATIGRAPHY BASED ON 934 29R WELL (NICHOLSON 1990)

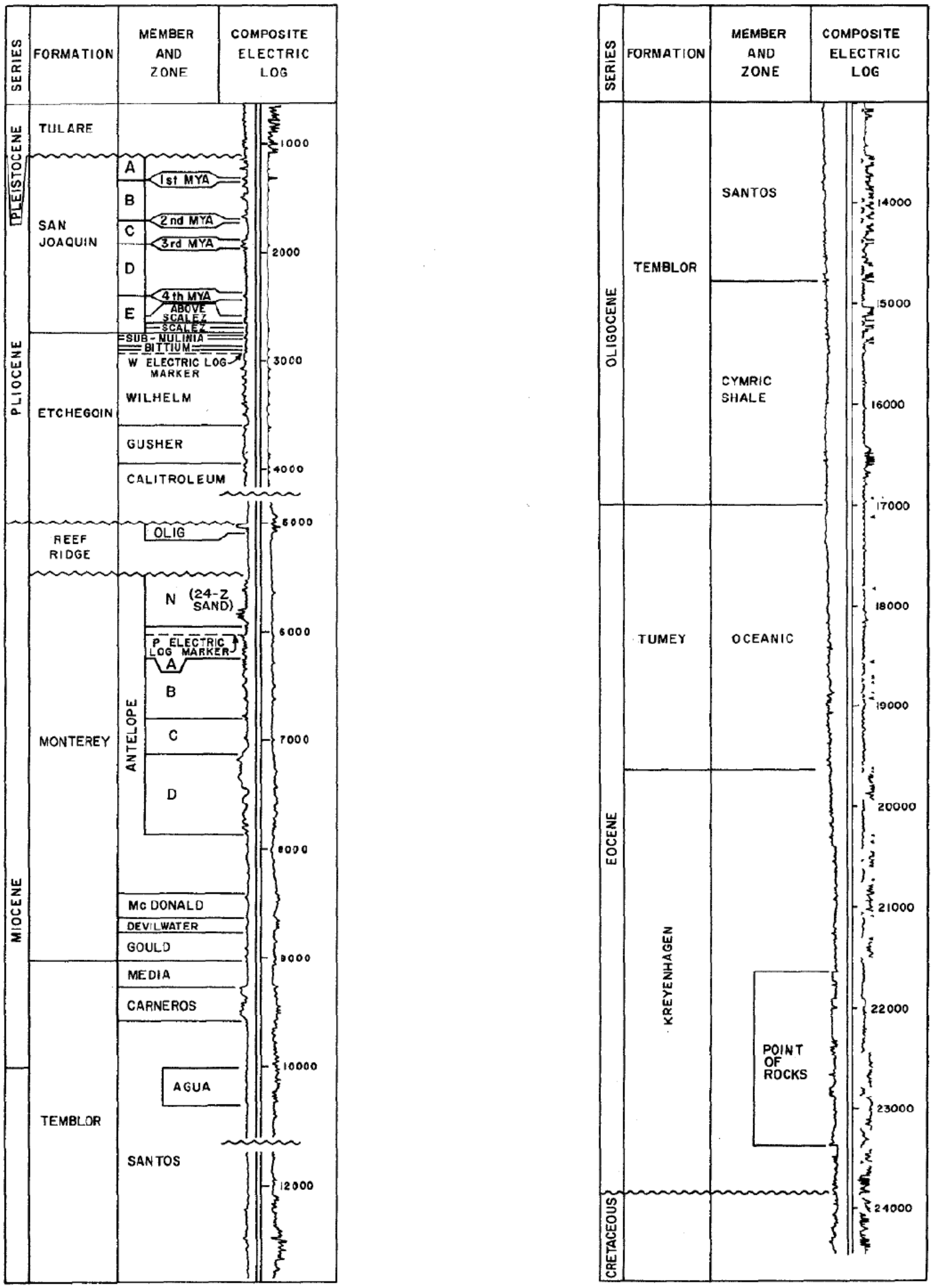

FIGURE 2-8 EHOF STRATIGRAPHIC COLUMN (DOGGR 1998)

The lithology overlying the Reef Ridge Formation is not targeted by the EOR, but the setting must be considered as part of the area of review. Overlying the Reef Ridge Formation is the Pliocene Etchegoin Formation, which includes several productive silty and sandy members (Calitroleum, Gusher, Wilhelm, Bittium and Sub-Mulinia) and intervening shales. Those are, in turn, overlain by the San Joaquin Formation, which includes the productive, basal Scalez sand member and overlying shales (Figures 2-6 and 2-8). These Pliocene rocks represent a depositional transition from deep water to shallow, including near-shore deposition. Isotopic analysis of these Pliocene oils suggests a separate Miocene source for the hydrocarbons in these reservoirs and refutes vertical leakage from the older Miocene Stevens Reservoirs as a source (Zumberger et al, 2005). The Pleistocene (approximately 2.5 million to 10,000 years ago) Tulare Formation is uppermost, from surface to 1,500 feet, in the EHOF and is comprised of fluvial and alluvial (river and surficial) sediments (Nicholson, 1990). The shallow Pliocene and Pleistocene section is cut by several shallow listric faults, some of which are sealing; however, these faults do not traverse through the Reef Ridge Shale and do not extend into the deeper Stevens Reservoirs (C&C Reservoirs, 2000) targeted for the EOR.

In summary, the structure and stratigraphy of the EHOF is ideally suited for the injection and trapping of CO_2. The CO_2 injection zones are within the Stevens Reservoirs. The stratigraphy within the Stevens Reservoirs is porous, permeable and can be very thick, providing an excellent EOR target and ample capacity for long-term CO_2 sequestration. Between the surface and the Stevens Reservoirs, there exist naturally occurring dense and thick overlying shales, which serve as excellent seals and have proven capable of containing fluids and gases for millions of years. While faults are present within the EHOF, these faults are non-transmissive as indicated by variable oil-water contacts, pressures and temperatures within individual Stevens Reservoirs. Furthermore, there are several productive horizons above the proposed injection zone within the Pliocene Etchegoin and San Joaquin Formations (approximately 1,500 to 4,000 feet deep.); however, isotopic evidence shows that the hydrocarbons within the shallow Pliocene reservoirs are not the result of simple vertical leakage from the deeper Miocene Stevens Reservoirs. Consequently, there are no natural pathways from the subsurface injection zones to the surface. Therefore, CO_2 leakage to the surface and atmosphere is highly improbable.

2.2.2 Summary of HECA Siting Study

To accommodate the HECA Project's need for CO_2 sequestration, a scoping/screening siting study was conducted to assess the potential for CO_2 sequestration near the HECA Project site (HECA, 2009). The southern end of the San Joaquin Basin located in and around Kern County and the northern end of the Ventura Basin located in and around Ventura County were targeted based on their carbon sequestration and EOR potential, as well as proximity to the HECA Project location. The study evaluated capacity, containment, and other specific criteria generally deemed important by current industry and scientific standards in carbon sequestration projects and deemed necessary to satisfy HECA Project objectives. This study identified at least one field within each basin that met these key factors of depth, pressure, lithology, porosity and permeability, structural integrity, and capacity:

- EHOF in the San Joaquin Basin, Kern County
- Ventura Field in the Ventura Basin, Ventura County

Based on this scoping/screening study, the focus of the subsurface effort was then directed to the EHOF in Kern County. The EHOF was determined to be the preferred field due to data obtained from previous CO_2 pilot studies. Another benefit was a shorter length of CO_2 pipeline to be installed, thereby decreasing construction impacts, time, and cost requirements. All of these findings are best aligned with the HECA Project objectives. The following excerpted discussion sets forth the further detailed study of the EHOF conducted in the site selection phase by the HECA Project (HECA, 2009).

> *"The Stevens Reservoirs are considered the best CO_2 EOR targets within EHOF. These reservoirs have been developed on 10 to 40 acre spacing and have produced in excess of 580 million barrels of oil (mmbo) to date. Reservoir pressure in the MBB sand is near the minimum miscibility pressure of approximately 2,415 pounds per square inch (psi) (Merchant 2006), indicating this reservoir is an ideal candidate for miscible-CO_2 EOR. By analog, documented West Texas miscible-CO_2 EOR's have produced an incremental 10 to 20 percent of oil, on average (Holtz et al. 2005). This range is also consistent with a CO_2 EOR pilot study in the Stevens sand at North Coles Levee field 2 miles east of EHOF conducted by ARCO (MacAllister 1989). The MBB reservoirs represent only a subset of the target Stevens Reservoirs currently suitable for miscible-CO_2 EOR."*

2.2.3 Geologic CO_2 Trapping Capacity

The OEHI site characterization confirms that the Stevens Reservoirs have sufficient volume to trap expected CO_2 deliveries from the HECA Project. Historic production records for the EHOF and injection data show that the volume of oil, gas, and water already extracted from the target injection zones exceeds the volume required to sequester the cumulative (full-life) volume of CO_2 expected from the HECA Project. Available capacity is demonstrated in the following tables.

Stevens Pore Volume Capacity

The Stevens Reservoirs within the 31S and North West Stevens (NWS) structures have been identified as the initial EOR and sequestration reservoirs. These reservoirs contain sufficient capacity to accommodate the injection of more than 20 years of expected CO_2 delivery from the HECA Project while maintaining reservoir pressures consistent with good EOR operating practices and below fracture pressures of the boundary zone. The available reservoir capacities were calculated using extensive available OEHI subsurface databases including electric logs, boring logs and historic extraction performance information.

	Billion Reservoir Barrels
Total Stevens Reservoir Capacity (31S and NWS Structures):	>7.5
Required Trapping Capacity for 20 years of Expected CO_2 Injection	<1.0

Cumulative Voidage to Date, from 31S and NWS Stevens Reservoirs

The table below shows that the net cumulative fluid volume produced to date, from the Stevens Reservoirs on the 31S and NWS structures, exceeds the CO_2 volume expected from the HECA Project.

	Billion Reservoir Barrels
Cumulative Fluid[1] Volume Produced:	>3.4
Cumulative Fluid[1] Volume Injected:	<2.1
Cumulative Net Fluid[1] Volume Produced:	>1.3
Required Trapping Capacity for 20 years of Expected CO_2 Injection:	<1.0

[1] Includes oil, gas, and water

In addition to the available capacity calculated above, during EOR operations, the additional production of oil, gas, and water will create further reservoir void that will allow for injection of additional CO_2.

2.3 CO_2 Handling Processes

The production facilities required for OEHI to operate a CO_2 EOR process at the Elk Hills Unit will consist of the following primary production units:

- CO_2 Injection and Recovery Equipment
  - CO_2 Supply System
  - Satellite Gathering Stations
  - Infield Gathering and Injection Distribution Pipelines
- Recovered CO_2 Purification and Compression
  - Central Tank Battery (CTB)
  - Reinjection Compression Facility (RCF)
  - CO_2 Recovery Plant (CRP)
  - Water Treatment Plant
- Backup CO_2 Injection Facility

Figure 2-9 provides a basic process flow diagram for the planned production facilities. Numeric values shown on the figure are preliminary and subject to change as additional engineering design efforts are completed. Figure 2-10 presents an aerial view of the Elk Hills Unit, indicating locations of each of the major production facilities and associated pipelines. Figure 2-10 also serves as a key to a series of aerial views of each Section containing project components. This series of Section-by-Section aerial views is presented in Appendix A.

