INFORMATION SHEET

ORDER NO. R5-2006-_________
CHEVRON CORPORATION AND
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
CHEVRON BAKERSFIELD FORMER REFINERY
AND WAIT TANK YARD GROUNDWATER CLEANUP
KERN COUNTY

Chevron Corporation (the Discharger) owns the former Chevron Bakersfield Refinery and adjacent Wait Tank Yard in Oildale, in the northeastern portion of Bakersfield. The Refinery and Wait Tank Yard (the Site) were in operation from about 1912 to 1986, and manufactured or stored a variety of hydrocarbon products including crude oil, gasoline, diesel, stove oil, furnace oil, road asphalt, and jet fuel. These are the primary contaminants found at the Site, which originated from spills and leaks from pipelines, tanks, and process units during the facility's operational phase.

The Discharger decommissioned and dismantled the former Refinery and Wait Tank Yard between May 1990 and September 1991, removing the aboveground and belowground facilities. During decommissioning operations, approximately 11,000 tons of petroleum hydrocarbon impacted soil was removed from the Site.

The Discharger initiated subsurface investigations at the Site in 1984. In 1986, refinery product (separate phase hydrocarbons (SPH), or free product) was discovered in two water supply wells in the former Wait Tank Yard. Sampling of monitoring wells returned benzene, ethylbenzene, toluene and total xylenes (BTEX) results with select BTEX constituents present in groundwater at concentrations greater than 20 parts per million, or milligrams per liter (mg/L).

Additional subsurface investigations during 1990-1992 determined the presence of two SPH plumes, one at the center (west central source area) and one near the eastern edge of the former Wait Tank Yard near the former Refinery parcel (central source area). Soil investigations determined that from depths of 22 feet to 200 feet below ground surface (bgs), total petroleum hydrocarbon (TPH) concentrations in soil are as high as 1,500 milligrams per kilogram (mg/kg). Groundwater is present at depths of 200 to 260 feet bgs.

In 1996, site remediation using product recovery and vapor extraction technologies commenced in the west central and central source areas. Three soil vapor extraction (SVE) wells in the west central area and four SVE wells in the central area were initially installed, with some wells operating as dual-phase extraction wells for SPH removal. At that time, a treatment system was installed on the Site, which consists of a water/oil separator, water storage tank, air stripper, liquid phase carbon treatment vessels, and a large vapor extraction and thermal oxidizer system.

By late 2000, over 3.3 million pounds of petroleum hydrocarbons had been removed from the unsaturated zone by vapor extraction activities, and had resulted in a large decrease in soil vapor concentrations. Despite these activities, no significant attenuation of the dissolved phase groundwater plume had been demonstrated, with the flux of hydrocarbons exceeding the biodegradation capacity of the aquifer. Dissolved plume chemistry showed that dissolved oxygen (DO), nitrate, and sulfate were reduced and dissolved iron and manganese were elevated, suggesting intrinsic biodegradation was occurring. In addition, with the installation of an additional off-site well, the dissolved groundwater plume was shown to exist at least 600 feet west of the Site property boundary.

The Discharger proposed to install air sparge wells in late 2000, due to the apparent exceedance of the biodegradation capacity of the aquifer. The purpose of the sparge wells was to reduce the concentrations of dissolved constituents in the plume, to reduce the source areas (including residual hydrocarbon in the saturated zone), and to increase DO levels in the regional aquifer to promote the biodegradation of hydrocarbons. The first phase of an air sparge remedial system was a proposed air sparge "curtain" across the dissolved plume at the western Site boundary to address the migration of dissolved-phase hydrocarbons off-site.

A deep sparge well, with screens 100 and 150 feet below the water table, was installed and tested in late 2001 and early 2002. Test results showed sparging was effective at 100 feet below the water table but not at depths of 150 feet.

Long-term sparging at the test wells along the western Site boundary during 2002 suggested that the primary hydrocarbon removal mechanism in this area was through stripping from groundwater rather than through biodegradation. While oxygen conditions were determined suitable for biodegradation, it appeared that nutrient conditions were limiting bacterial growth within the saturated zone. Consequently, the Discharger has proposed that nutrient injections be considered part of the air sparging remedy.

The Discharger proposes to conduct nutrient injection in conjunction with air sparging (biosparging) and soil vapor extraction for remediation of petroleum hydrocarbons in groundwater to reduce the anticipated cleanup time of the aquifer. The proposed soil vapor extraction and biosparging remediation system is based on the results of literature research and review, groundwater modeling, extensive review of the groundwater geochemistry at the Site, and discussions with Board staff. The Discharger proposes to inject nitrogen and phosphorus to enhance biological degradation of petroleum hydrocarbons, as existing groundwater monitoring data suggest that nutrient conditions are limiting bacterial growth within the saturated zone. Nitrogen will be injected with sparge air in the form of ammonia, and phosphorus will be injected with sparge air in the form of triethyl phosphate (TEP).

Both ammonia and TEP are highly soluble, with solubility limits of 34 percent and 12 percent in water, respectively; therefore, the majority of injected nutrients will partition into groundwater. Bacterial uptake of nitrogen and phosphorous into cellular mass, and sorption and fixation with inorganic cations, will result in the reduction of nutrient concentrations in groundwater. For nutrient demand calculations, the "treatment area" was defined as that portion of the contaminant plume undergoing nutrient-enhanced sparging. This area includes the upper 100 feet of the aquifer, 600 feet wide (perpendicular to groundwater flow) and 200 feet long (parallel to flow), at the western Site boundary.