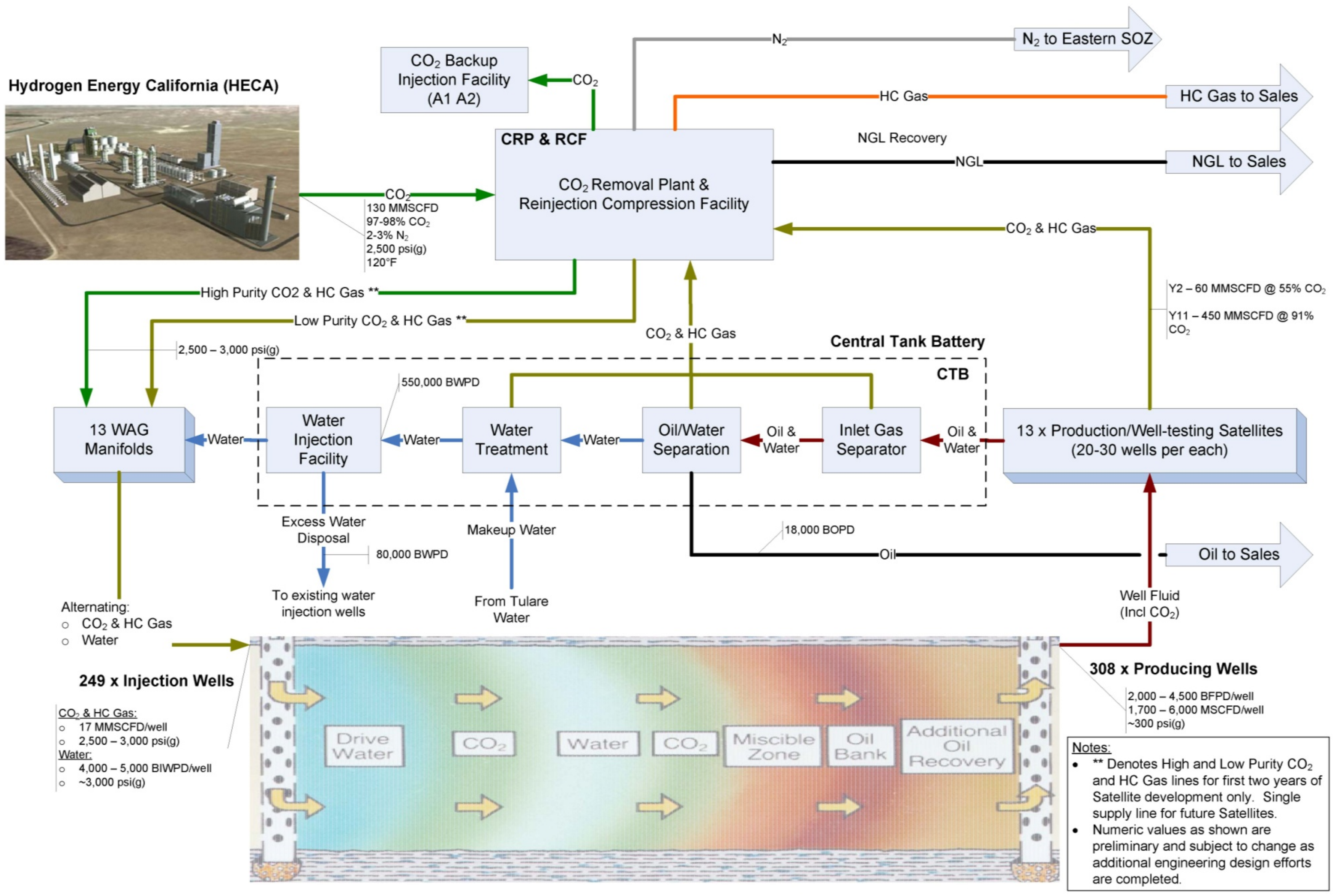

FIGURE 2-9 BASIC PROCESS FLOW DIAGRAM OF PLANNED CO_2 EOR PRODUCTION FACILITIES

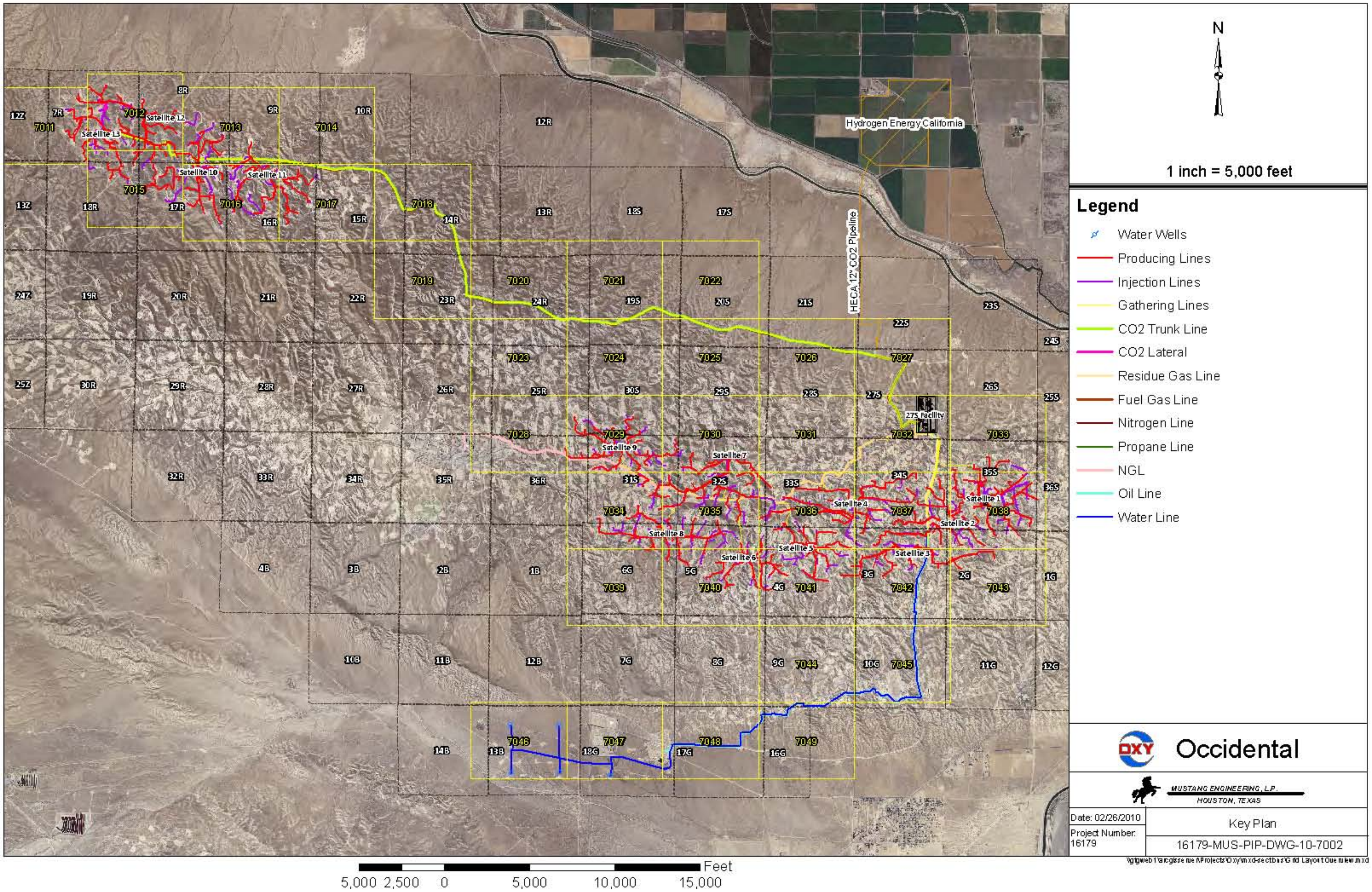

FIGURE 2-10 PROJECT OVERVIEW AND KEY PLAN FOR APPENDIX A

To facilitate CO_2 EOR from the Stevens Reservoirs, recovered fluids from the production wells will flow to one of 13 Satellite Gathering Stations, with three online initially and 10 additional systems added over time. The initial three Satellite Gathering Stations will be sufficient to accommodate CO_2 volumes provided by the HECA Project. The Satellite Gathering Stations will separate any produced gas from the oil and water. Installation of systems will start in the eastern portion (Sections 35S and 2G) and progress westerly (through Section 34S, 3G, 33S, 4G, 32S, 5G, 31S, 6G) as reservoir development evolves. Approximately 10 to 12 years after startup, injection systems will be installed in the northwest area (7R, 8R, 9R, 16R, 17R).

After separation, the gas and oil/water will flow separately via the infield gathering lines to the main process units for further processing. The liquid will flow to the CTB where the oil and water will be separated. The oil will be pumped to the existing oil shipment facility located at Section 18G of the Elk Hills Unit for export and sale. Produced water will be treated at the water treating portion of the CTB and pumped at injection pressure to the Satellite Gathering Stations for reinjection. All produced water will be reused in the reinjection process.

Produced gas from the Satellite Gathering Stations will initially flow to the RCF. At the RCF, the CO_2 gas will be dehydrated, compressed, blended with CO_2 purchased from the HECA Project, and reinjected in a closed loop system. As the volumes of recycled CO_2 increase over time, a CRP will be constructed to separate CO_2 from produced hydrocarbon gas and recycle the separated CO_2. The CRP will consist of several processing units for the separation of the CO_2 from the recovered natural gas.

The CO_2 from the CRP will be compressed and combined with the compressed CO_2-rich gas from the RCF and then combined with purchased CO_2 from the HECA Project. The CO_2 for injection will then be compressed to the required injection pressure and distributed back to the WAG units via CO_2 injection lines. The CO_2 and the injection water will be routed via the WAG manifold where the injection fluid will alternately be injected downhole as needed.

A backup CO_2 injection facility will be constructed at the A1/A2 producing reservoirs in the northwest area of the Elk Hills Unit. This facility will be constructed and available for:

1. Pressurization of the A1/A2 reservoirs for additional CO_2 EOR production; and,
2. Sequestration of CO_2 should there be a short term operating disruption at the HECA or Elk Hills facilities or an imbalance of supply and demand of CO_2.

OEHI will install a pipeline for CO_2 transport to the A1/A2 area in the northwest area of the Elk Hills Unit (Sections 7R, 18R).

Each of these processes is discussed in further detail below.

2.3.1 CO_2 Injection and Recovery Equipment

2.3.1.1 CO_2 Supply System

The CO_2 piped from the HECA plant will be received by the CO_2 supply system portion of the OEHI CO_2 Facility. The CO_2 supply system is the portion of the facility where recycled CO_2 from the RCF/CRP, combined with the supply CO_2 from the HECA Project, is compressed to the injection pressure.

In the initial years of CO_2 EOR operations, the average CO_2 content in the produced gas is relatively low. As a result, only the RCF equipment is initially required to process the lower quantities of CO_2. When CO_2 injected in the reservoir reaches the production wells in larger quantities, “breakthrough” has occurred. At this point, the CRP will be constructed to recover the larger quantities of CO_2.

The proposed plan is to inject two different levels of CO_2 purity during the initial years of CO_2 EOR. The recycled gas from the RCF will be blended with high-purity supply CO_2 from the HECA Project and injected as low-purity CO_2, while the rest of the supply CO_2 will be injected as high-purity CO_2. The high-purity CO_2 will be injected into the wells/areas that are just starting the CO_2 flood cycle, while the low-purity CO_2 will be injected into the areas that have been under CO_2 flood for some time.

This concept for the segregation of the CO_2 in the early years of the OEHI CO_2 EOR Project results in a design that has two separate headers and injection pumps: one for the high-purity system and a second for the low-purity system. Recycled gas from the RCF will flow to the low-purity header. CO_2 from the HECA Project will be mixed with this gas under flow control to maintain the desired concentration of the low-purity injection gas. The mixture will be compressed to the required injection pressure and injected through the low-purity discharge header. The remaining CO_2 from the HECA Project will flow under controlled pressure to the high-purity header.

2.3.1.2 Satellite Gathering Stations

The Satellite Gathering Stations (Satellites, also known as Production/Well-testing Satellites) will be a series of facilities that will provide primary separation of the oil/water and gas from the production well stream. Initially, three Satellites are scheduled to be installed to handle the expected production for the first several years of the field development. Ultimately, 13 Satellites are scheduled for full field development. Two different designs for Satellites are planned: one designed for 30 production wells and the second designed for 20 production wells. These two ‘standard’-sized Satellites are expected to handle the overall field configuration for the CO_2 EOR.

Each Satellite has an inlet manifold in which well flow lines associated with that Satellite are connected. Flow from each well flow line will be diverted into either the production separator or the test separator via automated manual valves.

- The production separator is a two-phase separator to handle primary vapor liquid separation of the fluid recovered from the production wells at each Satellite. Oil/water mixture will be separated from gases and flow under level control into the liquid gathering line and be routed to the CTB for further processing. The gases will be separated and routed to the inlet of the RCF and later the CRP. The entire field production pressure will be controlled at the RCF/CRP inlet header and the individual Satellites will 'float' on that pressure. Liquid and gas flow rates will be metered for production trending and monitoring.

- The test separator will be a three-phase, bucket and weir separator to allow for a 24-hour test cycle of each well serviced by that Satellite. The oil and water will be controlled by level control and the gas will be controlled by a back-pressure controller to hold the test separator pressure slightly above that of the associated production separator. Oil, water and gas from the test separator will be re-combined and directed to the inlet manifold and then to the production separator.

The Satellite also contains the water alternating gas (WAG) injection manifold. As described previously, water is injected under pressure to enhance the recovery of CO_2-oil mixture at the production wells. Alternating gas (CO_2) and water injection is a technique proven to enhance the recovery of oil. The CO_2 and water to be injected will be routed from the CRP/RCF via the high-pressure injection lines to the Satellite and to the WAG manifold. The WAG manifold for the initial Satellites will consist of three separate inlet headers:

1. Low-Purity CO_2
2. High-Purity CO_2
3. Injection Water

CO_2 or injection water will be manually directed from the manifold into the injection line from the manifold to the various injection wells. The injection fluid, CO_2 or water, will be metered at the WAG and flow will be controlled by an automatic choke at the injection well head.

2.3.1.3 Infield Gathering and Injection Distribution Flow Lines

The infield gathering flow lines and the injection distribution flow lines tie the various elements of the overall facilities together. The lines (four or five depending on

Satellite configuration) will be installed in a common trench or pipe-rack support for safety consideration and for ease of installation. Each Satellite will have a dedicated set of flow lines running to and from the Satellite and the CTB or RCF/CRP.

Flow lines planned for the OEHI CO_2 EOR Project include:

- 12-, 16- and 26-inch Gas Gathering lines
- 10-, 12- and 16-inch Liquid Gathering lines
- 10-, 12- and 16-inch Water injection lines
- 4-, 6- and 12-inch CO_2 injection lines

Satellites constructed later in the EOR project (after the first five or six) will only need a single 6-inch CO_2 injection line as the dual purity requirement for CO_2 handling will no longer be required as the average CO_2 content increases.

Additional preliminary design specifications for flow lines and wells include:

- Normal Operating Pressure – 300 - 400 pounds per square inch gauge (psig)
- Normal Operating Temperature - 20 – 140ºF, nominally assumed to be 110˚ F for simulation
- Maximum Allowable Working Pressure for the flow lines – 2,500 psig
- Average Production Well Flow Rate (at peak water rate) - Eight barrels oil per day (bopd)
- Average Injection Well Flow Rate (at peak water rate) - 4,550 bwpd or 59 thousand cubic feet CO_2 per day (mcfd)
- Average Production Well Flow Rate (at peak oil rate) - 300 bopd
- Average Injection Well Flow Rate (at peak oil rate) - 2,270 bwpd or 5057 mcfd CO_2
- Average Production Well Flow Rate (at peak gas rate) - 149 bopd
- Average Injection Well Flow Rate (at peak gas rate) - 2,234 bwpd or 5,956 mcfd CO_2
- Test Separators design rate - 500 bopd or 4,000 bwpd or 3 mcfd CO_2

2.3.1.4 Injection and Production Well Design Basis

Injection wells will conform to the provisions of DOGGR Class II UIC permits. Wellheads with CO_2 compatible metallurgy and corrosion-resistant coatings that are design-rated for the permitted injection pressure will be used on the injection wells. Casing on the injection wells is protected by cement on the exterior and the interior will be isolated from CO_2 by the injection packer. Wellheads with adequate design pressure rating on producing wells will be used, and will be protected by the injection of corrosion inhibitor chemicals to prevent any damage. A sample Class II UIC permit application for initial well construction will be provided to the California Energy Commission (CEC).

2.3.2 Recovered CO_2 Purification and Compression

2.3.2.1 Central Tank Battery

The CTB is the primary oil/water separation system for the CO_2 EOR process and will be collocated with the RCF and CRP at the CO_2 Facility at Section 27S of the Elk Hills Unit. It will consist of an inlet header system, gas separators, gas flume and vortex tanks (VT) for oil/water separation. The inlet liquid gathering lines from the Satellites will flow to the inlet liquid manifold where the oil and water will be manually directed to one of the three gas separator tanks.

The gas separator tanks will be designed for two-phase separation of the vapor and liquid. Two gas separators will be installed initially, with the third unit added as needed to handle the increasing liquid production. Gas from the CTB is transported to the inlet of the gas processing facilities, the CRP and RCF.

The liquid from the gas separators flows under level control to the gas flume where the oil and water are further de-gassed. The gas flume and VT will be designed based on two units operating at a maximum design capacity of 50 percent. One unit will be installed initially. The second unit will be installed when liquid production increases above 50 percent of maximum design capacity for the first unit. The gas from this process is combined with the gas from the gas separators. The oil and water from the flume flows by gravity to the VT where the oil and water separates by gravity. The VT is fitted with nozzles to impart a vortex spin to the water in the tank, allowing the water to remain in the tank longer and increasing separation. The oil is skimmed off the top of the VT and flows to the oil tanks, where it is pumped to Section 18G and metered for sale. The partially treated water flows to the water treating facilities.

2.3.2.2 Reinjection Compression Facility

The RCF is the first portion of the CO_2 treating/recovery facilities to be installed. It will consist of three two-stage, electric motor driven, centrifugal compressor systems each sized at 50 percent of design capacity. The third unit will function as a redundant spare and will provide for enhanced uptime and reliability. Each of these systems ("trains") will have an inlet scrubber and discharge air cooler on each of the two stages of compression. The RCF will be sized for a nominal flow of approximately 214 mmscfd or 107 mmscfd per train. The inlet pressure to the compressor trains will be controlled by a variable speed gearbox between the motor and compressor to adjust the compressor speed to maintain the required inlet pressure with capacity for each train being set by a load sharing controller.

Prior to compression, the inlet gas will first flow to the inlet gas separator to remove any condensed liquids from the gathering line. Next, the gas will flow to the inlet gas filter and coalescer to remove particulates from the inlet gas. The gas will then be dehydrated by a standard triethylene glycol (TEG) dehydration system to the CO_2 water content specification. This early dehydration step will allow for the use of standard carbon steel (CS) material throughout the RCF.

Both RCF trains will be installed during the initial plant construction. The RCF will have sufficient capacity to operate for approximately the first 4 years of production. By that time, the CRP will be installed and both plants will operate at partial load until peak gas rate is reached approximately 6 years later.

Figure 2-11 presents a basic process flow diagram for the RCF and CRP facilities. Numeric values shown on the figure are preliminary and subject to change as additional engineering design efforts are completed.

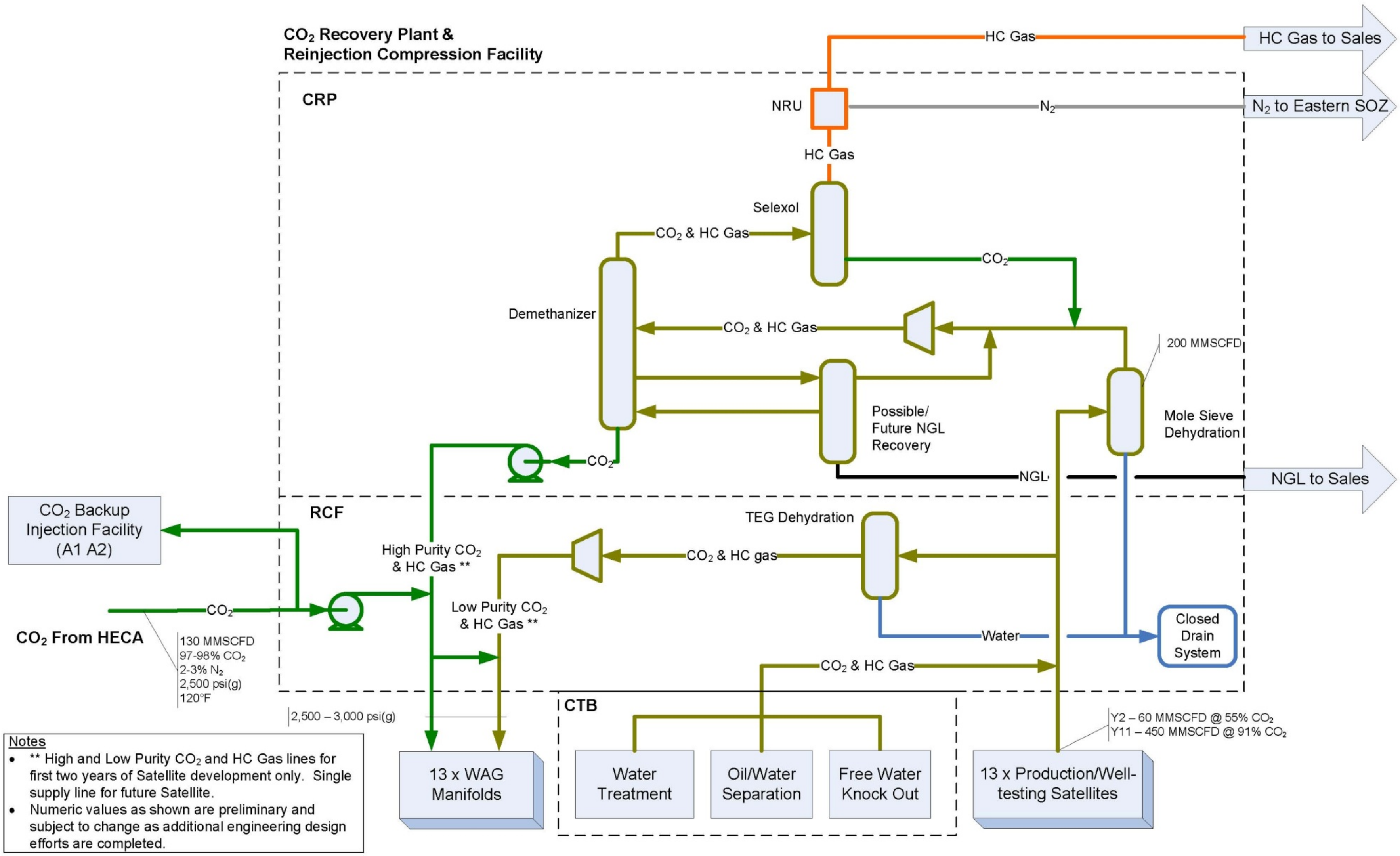

FIGURE 2-11 BASIC PROCESS FLOW DIAGRAM FOR THE RCF AND CRP FACILITIES

2.3.2.3 CO_2 Recovery Plant

The CRP is the second part of the gas treating/recovery plant. The CRP consists of six primary elements: (1) Fractionation System - for bulk CO_2 recovery, (2) a Natural Gas Liquids (NGL) Recovery System – for fluids from the associated gas, (3) Demethanizer System – for bulk CO_2 recovery, (4) Selexol Unit - for final treatment of the hydrocarbon gas, (5) Refrigeration system - for process cooling and (6) Nitrogen Rejection Unit.

Fractionation System

The Fractionation system will consist of a Mol Sieve dehydration package, booster compressor and a demethanizer fractionation tower with its associated heat exchangers. Inlet gas from the gas header will first flow to the inlet gas separator to remove any condensed liquids (condensate) from the gathering line. Next, the gas will flow to the inlet gas filter and coalescer to remove particulate matter from the inlet gas. The gas will then flow though the Mol Sieve dehydrators where water is removed to prevent ice or hydrate formation in the cold sections of the Fractionation system. The Mol Sieve dehydration system will consist of three beds, two dehydrating and one bed in regeneration. The regeneration will be done by withdrawing a small slipstream of the dehydrated gas downstream of the Mol Sieve bed. This regeneration gas will be compressed and heated in a regeneration gas compressor and heater. This heated gas will then flow through the Mol Sieve bed to drive out/boil out the absorbed water from the Mol Sieve material. The regeneration gas from the top of the bed will be cooled in an air cooler and the condensed water removed in the regeneration gas separator. The regeneration gas is then routed to upstream of the Mol Sieve bed to be dehydrated again.

The booster compressor will consist of two units (“trains”) each sized at 50 percent of the required total capacity. These trains will consist of single-stage, electric motor driven, centrifugal compressor systems. Each train will have an inlet scrubber and a common discharge air cooler. The booster compressors will be sized for a nominal flow of approximately 205 mmscfd based on the nominal feed rate of 200 mmscfd to the fractionation system plus recycle flows from the Selexol system and the NGL recovery system. The inlet pressure to the compressor trains will be controlled by a variable speed gearbox between the motor and the compressor to adjust the compressor speed to maintain the required inlet pressure with capacity for each train being set by a load sharing controller.

Gas flow from the booster compressors are split with some of the hot discharge gas flowing under temperature control through the Demethanizer (De-C1) reboiler to provide most of the heat needed for the fractionation process. The flow through the reboiler is controlled to meet process requirements in the fractionation tower. The remainder of the hot discharge gas flows through the discharge air cooler where the rest of the heat of compression is removed. The cooled gas from the discharge cooler is then recombined with the slip stream used for heat in the reboiler.

The total inlet gas stream then flows through a series of heat exchangers to further cool the feed to a low temperature to feed the De-C1. The heat exchangers are comprised of the following components:

a. Side reboiler – Further process heat is removed from the feed to provide heat for the fractionation tower.
b. Feed/Overhead exchanger – For recovery of cooling from the cold overhead gas stream from the Demethanizer.
c. Demethanizer feed gas chiller – Cooling with propane refrigeration to final process operating conditions.

Between the feed/overhead exchanger and the gas chiller, the partially condensed feed gas is sent to the NGL Recovery system. The temperature of this stream controls the amount of CO_2 that is condensed to liquid. The temperature must be low enough to condense most of the recoverable NGLs, but not so low as to condense the CO_2 that would be recycled to the inlet and increase booster compressor requirements.

NGL Recovery System

In the NGL Recovery system, the partially condensed inlet gas is flashed in a two-phase vertical separator. The uncondensed CO_2 is returned to the main heat exchanger train for further cooling and fed to the Demethanizer, and the cold condensed liquid is fed to the top of the NGL stabilizer. Heat from the electric reboiler vaporizes some of the liquid and provides stripping gas for mass transfer operation in the stabilizer. The lighter components (e.g., CO_2) are boiled out and the NGL product then flows from the bottom of the tower where it is cooled and pumped to storage. The CO_2 that is stripped from the NGL system feed flows from the stabilizer overhead and is recycled to the booster compressor inlet. NGLs recovered from this process will be piped to 35R for combination with liquids from existing processing facilities.

Demethanizer System

Demethanization is a process in which the inlet gas is chilled through various heat exchangers and refrigeration. The chilling of the gas condenses most of the CO_2 out of the gas stream (also called bulk removal of CO_2) and allows it to be separated in a tower called the Demethanizer tower. The CO_2 is then pumped back to the field for reinjection. The gas stream off the top of the Demethanizer is sent to the Selexol process to recover the remaining CO_2.

Selexol Unit

After bulk CO_2 recovery in the Fractionation system, the remaining gas flows to the Selexol system for final CO_2 recovery and gas treatment to meet the export gas specification. Selexol is a physical absorbent to remove CO_2 and hydrogen sulfide (H_2S), if present, from the natural gas. The absorption occurs in the Selexol contactor where a solvent, dimethyl ethers of polyethylene glycol (DEPG), flows counter currently downward against the gas to be treated. DEPG is generally regenerated by mixture of heating or pressure reduction to flash the CO_2 from the solvent.

The cool inlet feed gas is cross exchanged with cold residue gas from the contactor overhead in the inlet gas/sales gas exchanger. The cooled feed gas is then fed to the bottom of CO_2 absorber and flows upward counter current to the solvent and treated gas exits from the top of the absorber and flows to the inlet cross exchanger. The CO_2-rich solvent is flashed to a lower pressure, approximately 250 psig. The flash gas, which is relatively rich in hydrocarbons, is compressed and recycled to the inlet of the Selexol unit so that the CO_2 can be absorbed.

The semi-rich solvent is then flashed to consecutively lower pressures with the last stage of flash at vacuum. The flash gas from these regeneration flash separators is compressed in a multi-stage compressor to approximately 250 to 300 psig and the CO_2 is recycled to the inlet of the CO_2 Fractionation system where the CO_2 is recovered.

The lean solvent from the last stage of flash regeneration is filtered and cooled with propane to approximately 15˚F and pumped under flow control to the top of the CO_2 absorber.

The Selexol unit is followed by a cryogenic Nitrogen Rejection Unit (NRU) to reduce the nitrogen content from approximately 38 percent to a total of 4 percent of inerts. Supplemental compression will be added downstream of the NRU to boost the sales gas to the required delivery pressure of 1,200 psig.

Refrigeration System

The primary utility system for the CRP is a propane refrigeration system. The propane refrigeration system will consist of two units (“trains”) each sized at 50 percent of the required total capacity. Each train will consist of a four-stage, centrifugal compressor package. The refrigeration will be produced at two temperature levels: 10˚F for the inlet feed gas chiller and the Selexol chiller and -35˚F for the Demethanizer overhead condenser.

Nitrogen Rejection Unit

The treated gas that comes off the Selexol absorber contains some amounts of CO_2 (approximately 3 percent) and Nitrogen (approximately 38 percent) that need to be removed in order for the hydrocarbon gas to meet the pipeline sales specification. This treated gas goes to the NRU to separate these components. The NRU contains a small acid gas removal unit to separate out the CO_2; the CO_2 goes to the vapor recovery unit and is recycled back to the RCF and CRP. The nitrogen is separated from the hydrocarbon gas by chilling and liquefying the hydrocarbon gas. The nitrogen is then compressed and sent to injection wells at the eastern Shallow Oil Zone (SOZ) in the Elk Hills Unit. The hydrocarbon gas is then vaporized, compressed, and put into a gas pipeline.

2.3.2.4 Water Treatment Plant

The oily water from the inlet section of the CTB flows to additional treatment to remove oil, solids and other contaminants from the produced water. It is then pressurized in the injection pumps and sent to the Satellites for injection.

From the VT, the oily water flows under level control to a series of flotation cells. In the flotation cell, fuel gas is introduced to enhance coalescing of oil droplets in the oily water to remove the oil from the water. The partially treated water is then pumped by filter charge pumps through filters to remove solids from the produced water. The water then flows to the water tanks that serve as a surge volume for the system. Makeup water from the Tulare formation is pumped by electrical submerged pumps via a new 10-inch pipeline to the CTB for periods when the CO_2 is not available from the HECA Project. It is introduced into the water system upstream of the filters to allow for filtering and also for solids removal.

From the water storage tanks, the produced water is pumped by booster pumps and the water injection pumps to the water injection distribution system and then via the water injection to the WAG manifolds at the Satellites for injection into the wells. Control is manual with the number of pumps online balanced with the demand for injection water.

Low-pressure gas collected from the flume/vortex in the CTB and the flotation cell in the Water Treatment area is compressed by VRU to approximately 35 psig, where it is combined with gas from the gas separator. The combined low pressure gas stream is then compressed by the low-pressure compressor and routed to the inlet of the RCF and CRP for processing.