Nutrient dosage rates for biodegradation were calculated based on the mass on contaminants present in the treatment areas and the stoichiometric equations for biodegradation of the chemicals of concern. Nutrient dosage and demand will be balanced in an attempt to affect only a nominal increase in nitrate, ammonia, and phosphate concentrations in the aquifer.

Nitrogen and phosphate demand for bioremediation of non-strippable hydrocarbons will average approximately 4,900 pounds per year and 500 pounds per year, respectively. Inherent loss mechanisms in the aquifer will require higher dosages than those given above. The required ammonia and TEP concentrations in the biosparge airstream are calculated at 400 parts per million as vapor (ppmv) and 30 ppmv, respectively.

The Discharger has estimated a "delivery efficiency" for both ammonia and TEP. The delivery efficiency equals the mass of nutrient (nitrogen or phosphorous) used by the target heterotrophic bacteria (responsible for hydrocarbon degradation) divided by the total mass of nutrient injected. For nitrogen, a delivery efficiency of 50 percent was adopted. Nitrogen loss occurs through volatilization, immobilization (incorporation into cellular mass), and migration outside the treatment area. Dissolved nitrogen that may migrate from the treatment area will be beneficial to biodegradation of hydrocarbons in the off-site plume that extends downgradient of the treatment area. The Discharger expects that all of the bioavailable nitrogen will be "scavenged' by the bacterial population, such that any increase in the dissolved inorganic nitrogen concentration in the aquifer will be minor and transient.

The delivery efficiency for phosphorous injection is expected to be low, as the majority of injected phosphate is expected to form inorganic complexes with iron and manganese within the formation and precipitate out of solution. The assumed delivery efficiency for phosphorous was therefore set at 10 percent for modeling purposes.

In practice and as modeled, a significant portion of the injected nitrogen will be utilized for the biodegradation of hydrocarbons. If 50 percent of the nitrogen is used for biodegradation, the correlative nitrogen concentration would be 17.3 mg/l. The Discharger anticipates other loss mechanisms would further reduce residual nitrogen concentrations to much less than the 10 mg/l drinking water standard for nitrate (measured as nitrogen). In practice and as modeled, with inorganic losses of 50 percent and biologic uptake of 10 percent, the resultant dissolved phosphorous concentration in groundwater would be 6.9 mg/l.

Based on the calculations performed as part of remediation system design, the estimated cleanup time using biosparging for off-site groundwater plume cleanup is seven years. During that time, groundwater monitoring will be conducted to determine nutrient dosing rates and biological uptake and to minimize residual nutrient concentrations in groundwater downgradient of the treatment area. Based on the responsiveness of the indigenous hydrocarbon degrading bacteria, both nutrient form and dosing rates may be modified.

The Discharger will monitor eight downgradient wells (MW-18, MW-31, MW-35, MW-42, MW-44, MW-51A/B/C, MW-52, and MW-55AR/B), two upgradient wells (MW-16 and MW-29), and two wells in the treatment area (MW-21 and MW-34) as required in MRP No. _______. These wells are screened between about 250 and 300 feet bgs, except MW-44 (285-325 feet bgs), MW-51A/B/C (a triple completion well with screens between 280-399 feet bgs), MW-52 (330-350 feet bgs), and MW-55AR/B (two screens between 340 and 400 feet bgs). These wells will be sampled according to the schedule in attached MRP No. ________. Monitoring wells MW-44, MW-51A/B/C and MW-55AR/B, the furthest downgradient monitoring wells, will be the compliance wells at which groundwater concentrations must not exceed WQOs.

Monitoring will continue quarterly for ammonia, nitrate, nitrite, TKN, phosphate, and orthophosphate until these constituents are no longer present in the monitoring wells west of Manor Street at concentrations exceeding 80 percent of their respective WQOs (for four successive quarters). For monitoring wells east of Manor Street, monitoring will continue quarterly for ammonia, nitrate, nitrite, TKN, phosphate, and orthophosphate until these constituents are no longer present at concentrations exceeding their respective WQOs (for four successive quarters). Modifications to MRP No. _______ will be made at that time to continue process monitoring if any parameter does not return to pre-injection conditions.

The Discharger will submit a contingency workplan to investigate any byproducts of the nutrient injection process, or nutrient or hydrocarbon breakdown products, in the event these constituents exceed their respective WQOs at monitoring wells MW-44, MW-51A/B/C and MW-55AR/B. A workplan for remedial actions will be developed specifically for the nature and extent of the exceedance identified. These remedial actions could include groundwater extraction and treatment.

The permitted discharge is consistent with the anti-degradation provisions of 40 CFR 131.12 and State Water Resources Control Board Resolution No. 68-16. Some degradation of groundwater may occur from the injection of ammonia and TEP; however, the discharge will not cause an exceedance of water quality objectives or cause a significant impact on the beneficial uses of groundwater outside the treatment area. The continued remediation of polluted groundwater benefits the people of the state.

Issuance of this Order is an action to assure the restoration of the environment and is, therefore, exempt from the provisions of the California Environmental Quality Act (Public Resources Code, Section 21000, et seq.), in accordance with Section 15308 and 15330, Title 14, California Code of Regulations (CCR).

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