2.3.3 Backup CO_2 Injection Facility

A backup injection facility will be constructed at the A1/A2 producing reservoirs in the northwest area of the Elk Hills Unit. This facility will be constructed and available for:

1. Pressurization of the A1/A2 reservoirs for additional CO_2 EOR production

2. Sequestration of CO_2 should there be a short-term operational disruption at the HECA Project or Elk Hills facilities or an imbalance of supply and demand of CO_2

OEHI will install a pipeline for CO_2 transport to the A1/A2 area in the northwest area of the Elk Hills Unit (Sections 7R, 18R). Flows of CO_2 to the A1/A2 reservoir will be monitored in the same fashion as those flows to the primary injection zones.

On the discharge side of the CO_2 injection pumps is a pressure control valve that will route excess CO_2 to the Backup CO_2 Injection Facility, should there be a localized imbalance. This is matched by a second pressure control valve on the supply line from the HECA Project downstream of the custody transfer meter to also route excess CO_2 to the Backup CO_2 Injection Facility. It opens as the backpressure on the supply line increases indicating excess flow from the HECA Project over the flow from the CO_2 injection pumps to the injection wells. The third system works in conjunction with the upstream pressure controller on the HECA Project supply line. This third system is a direct pathway independent of the pressure controllers to route all the HECA Project supplied CO_2 to the Backup CO_2 Injection Facility, should there be a operational disruption at the CO_2 Facility (eg., a power failure).

3 Supporting Process Systems

3.1 Hazardous Material Management

A variety of hazardous reagents and materials will be stored and used at the OEHI CO_2 EOR Project in conjunction with construction, operation, and maintenance of the OEHI CO_2 EOR Project. In general, the type and character of these materials will be the same as those used today at the Elk Hills Unit.

Construction

Hazardous materials used during the construction of the OEHI CO_2 EOR Project would mainly be limited to fuels and construction materials, including:

- Gasoline, diesel fuel, and motor oil for construction equipment
- Compressed gas cylinders containing oxygen, acetylene, and argon for welding
- Paint and cleaning solvents
- Concrete form release
- Miscellaneous lubricants, adhesives, and sealants

Each construction contractor will be responsible for maintaining a set of Material Safety Data Sheets (MSDSs) for each onsite chemical they control and notifying their construction workers where these chemicals are stored and the associated hazards.

The most likely accidents involving hazardous materials during construction might occur from small-scale spills during cleaning or use of other materials in the storage areas or during refueling of equipment. Such spills will be immediately cleaned up and materials containing hazardous substances will be properly disposed in accordance with applicable laws, ordinances, regulations and standards (LORS).

Operations

Hazardous materials that may be routinely stored in bulk and used in conjunction with the OEHI CO_2 EOR Project operations include, but are not limited to, petroleum products, flammable and/or compressed gases, cleaning chemicals, paints, and some solvents. Table 3-1, Hazardous Materials Usage and Storage during Operations, lists each material and describes the approximate annual quantity needed and use of the material during operations.

TABLE 3-1 HAZARDOUS MATERIALS USAGE AND STORAGE DURING OPERATIONS[1]

Material	Potential Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Quantity Stored	Storage Type
Compressed Carbon Dioxide Gas[3]	Asphyxiant	EOR fluid; received from HECA; recovered from production wells	Outdoor	TBD	No aboveground storage, in process and transport pipelines only
Nitrogen[3]	Asphyxiant	Byproduct of hydrocarbon gas production and CO_2 separation, inert gas	Outdoor	TBD	No storage, in process and transport pipelines only
Natural Gas Liquids (NGL)	Flammable	Sales Product of Oil Recovery	Outdoor at 27S and transported to 35R plant via pipeline	TBD	No storage, in process and transport pipelines only
Produced Hydrocarbon Gas	Flammable	Sales Product of Oil Recovery	Outdoor at 27S and transported to 35R plant via pipeline	TBD	No storage, in process and transport pipelines only
DEPG or dimethyl ethers of polyethylene glycol	Flammable	Used in Selexol process for CO_2 recovery	Outdoor at 27S	TBD	AST with secondary containment
Chemical Reagents (acids/bases/—standards)	Corrosivity, Reactivity	Lab	Indoor chemical storage	<5 gallons	Small original containers

Material	Potential Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Quantity Stored	Storage Type
Miscellaneous Industrial Gases – Acetylene, Oxygen, Other Welding Gases, analyzer calibration gases	Ignitability, Toxicity	Maintenance Welding/ Instrumentation Calibration	Gas cylinder storage in Shop/ instrument shelters	Minimal	Cylinders of various volumes
Natural Gas	Ignitability	Startup/Backup /Auxiliary Fuel	Supply piping only	Utility supply on demand via pipeline	None
Diesel Fuel	Ignitability	Emergency generator/fire water pump fuel	Outdoors	2,000 gallons	ASTs with secondary containment
Paint, Thinners Solvents, Adhesives, etc.	Ignitability, Toxicity	Shop / Warehouse	Indoor chemical storage area	<20 gallons	Small original containers

Notes:

1 All numbers are approximate.

2 Potential hazardous characteristics based on material properties and potential health hazards associated with those properties.

3 Nitrogen and carbon dioxide are not hazardous materials but may be asphyxiants under some circumstances.

% = percent

< = less than

AST = aboveground storage tank

The storage, handling, and use of hazardous materials will be in accordance with applicable LORS. Storage will occur in appropriately designed storage areas. Bulk tanks will be provided with secondary containment to contain leaks or spills. Safety showers and eyewashes will be provided in appropriate chemical storage and use areas. Personnel who could potentially handle hazardous materials will be properly trained to perform their duties safely and to respond to emergency situations that may occur in the event of an accidental spill or release.

3.2 Hazardous Waste Management

3.2.1 Hazardous Construction Waste

The majority of hazardous waste generated during construction will consist of liquid waste such as waste oil from routine equipment maintenance, flushing and cleaning fluids, waste solvents, and waste paints or other material coatings. Additionally, some solid waste in the form of spent welding materials, oil filters, oily rags and absorbent, spent batteries, and empty hazardous material containers may also be generated.

Construction contractors will be required to employ practices consistent with the proper handling of all hazardous wastes in accordance with applicable LORS. This includes all licensing requirements, training of employees where required, accumulation limits and duration, and record keeping and reporting requirements. Wastes that are deemed hazardous will be collected in hazardous waste accumulation containers placed near the area of generation. After the end of each workday, the accumulation containers would be moved to the hazardous waste accumulation area, where hazardous wastes can be stored for up to 90 days after the date of initial generation. All hazardous wastes will be removed from the construction sites of the OEHI CO_2 EOR Project by a licensed hazardous waste management facility.

Table 3-2 lists the anticipated construction wastes including both hazardous and non-hazardous waste, and identifies the likely disposal method

TABLE 3-2 SUMMARY OF CONSTRUCTION WASTE STREAMS AND MANAGEMENT METHODS[1]

Waste	Waste Classification FIX	Amount	Disposal Method
Used Lube Oils, Flushing Oils	Hazardous or Non-Hazardous	1-10 55 gallon drums per month	Recycle
Hydrotest Water (One time per commissioning, reuse as practical, test for hazardous characteristics)	Hazardous or Non-Hazardous	TBD	Characterize. Drain non-hazardous to the Detention Basin. Dispose of hazardous at a hazardous waste disposal facility.
Solvents, Used Oils, Paint, Adhesives, Oily Rags	Cal-Hazardous[2] Recyclable	Unknown	Recycle or dispose of as hazardous waste.
Spent Welding Materials	Hazardous	Unknown	Dispose at a hazardous waste landfill.

Waste	Waste Classification FIX	Amount	Disposal Method
Used Oil Filters	Hazardous	Unknown	Dispose at a hazardous waste landfill.
Misc. Oily Rags, Oil Absorbent	Non-Hazardous or Hazardous Recyclable	(1) - 55 gallon drum per month	Recycle or dispose at a hazardous waste landfill.
Empty Hazardous Material Containers	Hazardous Recyclable	1 cubic yard per week	Recondition, recycle, or dispose at a hazardous waste landfill.
Used Lead/Acid and Alkaline Batteries	Hazardous Recyclable	No greater than 1 ton per year	Recycle
Sanitary Waste from Workforce (Portable Chemical Toilets)	Non-Hazardous	Approximately 390 gallons per day	Pump and dispose by sanitary waste contractor.
Site Clearing – Grubbing, Excavation of Non-Suitable Soils, Miscellaneous Debris	Non-Hazardous	Minimal	Reuse Soils or dispose at a non-hazardous waste landfill.
Scrap Materials, Debris, Trash (Wood, Metal, Plastic, Paper, Packing, Office Waste, etc.)	Non-Hazardous	Approximately 40 cubic yards per week	Recycle or dispose at a non-hazardous waste landfill.

Notes:
1 All Numbers are estimates
2 Under California regulations

3.2.2 Hazardous Operations Waste

As with construction hazardous waste described above, where appropriate, hazardous waste resulting from operation activities will also be collected in hazardous waste accumulation containers placed near the area of generation. After the end of each workday, the accumulation containers will be moved to hazardous waste accumulation areas where hazardous wastes can be stored for up to 90 days after the date of generation. All hazardous wastes will be properly removed from the OEHI CO_2 EOR Project Site in accordance with applicable LORS.

Table 3-3 lists the anticipated construction wastes which includes both hazardous and non-hazardous waste, and identifies the likely disposal methods.

TABLE 3-3 SUMMARY OF OPERATIONAL WASTE STREAMS AND MANAGEMENT METHODS[1]

Waste Stream	Waste Classification	Anticipated Maximum Amount per Year	Disposal Method
Water Treatment Plant Sludge and Used Water Filter Media	Non-Hazardous	**TBD**	Characterize and dispose as non-hazardous or hazardous waste.
Used Oil	Hazardous	**TBD**	Recycle. Expected to meet the regulatory exemption for used oil when recycled.
Spent Grease	Hazardous	**TBD**	Characterize and dispose as hazardous waste.
Miscellaneous Filters and Cartridges	Hazardous or Non-Hazardous	**TBD**	Characterize and dispose as non-hazardous or hazardous waste.
Tank Bottoms Sludge	Hazardous or Non-Hazardous	**TBD**	Characterize and dispose as non-hazardous or hazardous waste.
Triethylene Glycol	Hazardous or Non-Hazardous	**TBD**	Recycle. Characterize and dispose as non-hazardous or hazardous waste.
Miscellaneous Solvents	Hazardous	**TBD**	Recycle or disposal as hazardous waste.

Waste Stream	Waste Classification	Anticipated Maximum Amount per Year	Disposal Method
Flammable Lab Waste	Hazardous	**TBD**	Characterize and dispose as hazardous waste.
Universal Wastes	Hazardous	**TBD**	Recycle. Characterize and dispose as hazardous waste.
Waste Paper and Cardboard	Non-Hazardous	**TBD**	Recycle.
Combined Industrial Waste (Used PPE, materials, small amounts of refractory, slurry debris, etc.)	Non-Hazardous	**TBD**	Dispose at a non-hazardous waste landfill.

Notes:
1 All Numbers are estimates
2 PPE—personal protective equipment

3.3 Stormwater Management

Clean stormwater runoff from process areas (27S CO_2 Processing Facility) will be routed to an onsite stormwater retention basin during construction activities. Construction project site stormwater runoff in non-process areas but within the main plant area will be routed to a retention basin. Retention basins and stormwater collection/conveyance systems will be designed in accordance with the Kern County Development Standards.

Stormwater from non-process areas outside the main plant area but within the OEHI CO_2 EOR Project Site is expected to reflect natural discharge conditions. Runoff from these areas follows natural drainage patterns of the Elk Hills Unit and will be subject to the California Stormwater Construction General permit, as appropriate.

A project-specific construction stormwater pollution prevention plan (SWPPP) will be developed prior to construction, incorporating the recently updated California Stormwater Construction General permit. The OEHI CO_2 EOR Project stormwater will be managed using best management practices (BMPs), Rainfall Erosivity Waiver, or NOI coverage under California Stormwater Construction General permit, as appropriate.

3.4 Fire Protection

The OEHI CO_2 EOR Project Fire Protection Program includes both fire prevention and protection measures. Employment of conservative equipment layouts, segregation of critical components, and the remote location of non-essential resources, are the backbone of the fire mitigation/suppression measures employed.

Conservative equipment spacing and segregation of potentially hazardous activities from the balance of the OEHI CO_2 EOR Project are the guiding principles employed to protect personnel and property. Automation and sensing equipment will be strategically located throughout the OEHI CO_2 EOR Project to detect and alarm hazardous levels. Oil containment and equipment spacing will isolate large transformers from adjacent facilities. Structural steel will be protected with fire-proofing materials in strategic areas. Grading and paving plans will be prepared to complement this objective.

Preliminary design of the firewater system for the facilities includes a storage tank and two firewater pumps. Detailed design of the system will be performed in later stages of engineering; it will address system layout, automated and manual portions of the .system.

The degree and extent of fire protection and suppression systems provided will be in accordance with applicable LORS, standards, and company guidelines

3.5 Control Systems

CO_2 Gas Plant Facility

The CO_2 Facility will be controlled from a new CO_2 control building within the plant area. The control room is to cover the operation of the RCF, CTB, CRP, Satellites, producing and injection wells. The plant Integrated Control and Safety System (ICSS) will be a Distributed Control System with monitoring, control, and shutdown capabilities. The ICSS shall consist of both a Process Control System and a Safety Instrumented System that are fully redundant and independent of each other. The configuration, maintenance, and operating environment for these systems shall be achieved from the same Human Machine Interface (HMI)/Engineering station. There will be several HMIs that can view and monitor the entire facility and they will be capable of backing up and achieving the same functionality in case one HMI fails.

The new control room will contain Operator Workstations and Engineering Workstations to provide operators a means of interfacing and controlling the CO_2 Facility, and injection and production wells. New CO_2 control equipment will be added to the existing Elk Hills Unit control system, and will be connected via fiber optic ring from the CO_2 control building to the existing Central Control Facility.

For ease of maintenance and a preferred environment for electronic equipment, the control panels for the Control and Safety System shall be located in non-hazardous air-conditioned buildings inside the CO_2 Facility area.

Satellite Gathering Sites, Production and Injection Well Sites

Each satellite site will have a controller that is used to monitor and control any local satellite processes and conditions. It will communicate back to CO_2 Facility via a fiber optic cable.

A radio and antenna shall exist at each satellite site. The radio will be used to communicate to all the related production and injection wells control panels. The radio signal will then be communicated back to the CO_2 Plant for operator interaction, via fiber optics.

3.6 Utilities

OEHI has existing plans to install a new 320/115 kilovolt (kV) electrical substation and electrical distribution lines in the Elk Hills Unit. This planned upgrade will make up to 500 megawatts (MW) of power available from Pacific Gas and Electric (PG&E) (the local utility company) and will be completed prior to the OEHI CO_2 EOR Project construction. This upgrade will ensure that sufficient power is available to the OEHI CO_2 EOR Project.

Five wells will be drilled and equipped as make-up water wells. They are located in Sections 13B and 18G, and will produce nominally 10,000 bwpd each. Makeup Water pumps transport water to the CO_2 Facility in Section 27S for use as make-up injection water for the reservoirs when the HECA CO_2 gas is unavailable. Potable water will be supplied from the existing potable water system. An internal connection will be added from the 36S potable water tank and system.

The following tie-ins to the project are expected:

Commodity	Tie-In Location	Design Conditions
CO_2 from HECA	Nominally at main plant boundary in 27S	
Fuel Gas	In 35R adjacent to existing gas plants	

Commodity	Tie-In Location	Design Conditions
Water	Tulare water in 13B and 18G, pipeline to 27S	Not potable quality
Propane	Pipeline to 35R plant	HD5 propane
Electric Power	In the SW corner of 28S	115kV, assume required power is available
Potable Water	36S potable water tank	Connection from existing potable water system

3.7 Project Buildings/Facilities

Three new buildings are required at the CO_2 Facility:

- Administration/Control Building
- Maintenance/Warehouse Building
- Compressor Shelters

3.8 Security Systems

The Elk Hills Unit has a fully fenced perimeter with a roving security patrol that operates around the clock. Access into Elk Hills is through manned guard gates where pictured security ID badges are shown to gain entrance to the operations. The CO_2 Facility will be fenced and secure access provided adjacent to the administration/control building. The satellites and pipelines are located within the boundary limits of the Elk Hills Unit, and no additional specific security provisions have been made for these components since a gated security fence limits access at this time.

3.9 CO_2 Monitoring, Measurement, Verification and Closure

3.9.1 Monitoring, Measurement and Verification

As it relates to the HECA Project the CO_2 EOR process will be subject to monitoring, measurement, and verification (MMV) requirements. A site-specific MMV Plan will be developed with the objective of demonstrating permanent trapping of HECA-provided CO_2. The MMV Plan will include consideration of the existing detailed subsurface, seismic, geochemical characterization and wellbore construction details that have been generated from the extensive data covering the EHOF. Selection of the appropriate suite of tools to satisfy the MMV objectives will be based on an assessment of the potential risks, taking into account the unique characteristics of the EHOF and the performance expectations at the site.

There are several components that will be incorporated into the MMV Plan. OEHI's development plan for the Elk Hills Unit, which includes injection of CO_2 for EOR, will be used to predict the field's future production over a period of many years. Reservoir characterization, which includes geologic and petro-physical analysis, and reservoir simulation modeling will be used to develop reliable recovery forecasts. Reservoir characterization and forecasting will be confirmed by applying the following:

Demonstration of Well Integrity

- Monitoring of wellhead and annular pressures of all wells completed in EOR reservoirs, supplemented by downhole pressure and temperature measurements, where available

- Well integrity monitoring and cement evaluation

Demonstration of Horizontal Containment

- Monitoring of wellhead and annular pressures of wells completed in vertically adjacent reservoirs, supplemented by downhole pressure and temperature measurements in the offset reservoirs, where available

Demonstration of Sequestered Volumes

- Material balance

- Recovered fluid geochemical sampling

In connection with the foregoing, OEHI will supply any requested information to address the following:

- Subsurface data to characterize and represent in 3 dimensions the sedimentary section, structural geology and seismicity of the injection zone and overlying areas

- Subsurface data to characterize and demonstrate that the injection zone is sufficiently porous to receive CO_2 under expected operating conditions and extensive enough to receive the anticipated volume of CO_2 injected

- Subsurface data to characterize and demonstrate that the confining zone is sufficiently impervious to restrict vertical movement of CO_2 beyond the confining zone under expected operating conditions and extensive enough to contain the anticipated volume of CO_2 injected

- Geo-mechanical data to characterize rock stress, rock strength and fault stability

- Over the period of CO_2 injection, geochemical data to characterize formation fluids in the injection zone and the lowermost porous unit above the confining zone

- Over the period of CO_2 injection, well-related injection data to allow physical and chemical characterization of injection fluids, including injection pressure, flow rate and temperature

- Over the period of CO_2 injection, well-related mechanical integrity data to demonstrate integrity of the wellbore such as concrete seals and wellbore packers and other as may be required by permit

3.9.2 CO_2 EOR Well Field Closure

The OEHI CO_2 EOR operations will be closed after all economic production of hydrocarbons has been exhausted, which is not expected for at least 20 years. The closure phase consists of site decommissioning, well plugging and abandonment, and appropriate post-injection care and monitoring. In addition to those measures generally required for closure of UIC Class II wells, OEHI will conduct closure activities that demonstrate that the injected CO_2 is properly contained within the confinement zone and is not endangering human health or the environment. Closure will be conducted pursuant to a post-injection closure plan that will be performance-based and specifically tailored for the OEHI CO_2 EOR Project.

4 Project Construction

OEHI is currently in the early stages of project economic and engineering development. Specific details regarding project construction are not yet available. As OEHI moves through its project development FEED process, this section will be populated and submitted to interested parties.

This section will contain the following material when completed:

4.1 Project Site Construction

4.2 Construction Planning

4.3 Mobilization

4.4 Construction Facilities, Parking, and Lay-down Areas

4.5 Emergency Facilities

4.6 Construction Utilities and Site Services

4.7. Construction Materials and Heavy Equipment Deliveries

4.8 Hazardous Materials Storage

4.9 Construction Disturbance Area

4.10 Stormwater Runoff Prevention Plan

4.11 Linear Construction

4.12 Construction Workforce

4.13 Construction Equipment Requirements

4.14 Construction Traffic

5 Project Operation Scenarios

OEHI is currently in the early stages of project economic and engineering development. Specific details regarding project operation are not yet available. As OEHI moves through its project development FEED process, this section will be populated and submitted to interested parties.

This section will contain the following material when completed:

5.1 Startup Operations

5.2 Normal Operations

5.3 Upset Operations

5.4 Shutdown and Decommissioning

5.5 Project Staffing

6 Facility Safety Design

Occidental has a long-standing commitment to protecting community, employee and contractor health and safety, and the environment. Maintaining strong health, environment, safety and security (HES&S) programs is one of Occidental's highest priorities and the company strives for continual improvement in HES&S performance.

OEHI has a management system that effectively coordinates HES&S activities. This Health, Environment and Safety Management System (HESMS) includes the following seven elements:

Basic HESMS Elements	Description
Leadership and Commitment	Addresses management's commitment to the Occidental Petroleum Corporation's HES&S Principles, Policy Statement and the management culture essential to success.
Policy and Strategic Objectives	Address corporate intentions, principles of action and HES&S goals.
Organization, Resources and Documentation	Addresses organizing people, resources and documentation for sound HES&S performance.
Evaluation and Risk Management	Addresses identifying and evaluating HES&S risks for activities, products and services, and developing risk reduction measures.
Planning	Addresses planning work activities, including planning for change and emergency response.
Implementation and Monitoring	Addresses HES&S performance and monitoring activities and necessary corrective action.
Auditing and Reviewing	Addresses periodic assessments of systems performance, effectiveness and fundamental suitability.

Integration of Safety and Health into Management Planning

At OEHI, HES&S includes the functional areas of occupational health, industrial hygiene, safety, product stewardship, process safety, transportation and pipeline safety, environmental protection, remediation, physical security and management of risks pertaining to the foregoing areas. The entire OEHI organization – including the OEHI Leadership Team and all plant and field managers, supervisors, employees and contractor personnel – are responsible for implementing the HESMS and are accountable for HES&S performance.

Operation, maintenance, and safety design features at the Elk Hills Unit will ensure that all Project-related surface equipment, including but not limited to, well safety systems, wellheads, separators, pumps, manifolds, valves, and pipelines used for the OEHI CO_2 EOR Project, will be maintained in good condition at all times to safeguard life, health, property, and natural resources.

Safety Philosophy

OEHI's management, employees and contractors are committed to continuously reducing workplace hazards while striving for an injury-free workplace. Safety and health philosophy and expectations are summarized in the Elk Hills Safety Credo, which is distributed to OEHI employees and contractor personnel, and summarized below:

- Safety is a core business value
- All accidents are preventable
- Working safely is a condition of employment
- No job is so important that it cannot be done safely
- Safe production is our standard

Each employee and contractor is responsible for his or her safety and the safety of others while working on OEHI properties. The HES&S Department is responsible for ensuring that there are effective programs to protect the health and safety of employees, contractors, subcontractors, visitors and neighbors.

Safety and health responsibilities for OEHI employees and contractors are detailed in OEHI's Safety Handbook and include, but are not limited to, the following:

- Performing every job safely for the benefit of self, coworkers, contractors, subcontractors, visitors, the public, and for the protection of company assets and the environment.
- Immediately reporting job-related injuries, equipment damage, near misses, spills, and fires, regardless of severity, to a supervisor and to the Communication Operations Center (COC).
- Taking necessary actions to P.A.U.S.E. (People Actively Using Stop Work Enforcement), or intervene and correct any unsafe condition, practice, situation, or the unsafe behavior of any person.

- Actively participating in safety meetings, safety training, and pre-job safety tailgate meetings and the safety observation process.

- Becoming familiar with emergency procedures applicable to the job and the OEHI Safety Handbook and other pertinent OEHI safety policies, procedures and guidelines, manuals, handbooks and publications.

OEHI uses a number of management techniques to ensure that employees, managers/supervisors and contractors demonstrate accountability for OEHI HES&S goals.

Contractor Management Program

OEHI's contractor safety management program has been developed to promote a safe working environment for OEHI employees, contractors, subcontractors, visitors and the public. This program establishes the minimum requirements and expectations for contractors and their subcontractors and includes criteria for prequalification, selection, site safety and health orientation, pre-job activities, work in progress, and performance evaluation.

All contractors and service providers must pre-qualify prior to a bid award or performing any onsite task or service. Contractors are selected for the bid process upon completion of the safety and health criteria evaluation and a review of the contractor's ability to comply with OEHI applicable safety and health requirements. The final contractor selection is made based on the contractor's HES&S performance, cost, availability and technical qualifications.

Contractors must prepare a comprehensive health and safety plan before performing and completing any work. Contractors are also required to (1) hold regular safety meetings; (2) conduct Job Safety Analysis to identify and eliminate workplace hazards; (3) have an active Behavioral Based Safety (BBS) Observation program that identifies at-risk behaviors and mentors/coaches employees on safe work practices; (4) report and investigate significant and important incidents; (5) be familiar with OEHI's Emergency Procedures and (6) ensure that new contractor personnel (including both contractor employees and subcontractors) are familiar with OEHI safety practices.

Audits are conducted for selected projects to determine compliance with safety policies and practices and assessment of hazards. All hazards must be mitigated by the contractor or the OEHI facility, as appropriate, and non-compliance issues promptly corrected.

Facility Design and the Management of Process Risks

OEHI Process Risk Management (PRM) program provides the means to identify and increase the awareness of foreseeable processes and operational risks that could potentially lead to an unplanned and unwanted event, and leads to recommendations that would eliminate or mitigate such risks. It provides a framework for continuous improvement in managing HES&S risks and facilitating the integration of HES&S risk management into business planning and decision making processes.

The requirements of the PRM program are designed to ensure a consistent and risk-based methodology for HES&S risk management and to ensure mitigation or discontinuance of participation in any activity that poses an unacceptable HES&S risk. Key elements include: i) compliance with applicable laws and regulations pertaining to HES&S risk management, ii) that facilities and equipment shall be designed, constructed, operated and maintained to meet internal OEHI standards, and iii) that recognized and generally accepted good engineering practices be applied.

In addition to any federal/country, state, and/or local regulatory programs for managing process-related risks, the following OEHI internal requirements are generally applicable.

- Facility Technical Information - Provide complete and accurate technical information to provide a basis for identifying and understanding chemical, technology and equipment related hazards.

- Management of Change - Identify and control HES&S hazards created by proposed changes in personnel, processes, equipment, structures, and procedures.

- Mechanical Integrity & Quality Assurance - Verify critical equipment, piping, components and instrumentation are designed, engineered, procured, fabricated, installed, tested, inspected and maintained according to required design specifications and standards.

- Operating & Maintenance Procedures - Provide clear instruction for safely conducting critical activities, including handling of hazardous materials, permit to work activities, inspection, and maintenance.

- Pre-Startup Safety Reviews - Verify that all new or significantly modified facilities have been thoroughly checked for safety, operability, and maintenance viability prior to startup.

- Process Hazards Reviews - Provide systematic approach for identifying and assessing HES&S Hazards and their possible consequences.

6.1 Natural Hazards

The OEHI CO_2 EOR Project will be planned, engineered, designed, constructed, and operated to meet the requirements of all applicable LORS. An overview of hazards that will be addressed in the OEHI CO_2 EOR Project is provided below.

6.1.1 Seismicity

In the context of CO_2 EOR, it is important as part of site selection to understand the risks of potential CO_2 leakage from the reservoirs due to seismicity. These reservoir risks are generally twofold: the first is induced seismicity from injection activities, and the second is potential leakage risk due to naturally occurring seismic activity. The OEHI CO_2 EOR Project evaluated both of these concerns with respect to the EHOF. The results are presented below.

6.1.1.1 Induced Seismicity

Even with decades of fluid injection for EOR, there is no public record of measurable induced seismicity at Elk Hills. The Elk Hills Unit contains significant volumes of gas in place and has undergone significant water and gas injection operations, including a pilot CO_2 injection project conducted in 2004.

In 2008, a regional seismicity study was conducted for the EHOF. The study found:

> *The risk of induced seismicity due to CO_2 injection operations was remote and highly unlikely (Terralog Technologies, 2008). Furthermore, even in the unlikely case of an induced seismic event, any such seismic event would likely be less than magnitude 4, based on the geologic setting, areal extent and depth of proposed operations, and anticipated pressure and stress changes (Terralog Technologies, 2008). Seismic events on the order of magnitude 3 to 4 may be felt within the immediate area (approximately 1 km), but would not be expected to cause structural damage to facilities or buildings for several reasons. Most surface structures near the EHOF are likely to be at distances of about 6 to 30 miles (10 km to 50 km) from the epicenter of any induced seismic event. Assuming the highly unlikely scenario of an induced seismicity event of magnitude 4 located at a depth of about 6 miles (10 km), the induced horizontal ground acceleration would be on the order of 0.01 g, which is an order of magnitude lower than the California seismic codes. Seismic codes in California require structures to withstand horizontal acceleration in excess of 0.1 g, with varying strength depending on the seismic zone location and the use of the structure. Therefore, even with the assumption of an induced seismic*

event, there is minimal risk that any damage would result to surface structures. This induced seismicity of this magnitude also would not cause any damage to injection equipment or the reservoirs, as detailed in the following section. (HECA, 2009).

6.1.1.2 Naturally Occurring Seismicity

Since 1990, there have been 129 naturally occurring earthquakes recorded with a magnitude greater than 3.0 within a 60-mile (100 km) radius of Elk Hills (Figure 6-1). The vast majority of these have occurred along the White-Wolf fault, approximately 30 miles southeast of Elk Hills (Southern California Earthquake Data Center web site). The EHOF is situated about 15 miles east of the San Andreas Fault.

Natural seismicity of magnitude 3 to 6 is not likely to impact field operations and is highly unlikely to lead to leakage of any injected CO_2 from the EHOF. This assessment is based on decades of historical data for earthquake effects on wells in oil and gas operations in Southern California. It is also based on the geological setting of the injection project, which is in relatively soft and shallow (approximately 6,000 feet below ground surface) sediments. Most major earthquakes with a magnitude 6 and above in California occur at depths of 6 miles or more in brittle basement rock, while the proposed injection reservoirs at Elk Hills Unit is less than 2 miles deep in relatively soft sandstone. The strength of seismic waves decreases with distance; therefore, the large separation between major earthquake source and injection reservoirs would help prevent well damage (W. Foxall and J. Friedmann, 2008).

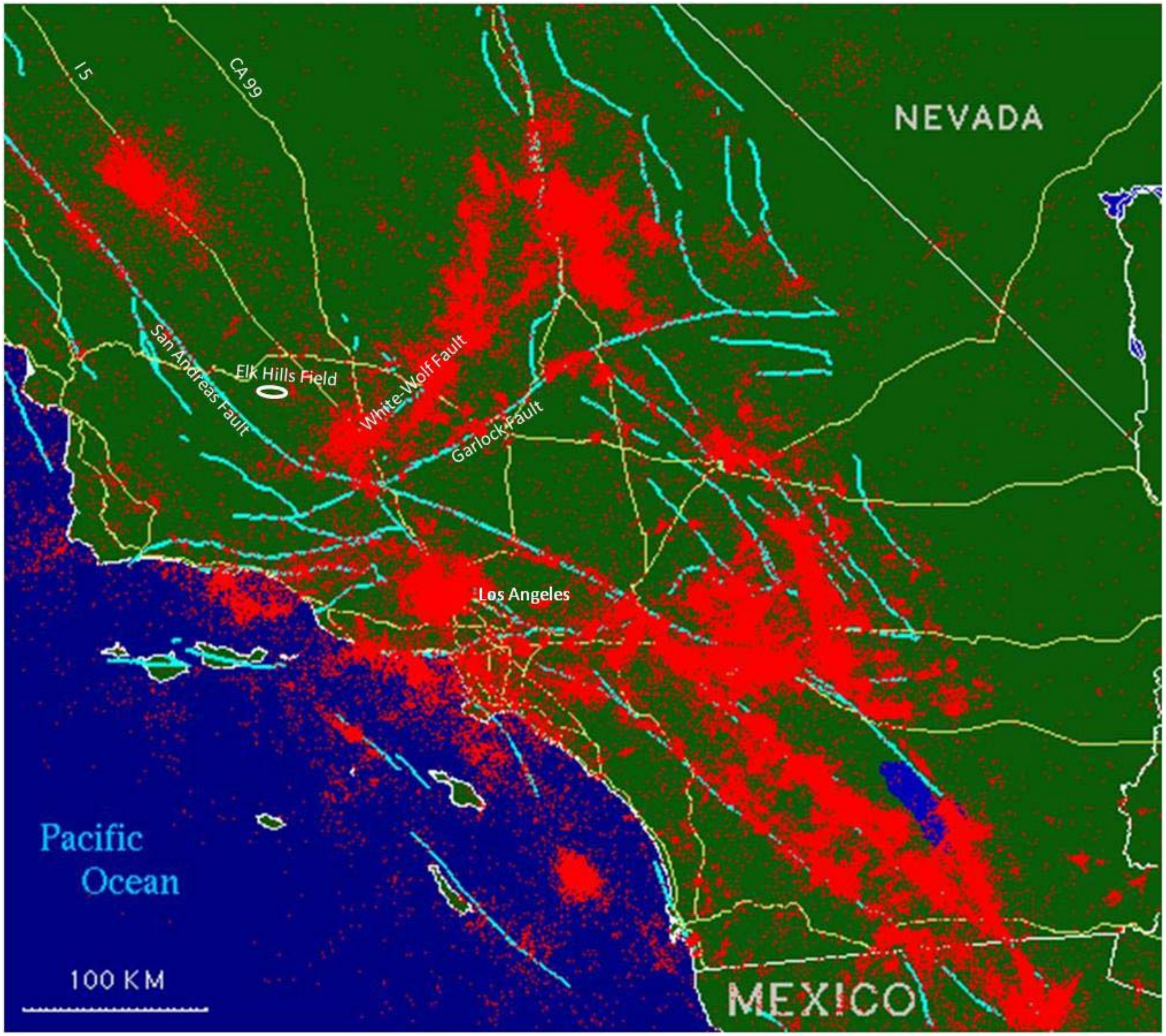

FIGURE 6-1 SEISMIC EVENTS IN SOUTHERN CALIFORNIA FROM 1932 TO 1996 (SOUTHERN CALIFORNIA EARTHQUAKE DATA CENTER)

In summary, the risk of induced seismicity from CO_2 EOR and Sequestration is remote. Moreover, even in the unlikely event of induced seismicity, the predicted magnitude would be no greater than 4.0. This type of event (4.0 magnitude) is comparable to the existing natural seismicity in the EHOF area and, as discussed above, would not cause structural damage to surface facilities in the nearby area. With respect to natural seismic events, there is abundant historical data and information demonstrating that a rather significant seismic event (on the order of magnitude 6), even if located in the immediate area of the EHOF, should not cause significant damage to wells or lead to leakage of injected CO_2. Finally, due to the numerous shale-sealed formations above the target injection zone, any vertical gas migration that might occur from the injection interval would be contained and not reach the surface.

6.1.2 Floods

The OEHI CO_2 EOR Project is not located within an area identified as having flood hazards or shallow groundwater. Based on the Federal Emergency Management Agency Flood Insurance Rate Map “Kern County, California, and Incorporated Areas” (Map 06029C2225E), dated 2008, the OEHI CO_2 EOR Project is not in the 100-year flood zone. Provided proper drainage design, the OEHI CO_2 EOR Project is not likely to experience flooding.

6.1.3 Wind Loads

The basic design wind speed (3 second gust) is 85 miles per hour as per CBC 2007. Wind loads on structures, systems, and components will be determined from ASCE 7 05 and CBC 2007.

6.2 Emergency Systems and Safety Precautions

6.2.1 Community and Stakeholder Awareness

OEHI values the importance of community awareness in the Kern County area and will engage in dialogue with the community and various stakeholders to maintain public confidence in the integrity of the OEHI CO_2 EOR Project.

Community/Stakeholder issues will be identified through the CEC siting process for the HECA Project by listening and consulting with concerned stakeholders: employees, contractors, regulatory agencies, public organizations, and communities. All communications will be responded to in a timely manner.

6.2.2 Emergency Preparedness

The OEHI CO_2 EOR Project will develop and use communications and response plans for emergency situations in accordance with applicable LORS. Prior to any activity, the response plan will be reviewed by the appropriate manager, who will take necessary actions to prepare to respond to an emergency event. All plans will be coordinated with the local emergency response organizations within Kern County, and the Bakersfield area in particular. Area hospitals and clinical medical services have been identified along with fire protection.

6.2.3 Specific Project Emergency Systems

The OEHI CO_2 EOR Project's auxiliary systems described below support, protect, and control the Project.

Fire Protection

See Section 3.4, Fire Protection, for details on the fire protection system for the OEHI CO_2 EOR Project.

Lighting System

The lighting system provides plant personnel with illumination in both normal and emergency conditions. The system consists primarily of alternating current (AC) lighting, and includes direct current (DC) lighting for activities or emergency egress required during an outage of the OEHI CO_2 EOR Project's AC electrical system. Lighting fixtures will be directionally oriented, shielded, and hooded to minimize offsite migration of light. The electrical distribution system also provides AC convenience outlets for portable lamps and tools.

Grounding System

The OEHI CO_2 EOR Project's electrical systems and equipment are susceptible to ground faults, switching surges, and lightning, which can impose hazardous voltage and current on Project equipment and structures. To protect against personnel injury and equipment damage, the grounding system provides an adequate path to dissipate hazardous voltage and current under the most severe conditions. Bare conductor is installed below grade in a grid pattern, and each junction of the grid is bonded together by welding or mechanical clamps. The grid spacing is designed to maintain safe voltage gradients. Ground resistivity readings are used to determine the necessary grid spacing and numbers of ground rods. Steel structures and non-energized parts of Project electrical equipment are connected to the grounding grid.

Emergency Relief System

The OEHI CO_2 EOR Project is furnished with pressure relief devices to protect equipment from overpressure. At the satellite units, any releases from pressure relief devices are routed through a local tank to capture any liquids entrained in the release. Gases including CO_2 and produced hydrocarbons would be vented directly to atmosphere in this emergency situation. At the CO_2 Facility, any excess gas resulting from a pressure relief would be routed to a flare relief system designed to handle an emergency or upset condition.

Cathodic and Lightning Protection System

Cathodic protection may be utilized using an impressed current or buried anode system to prevent corrosion of buried carbon steel piping and structures. Protective coatings are applied as primary protection and to minimize cathodic protection current requirements. The requirement for a cathodic protection system will be determined during detailed design. Lightning protection will be furnished for buildings and structures as appropriate.

Instrument Air System

The instrument air system provides dry, filtered air to pneumatic operators and devices throughout the OEHI CO_2 EOR Project. Air from the service air system is dried, filtered, and pressure-regulated prior to delivery to the instrument air piping network. This supports continual safe operation of the instruments controlling Project operation. The instrument air system will include two compressors each with the capacity for 100 percent of operating needs.

Emergency Response Procedures

Prior to commencement of construction activities, all requisite parties, i.e., the contractor, project management, and OEHI's assigned operations and management staff, will meet and develop a site-specific construction emergency response program. A review of the developed programs with local government emergency response organizations will ensure completeness and proper coordination.

6.3 Technology Selection and Facility Reliability

6.3.1 Technology Selection

EOR technologies have been utilized at the Elk Hills Unit for many years and such technologies have been widely used in the oil and gas (O&G) industry for even longer. CO_2 EOR has been employed for almost 40 years at Permian basin fields owned by

Occidental. The proposed technologies for the OEHI CO_2 EOR Project have been demonstrated effective and reliable for similar EOR projects at Elk Hills Unit and within the O&G industry.

The OEHI CO_2 EOR Project utilizes common technologies for the injection, production, separation and gas processing associated with the process fluids (oil, water, CO_2, hydrocarbon gas, etc). In comparison with the complex chemical reactions and associated equipment found at a refinery or chemical plant, the processes and technology options for the OEHI CO_2 EOR Project are relatively limited. The composition, flow rates and pressures of the produced fluids and gas streams determine the type, size and configuration of process equipment selected. Potential design options for certain equipment will also be limited by applicable LORS, such as those pertaining to protection of air quality and process safety. Material selection is important due to the process conditions, for instance the corrosive nature of CO_2 when free water is present (sometimes also called wet CO_2) and requires mitigation and design attention.

Production systems at the satellites and CTB will consist of separators and tanks to separate the gas vapor (i.e. CO_2, hydrocarbon gas, nitrogen mixture) from the liquid (oil and water). The gas vapors evolve out of the liquids and rise to the top of these processes because they are less dense while the liquids are heavier and removed separately. Tanks are used to separate the oil from the water because oil will float to the top of water and can be skimmed off. The gas from the separators and tanks are gathered via vapor recovery units and compressors, preventing release of gases to the atmosphere during normal operations. These are the conventional proven technologies in the O&G industry for both EOR and non-EOR projects.

Recovered gas is sent to the RCF and/or CRP from the satellites and the CTB for further gas handling. Gas gathering manifolds on the front end of the gas handling processes will permit sending lower CO_2 content to the CRP and the higher CO_2 content gas to the RCF by using valves to divert gas from the incoming satellites to the two different trains, as required. The RCF and CRP use demonstrated and commonly used technologies for gas handling and processing for EOR projects that are efficient, effective and reliable in the O&G industry. The RCF train consists of dehydration and compression. The dehydration system removes the free water so that the gas is non-corrosive and then the compressors boost the pressure of the process gas so that it can be reinjected into the injection wells.

The CRP is designed to remove the NGL's and hydrocarbon gas for sales. The concentrated CO_2 stream is reinjected into the injection wells. The CRP consists primarily of a demethanizer, Selexol process and NRU to separate the components in the gas stream. These are common, proven technologies to separate the components in the gas stream. The demethanizer chills the CO_2 so that much of it condenses as a liquid and is pumped back to the field for reinjection. The gas that doesn't condense goes to the Selexol process where CO_2 is further removed. The nitrogen and hydrocarbon mixture goes to the NRU so that it can be separated in order to meet natural gas pipeline specifications. Some of the sub-processes to achieve desired results are a dehydration system to remove the water from the gas, compression to boost the gas to the desired pressure before entering the demethanizer, propane refrigeration system to achieve the cooling of the gases to condense NGLs and CO_2 at desired temperatures, pumps to move the fluids, and heat exchangers to cool the process gases after they have been compressed. Even though the processes that are being utilized are reliable and common technologies, further design optimization will be undertaken in the FEED and detailed engineering of the project

The OEHI EOR CO_2 Project will use appropriate materials for the respective process conditions that exist throughout the project. Detailed material selection specifications and drawings will be developed during the FEED and detailed engineering of the project. Pipelines that are buried underground will have external coatings to protect the pipe from water and external corrosion. Process streams that contain CO_2 or mixtures of hydrocarbon gas and CO_2 without free water will be transported through carbon steel plant piping and pipelines because the CO_2 is non-corrosive when there is no free water present. The dehydration systems that were previously discussed remove the free water from these process streams. For piping systems that contain free water and that could have a corrosive environment, material selections will consist of internally plastic coated carbon steel pipe, poly-lined carbon steel pipe, or stainless steel pipe. These material selections are common in other EOR projects and have been proven to mitigate corrosion. Process equipment like separators, pumps, tanks, compressors, etc will either be IPC, stainless steel or fiberglass/epoxy composites for corrosion protection, as appropriate. Some of the process systems that will have free water present are as follows

- Producing well flowlines
- Satellite separators and piping
- Gas gathering lines from the satellites to the CRP and RCF
- Liquid gathering lines from the satellites to the CTB
- CTB equipment
- RCF and CRP piping and systems prior to the dehydration systems
- Water injection pumps and piping
- Injection well tubing

Much of the gas processing equipment and piping will be in non-corrosive service for which carbon steel is appropriate. Portions of the demethanizer and NRU unit operations will be stainless steel or low-temperature carbon steels because of some of the expected low-process temperatures.

6.3.2 Facility Reliability

As mentioned above, processes and materials that are common to CO_2 EOR projects in the O&G industry are being utilized, as appropriate, for the facilities and pipelines of the OEHI CO_2 EOR Project. Operating and maintenance practices will follow industry requirements. Automation and control systems, as previously described, will enhance operational control and ensure the safety and reliability of the facilities. Maintenance programs and mechanical integrity practices will be developed and followed to contribute to the reliability of the facilities. Reliability and availability studies, equipment and spare part philosophy and process hazards analysis will be performed in FEED and detailed engineering stages to identify other options to maintain reliability of the facilities. These items will contribute significantly to the reliability of the facilities and pipelines.

7 Compatibility with Laws, Ordinances, Regulations and Standards

There are many LORS that impact operations at the Elk Hills Unit, most notable are the DOGGR permitting process and the CEC process. There are numerous other LORS and/or permits to which project activities are subject. Some of these permits or agency reviews will certainly be required and others of them may become applicable pending final decisions on location or site specific activities.

7.1 Division of Oil, Gas and Geothermal Resources

The OEHI EOR CO_2 Project plans to construct and operate CO_2 Class II injection wells to enhance oil recovery within the Elk Hills Unit. Permitting of injection wells associated with EOR operations is well established and regulated by the DOGGR under authority granted through EPA's existing UIC Class II regulations. Under California law, DOGGR has responsibility for permitting injection and extraction wells and associated well facilities, including those anticipated for the OEHI CO_2 EOR Project. DOGGR has been given primacy to permit Class II injection wells in the State of California under the UIC program pursuant to Section 1425 of the Federal Safe Drinking Water Act, 42 U.S.C. § 300h-4 (see 48 Fed. Reg. 6336 [Feb. 11, 1983]). The wells and associated well facilities will be permitted pursuant to authority provided to DOGGR in the Public Resources Code and in accordance with applicable DOGGR regulations (see generally Cal. Pub. Res. Code Division 3, Chapter 1 and 14 Cal. Code Regs. Division 2). DOGGR has statutory responsibility under Division 3 of the Public Resources Code to regulate all oilfield operations in the State of California.

The Tulare Aquifer, underlying the Elk Hills Unit, is defined as a producing unit in the California Oil and Gas Fields (Vol 1). In 2004, DOGGR granted permit #22800022, allowing injection of disposal water into this reservoir. As part of the OEHI EOR CO_2 Project, applications will be submitted and approvals sought from DOGGR for additional water and CO_2 injection in various locations of the Elk Hills Unit.

7.2 Biological Resources

Numerous biological resources occur within and around the Elk Hills Unit. Some of these resources are protected and/or identified as threatened or endangered by state and federal laws and regulations. OEHI has worked closely with the resource agencies having jurisdiction over protected species since ownership of the Elk Hills Unit was transferred to OEHI in 1998.

7.2.1 Endangered Species Act of 1973

Through federal action and by encouraging the establishment of state programs, the 1973 Endangered Species Act (ESA) provided for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend.

Section 7 of the ESA requires federal agencies to ensure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat. Prior to the transfer of the Elk Hills Unit to OEHI, DOE's oil production activities complied with the ESA via a series of formal Section 7 Consultations with the United States Fish and Wildlife Service (USFWS), which resulted in the issuance of several Biological Opinions (BOs).[3] The BOs included authorization for take of listed species that is incidental to an otherwise lawful act. This is called an Incidental Take Statement. The most recent BO and associated Incidental Take Statement were issued in 1995, which allowed for the maximum efficient rate (MER) of oil recovery and authorized the incidental take of several listed species.

When Congress directed DOE to sell NPR-1 (National Petroleum Reserve – 1), they were also directed and authorized to transfer the Incidental Take Statement ("permit") to the purchaser of NPR-1 and provided that the transferred permit "shall cover the identical activities, and shall be subject to the same terms and conditions as apply to the permit at the time of transfer."[4] This provision was interpreted by the U.S. Department of the Interior to mean that the 1995 BO and accompanying Incidental Take Statement were to be transferred to the purchaser of NPR-1. OEHI completed the purchase of NPR-1 in February 1998, and has since been operating the Elk Hills Unit consistent with the BO and associated Incidental Take Statement.

7.2.2 California Endangered Species Act

The California Endangered Species Act (CESA) states that all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved. CESA is under the jurisdiction of the California Department of Fish and Game (CDFG) and they have been directed to work with all interested persons, agencies and organizations to protect and preserve such sensitive resources and their

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[3] USFWS. 1995. Reinitiation of Formal Consultation Concerning Oil Production at Maximum Efficient Rate on Elk Hills Naval Petroleum Reserve, Kern County, California

[4] 3413(d) of National Defense Authorization Act for Fiscal Year 1996

habitats. Similar to the federal ESA, CESA also allows for take incidental to otherwise lawful development projects under Section 2081(b).[5]

To comply with CESA, OEHI has also operated under the terms of a 1997 Memorandum of Understanding[6] (MOU) with CDFG that was subsequently amended to extend its term to 2009. OEHI has been working with CDFG to amend and extend the MOU for an additional period and anticipates executing the amendment soon. The MOU incorporated by reference the 1995 BO and all of its requirements as part of the agreement. The MOU included several additional measures that relate to species with State of California protection. OEHI continues to operate in compliance with the MOU.

7.2.3 Habitat Conservation Plan

Both the BO and the MOU anticipated the possible sale of the Elk Hills Unit by the federal government and the subsequent need for issuance to the new, non-federal owner of a section 10(a)(1)(B) permit under the ESA (and a section 2081(b) permit under CESA). Limits related to habitat disturbance in the BO were based on a series of assumptions of productivity and extraction rates, which were based on DOE's history of oil extraction activities at the site. OEHI has been working with the USFWS to accommodate continued operation beyond habitat disturbance limits set by the BO originally issued to the DOE in 1995 and to obtain incidental take authorization through the ESA Section 10 process and the CESA Section 2081(b) process, both of which require the development and submittal to the USFWS and CDFG of a Habitat Conservation Plan (HCP). A draft HCP has been submitted to both the USFWS and CDFG for review; however, the HCP process is often long (5 to 15 years) and until such time that the HCP is reviewed and approved by the agencies, OEHI continues operation of the Elk Hills Unit in accordance with the conservation measures and mitigation requirements set forth on the 1995 BO and 1997 MOU.

The draft HCP covers all of the approximately 47,884 acre (74.8 square miles) Elk Hills Unit (the area covered by the BO is 47,409 acres, the difference being the more than 475 acres that were purchased as future mitigation land after the original Purchase Sale Agreement with the DOE), as well as selected rights of way within a 2-mile conservation buffer around the Elk Hills Unit.

7.2.4 Covered Species

The 1995 BO and Incidental Take Statement authorized take of the following species: San Joaquin kit fox (Vulpes macrotis mutica), blunt-nosed leopard lizard (Gambelia sila), the giant kangaroo rat (Dipodomys ingens), and Tipton's kangaroo rat

[5] California Fish and Game Code Section 2080-2081 Consistency Determinations

[6] CDFG. 1997. California Endangered Species Act Memorandum of Understanding and Take Authorization for Occidental of Elk Hills; December.

(Dipodomys nitratoides nitratoides). Measures were also incorporated to minimize adverse effects on several plant species, including the Hoover's woolly-star (Eriastrum hooveri), which has been delisted under the ESA, Oil nest straw (Stylocline citroleum), Kern mallow (Eremalche kernensis; no subspecies designation) and San Joaquin woolly threads (Monolopia congdoni).

The MOU applies to and authorizes take for all of the species covered by the USFWS BO (although no direct take of blunt-nose leopard lizard is authorized by the MOU), as well as species not listed under the ESA, but having California State protection including: western burrowing owl (Athene cunicularia hypugea), San Joaquin antelope squirrel (Ammospermophilus nelsoni), and also San Joaquin wooly-threads (Lembertia congdonii).

7.2.5 OEHI Operations and Species Affects

OEHI has operated since 1998 under the MOU (as amended) and the USFWS BO, adhering to all of the requirements contained therein. These agreements apply to all ground-disturbing activities (both temporary and permanent) within the Elk Hills Unit. Typical ground-disturbing activities include: oil production, extraction, development and transport, access road construction, pipeline, utility and service line excavation and construction, associated oil production facility construction, etc. The BO contains conservation and mitigation measures that include pre-construction surveys, species and habitat monitoring requirements, post-construction conservation measures and assigns values to habitats impacted as a result of ground disturbance. All of these measures are intended to avoid and minimize potential effects to listed species and their habitat and to provide compensation for those effects that are unavoidable (i.e. habitat removal due to construction).

Habitat values are determined by the degree of disturbance that exists within each section of land. High or Red Zone has < 10 percent disturbance, Medium or Green Zone has 11 – 25 percent disturbance, and low or White Zone has > 25 percent disturbance. The Elk Hills HCP that is in draft form also sets habitat values for lands within the Elk Hills Unit as Low, Moderate and High Relative Value Lands. The majority of the lands that fall within the Elk Hills Unit boundaries (~47,000 acres) are considered moderate value (~74 percent), followed by high-value lands (~24 percent) with a very small area of low-value lands (2 percent). The base mitigation ratio is 3:1 (acquired land: impacted land). If the acquired land is of higher value than the affected land, the ratio could be lowered to 2:1.

Since ownership was transferred to OEHI in 1998, no direct or indirect take of any covered species has occurred as a result of project construction and/or operation. Additionally, as required in the BO and reiterated in the MOU, 7,075 acres were to be acquired as Habitat Management lands on or adjacent to the Elk Hills site. This acreage has been acquired by OEHI and is ready for placement in a conservation easement for management as species' habitat in perpetuity. The conservation easement for these lands is currently under review by CDFG. Once the conservation easement is approved, it will be recorded with Kern County, encumbering the surface title to the lands, thereby ensuring they are always maintained as Habitat Management Lands.

In anticipation of ongoing operation, OEHI has continued to acquire mitigation lands to offset future ground-disturbing activities within the Elk Hills Unit. OEHI has acquired significant additional acres that will be used as mitigation for future impacts. Activities associated with EOR are part of the ongoing activities covered by the BO and MOU and, thus, would be handled in accordance with requirements of those agreements. All preconstruction surveys, species monitoring, post-construction requirements and mitigation assignments on Habitat Management lands for ground disturbance will be included as part of the EOR activities proposed at the Elk Hills Unit.

7.3 Permits and Approvals

There are several other approvals which may be required for activities related to EOR in Elk Hills. The following sections contain brief summaries of each.

7.3.1 Clean Water Act Section 404 Permit

The U.S. Army Corps of Engineers (USACE) has jurisdiction over wetlands and waters of the U.S. Construction of access roads to new or existing oil wells, pipeline construction or associated EOR facilities is not likely to affect aquatic features under USACE jurisdiction. Efforts to avoid or minimize potential effects to these jurisdictional features will be made, but in the event avoidance is not feasible, OEHI will secure a Clean Water Act (CWA) Section 404 permit for fill of wetlands and waters of the U.S. from USACE.

7.3.2 CWA Section 401 Water Quality Certification and Waste Discharge Requirements

The State Water Resources Control Board (SWRCB) has jurisdiction over waters of the State of California and has been delegated authority for issuance of CWA Section 401 Water Quality Certifications from the EPA. That authority to issue 401 Water Quality Certifications has been delegated to the Regional Water Quality Control Board (RWQCB). Construction of access roads to new or existing oil wells, pipeline construction or associated EOR facilities could potentially affect aquatic features under RWQCB jurisdiction. Efforts to avoid or minimize potential effects to these jurisdictional features will be made, but in the event avoidance is not feasible, OEHI will secure a Section 401 Water Quality Certification (or waiver) from the RWQCB.

7.3.3 San Joaquin Valley Air Pollution Control District

The San Joaquin Valley Air Pollution Control District (SJVAPCD) implements several regulations that apply to both construction and operation of OEHI. Regulation VIII Fugitive Dust Rules apply to all construction activities. Standards for the control of visible emissions will be required during all construction and drilling phases of the OEHI EOR CO_2 Project. Portable Equipment Registration for certain portable emissions units would be required for well drilling, service or workover rigs, pumps, compressors, generators and field flares. Any new air emitting equipment that would be installed as part of the OEHI CO_2 EOR Project would be subject to SJVAPCD Regulation II

7.3.4 Groundwater and Water Quality

Well-drilling activities would need to comply with all requirements established by the RWQCB, including Title 27 California Code of Regulations (CCR), Section 20090(g), or Waiver Resolution No. R5-2008-0182. All downhole well operations would be conducted in a manner that protects groundwater in accordance with Title 14 CCR Division 2, Chapter 4, Subchapter 1. As previously mentioned, the OEHI CO_2 EOR Project is not located within an area identified as having shallow groundwater.

The SWRCB recently adopted a new Construction General Permit, Order 99-08-DWQ in July 2009. The General Construction Permit has requirements for preventing untreated runoff from entering waterways. The Construction General Permit requires monitoring of stormwater runoff and measures to prevent sedimentation, turbidity and pollution from impacting receiving waters. All excavation and construction activities would be required to comply with the Construction General Permit requirements which may require preparation of a SWPPP and ongoing project stormwater monitoring.

The SWRCB also has an Industrial General Permit, Order 97-03-DWQ. This statewide permit is applicable to only certain types of operations. The Statewide Industrial General Permit applies to current operations at Elk Hills Unit and will apply to the OEHI CO_2 EOR Project.

Stormwater is managed, not only at the statewide level, but also at the local level. Compliance with all local stormwater requirements would also be required.

The agencies listed in Table 7-1 below are expected to use this document in their decisionmaking process. Table 7-1 also lists permits and approvals that will be required to implement the OEHI CO_2 EOR Project, and a list of related environmental review and consultation requirements imposed by federal, state, or local laws, regulations, or policies.

TABLE 7-1 LISTING OF APPLICABLE AGENCIES

Agency	Permits/Approvals	Environmental Review/Consultation Requirements
Department of Conservation, Division of Oil, Gas and Geothermal Resources (DOGGR)	• Application for permits to drill	• Responsible agency • Consulted during process • Reviews Draft Environmental Impact Report (EIR)
San Joaquin Valley Air Pollution Control District (SJVAPCD)	• SJVAPCD Regulation VIII Fugitive Dust Rules • Mobile Equipment Permits (drill rigs, flares, etc.) • Stationary source permitting requirements for equipment requiring a permit to construct/operate	• Responsible agency • Consulted during process • Reviews Draft EIR
California Regional Water Quality Control Board (RWQCB)	Waste Discharge Requirements/ Waiver (if necessary), Section 401 Water Quality Certification (if necessary)	• Responsible agency • Consulted during process • Reviews Draft EIR
California Department of Fish and Game (CDFG)	CESA 2081(b) take permitting, Section 1600 Lake or Streambed Alteration Agreement(s) (SAA) for impacts to waterways or lakes (OEHI has a long-term SAA that expires in 2020).	• Responsible agency/Trustee agency • Reviews Draft EIR

Agency	Permits/Approvals	Environmental Review/Consultation Requirements
U.S. Fish and Wildlife Service (USFWS)	ESA Incidental Take Authorization (via approval of an HCP or individual Section 7 Consultation)	• Reviewing agency
U.S. Army Corps of Engineers (USACE)	Section 404 Clean Water Act permitting for impacts to wetlands or waters of the U.S.	• Reviewing agency • Permit issuance if access roads, facility or other construction activities impacted jurisdictional aquatic resources
State Water Resources Control Board	General Construction Permit, Order 99-08-DWQ General Industrial Permit	• Reviewing Agency • Permit issuance
Kern County	Building permits, grading permits (although well drilling is exempt from grading permits in Kern County, roadway and facility construction may require Kern County grading permits), National Pollutant Discharge Elimination System (NPDES)/County stormwater compliance and other ministerial type permits	• Reviewing agency • Consulted during process • Reviews Draft EIR
The Department of Toxic Substances Control (DTSC)	Issues Hazardous Waste Facility Permits required by Health and Safety Code, section 25200	• Reviewing Agency • Issues Hazardous Waste Permits

8 Alternatives

To implement the policy of reducing significant environmental impacts, CEQA requires that an EIR identify both feasible mitigation measures and feasible alternatives that could avoid or substantially lessen the OEHI CO_2 EOR Project's significant environmental effects (Pub Res C §§21002, 21002.1(a), 21100(b)(4), 21150). Additionally, an EIR must describe a reasonable range of alternatives to the proposed project, or to its location, that would feasibly attain most of the Project's basic objectives while reducing or avoiding any of its significant effects.

There are four threshold tests for suitable alternatives. Potential alternatives are reviewed to determine whether they:

- Can substantially reduce significant environmental impacts;
- Can attain most of the basic project objectives;
- Are potentially feasible; and
- Are reasonable and realistic.

Alternatives to the proposed project that did not satisfy all four criteria were excluded from analysis in accordance with CEQA Guidelines (14 CCR §15126.6(c)). Two Alternatives scenarios that will be carried forward for analysis are listed below – the mandatory No Project analysis and an analysis of alternate pipeline routes and Rights of Way (ROW). In addition, it is important to note that other viable alternatives may be identified later during the public scoping process and subsequently carried forward for analysis.

No Project Alternative

According to CEQA, an EIR's discussion of alternatives to the project must include a "No Project" alternative, along with an analysis of the impacts of that alternative. The purpose of a discussion of the No Project alternative is to allow a comparison of the environmental impacts of approving the proposed project with the effects of not approving it (14 CCR §15126.6(e)(1)). The No Project Alternative will consider the continued operation of the Elk Hills Unit under OEHI's current operational policies and plans for the foreseeable future.

Alternate Pipeline and ROW Routes to Facilitate Project

This alternative will analyze different pipeline routes and ROW access routes to project-related equipment such as the Satellite Gathering Stations or the Reinjection

Compression Facility. The intent of this analysis is to ascertain if alternate routes for pipelines or ROW can lessen potential ground disturbance impacts that would occur if the proposed project were implemented.

9 References

C&C Resources, 2000. Geologic database, http://www.ccreservoirs.com.

California Oil and Gas Fields, 1998, 1992, and 1982. California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR), Volumes I, II and III. 1,472 pp. EHOF information is on pp. 168 173.

Callaway, D.C., and E.W. Rennie Jr., 1991. San Joaquin Basin, California: In H.J. Gluskofer, D.D. Rice, and R.B. Taylor (eds.) Economic Geology, U.S.: The geology of North America: The Geological Society of North America Vol. P-2, p. 417 430.

DOE-NETL (Department of Energy-National Energy Technology Laboratory), 2008. Storing CO_2 with Enhanced Oil Recovery. DOE/NETL-402/1312/02 07 08. 55p.

DOGGR (California Division of Oil, Gas and Geothermal Resources), 2007. 2006 Annual Report of the State Oil & Gas Supervisor; Sacramento: California Department of Conservation, 270 p.

Fiore, P. E., D. D. Pollard, W. R. Currin and D. M. Miner, 2007. Mechanical and stratigraphic constraints on the evolution of faulting at Elk Hills, California, AAPG Bulletin, v. 91, no. 3, p. 321 341.

Foxall, W., and S.J. Friedmann, 2008. Frequently asked questions about carbon sequestration and earthquakes. Lawrence Livermore National Laboratory, Doc No. LLNL-BR-408445. 3 pp.

Hydrogen Energy California (HECA), 2009. Revised AFC Volume I, 08-AFC-8. Prepared for the California Energy Commission (CEC). August, 2009.

IPCC, 2005: Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H.C. de Coninick, M. Loos, and L.A. Meyer (eds)]. Cambridge University Press, Cambridge, UK and New York, NY, USA 442 pp.

MacAllister, D.J., 1989. Evaluation of CO_2 flood performance: North Coles Levee CO_2 Pilot, Kern County, California, SPE 15499, JPT, February 1989, pg 185.

Merchant, D., 2006. Geologic Storage Options for CO_2 Sequestration of Carbon Dioxide, Elk Hills Field, CO_2 Tertiary Evaluation. HEI Internal Report 56 pp.

McJannet, G.S., 1996. General overview of the Elk Hills Field: Proceedings SPE Western Regional Meeting, Anchorage Alaska, May SPE 35670, 10p.

Nicholson, G. E., 1990. Structural overview of Elk Hills in Kuespert, J. G. and S. A. Reid, Structure, Stratigraphy and Hydrocarbon Occurrences of the San Joaquin Basin, California, Pacific Section SEPM and AAPG, p. 133 140.

Reid, S.A., 1990. Trapping characteristics of upper Miocene turbidite deposits, Elk Hills Field, Kern County, California: In J.G. Kuespert, and S.A. Reid (eds.), Structure, stratigraphy and hydrocarbon occurrences of the San Joaquin Basin: California, Pacific Section, SEPM & AAPG Guidebook No. 65, p. 141 156.

Southern California Earthquake Data Center, Website, http://www.data.scec.org/

Terralog Technologies USA, Inc., 2008. Potential for Induced Seismicity From CO_2 Injection Operations at Elk Hills, HEI Internal Report. 30 pp.

U.S. Department of Energy, Website, http://www.fossil.energy.gov/programs/reserves/npr/index.html.

Zumberger, J. E., J. A. Russell and S. A Reid, 2005, Charging of Elk Hills reservoirs as determined by oil geochemistry, AAPG Bulletin, v. 89, no. 10, p. 1347 1371.

List of Acronyms

AC	alternating current
ACEC	Area of Critical Environmental Concern
AFFF	Aqueous Fire Fighting Foam
BBO	Billion Barrels of Oil
BBS	Behavioral Based Safety
BLM	Bureau of Land Management
BMP	Best Management Practices
BO	Biological Opinion
BOPD	Barrels of Oil Per Day
BWPD	Barrels of Water Per Day
CCF	Central Control Facility
CCR	California Code of Regulations
CCS	Carbon Capture and Sequestration
CDFG	California Department of Fish and Game
CEC	California Energy Commission
CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
CLEP	Coles Levee Ecological Preserve
CNLM	Center for Natural Lands Management
CO_2	Carbon Dioxide
COC	Communications Operations Center
CRP	CO_2 Recovery Plant
CS	Carbon Steel
CSA	Canadian Standards Association
CTB	Central Tank Battery
CWA	Clean Water Act
DC	Direct Current
De-C1	Demethanizer
DEPG	Dimethyl Ethers of Polyethylene Glycol
DOE	Department of Energy
DOGGR	California Division of Oil, Gas, and Geothermal Resources
EHOF	Elk Hills Oil Field
EIR	Environmental Impact Report
EOR	Enhanced Oil Recovery
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act

List of Acronyms *(continued)*

FEED	Front End Engineering Design
FM	Factory Mutual Research Corporation
GS	Geologic Sequestration
H2S	Hydrogen Sulfide
HCP	Habitat Conservation Plan
HECA	Hydrogen Energy California
HES	Health, Environment, and Safety
HES&S	Health, Environment, Safety and Security
HESMS	Health, Environment, and Safety Management System
HMI	Human Machine Interface
ICSS	Integrated Control and Safety System
IEEE	Institute of Electrical and Electronic Engineers
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
ISA	Instrument Society of America
Km	kilometer
kV	kilovolt
LORS	Laws, Ordinances, Regulations, and Standards
MCFD	Thousands of Cubic Feet Per Day
mD	millidarcy
MDB&M	Mount Diablo Baseline and Meridian
MER	Maximum Efficient Rate
MMSCFD	Millions of Standard Cubic Feet Per Day
MMV	Monitoring, Measurement, and Verification
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
Msl	mean sea level
MW	Megawatt
NETL	National Energy Technology Laboratory
NGL	Natural Gas Liquids
NPDES	National Pollutant Discharge Elimination System
NPR	National Petroleum Reserve
NRU	Nitrogen Rejection Unit
NWS	North West Stevens
OEHI	Occidental of Elk Hills, Inc.
O&G	Oil and Gas

List of Acronyms *(continued)*

OOG	Occidental Oil and Gas Corporation
PG&E	Pacific Gas and Electric
PPE	Personal Protective Equipment
PPM	Parts Per Million
PRM	Process Risk Management
PSIG	Pounds Per Square Inch Gauge
RCF	Reinjection Compression Facility
ROW	Rights of Way
RWQCB	Regional Water Quality Control Board
SAA	Streambed Alteration Agreement
SOZ	Shallow Oil Zone
SJVAPCD	San Joaquin Valley Air Pollution Control District
SWPPP	Stormwater Pollution and Prevention Plan
SWRCB	State Water Resources Control Board
TEG	Triethylene Glycol
UIC	Underground Injection Control
UL	Underwriter's Laboratories
UNEP	United Nations Environment Programme
USACE	United States Army Corps of Engineers
USDW	Underground Sources of Drinking Water
USFWS	United States Fish and Wildlife Service
VT	Vortex Tank
WAG	Water Alternating Gas
WMO	World Meteorological Organization

Glossary of Terms

Asphyxiant	Inducing or tending to induce asphyxia (the extreme condition caused by lack of oxygen and excess of carbon dioxide in the blood, produced by interference with respiration or insufficient oxygen in the air; suffocation). A substance, such as a toxic gas, or an event, such as drowning, that induces asphyxia.
Corrosivity	Corrosive wastes are acids or bases (pH less than or equal to 2, or greater than or equal to 12.5) that are capable of corroding metal containers, such as storage tanks, drums, and barrels.
CO_2 Facility	The central processing facility at Section 27S where purchased CO_2 is received and produced fluids and gases are received, processed, separated, distributed, compressed and distributed for re-injection. This unit consists of the CTB, RCF, CRP and all associated ancillary equipment.
Hazardous	A situation that poses a level of threat to life, health, property, or environment.
Ignitability	Ignitable wastes can create fires under certain conditions, are spontaneously combustible, or have a flash point less than 60 °C (140 °F). Examples include waste oils and used solvents.
Interfacial Tension	A property of the surface of a liquid that causes the surface portion of liquid to be attracted to another surface, such as that of another portion of liquid
Metallurgy	A domain of materials science that studies the physical and chemical behavior of metallic elements, their intermetallic compounds, and their mixtures, which are called alloys.
Miscible	The property of liquids to mix in all proportions, forming a homogeneous solution. In principle, the term applies also to other phases (solids and gases), but the main focus is usually on the solubility of one liquid in another.
Reactivity	Reactive wastes are unstable under "normal" conditions. They can cause explosions, toxic fumes, gases, or vapors when heated, compressed, or mixed with water.

Sequester	In the context of carbon dioxide, sequestration refers to the placement of the carbon dioxide molecules in a location where they are separated from the atmosphere of the planet, in this case in the subsurface in formations currently holding crude oil and hydrocarbon gas.
Supercritical	Refers to carbon dioxide that is in a fluid state while also being at or above both its critical temperature and pressure, yielding rather uncommon properties. Carbon dioxide usually behaves as a gas in air at STP or as a solid called dry ice when frozen. If the temperature and pressure are both increased from STP to be at or above the critical point for carbon dioxide, it can adopt properties midway between a gas and a liquid.
Toxicity	Toxic wastes are those containing concentrations of certain substances in excess of regulatory thresholds which are expected to cause injury or illness to human health or the environment.
Trapping	In the context of carbon dioxide, trapping refers to the physical, geophysical or geochemical retention of carbon dioxide molecules in the subsurface in formations currently holding crude oil and hydrocarbon gas.
Wellbore	Any hole drilled for the purpose of exploration for or extraction of natural resources such as water, gas or oil where a well may be produced and a resource is extracted for a protracted period of time.
Wellhead	A general term used to describe the component at the surface of an oil well that provides the structural and pressure containing interface for the drilling and production equipment.