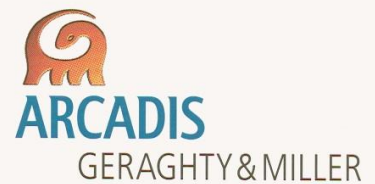


Remedial Action Plan

South Sprint Facility, Padre Island, Texas



27 May 1999

P R E P A R E D F O R

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ARCADIS GERAGHTY & MILLER

REMEDIAL ACTION PLAN
SOUTH SPRINT FACILITY, PADRE ISLAND, TEXAS
ENRON OIL & GAS

May 28, 1999

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Introduction

ARCADIS Geraghty & Miller, Inc. has prepared this Remedial Action Plan (RAP) to summarize existing groundwater data collected during the delineation activities at the South Sprint site (Preliminary Site Investigation, South Sprint Facility, May 1998) and to describe the scope of work to remediate the phase-separated hydrocarbon (PSH) affected groundwater and soil. The RAP provides the recommended plan for active remediation at the facility.

The scope of work will initially involve collecting water samples and confirmation soil sampling to delineate the extent of total petroleum hydrocarbon (TPH)-impacted soils at the site. Following the delineation phase of the project, soil that exceeds TPH cleanup levels will be treated using the following method:

- On-site Bioremediation. The soils will be bioremediated on-site within a lined and bermed area. The soils will be actively bioremediated under aerobic conditions using a combination of tilling, water additions, and nutrient additions.

Background

Enron Oil & Gas Company currently operates a natural gas production facility (South Sprint) on Padre Island, Texas (Figure 1). Soil and shallow groundwater at the South Sprint facility have been impacted by historic petroleum hydrocarbon releases. Groundwater pumping prior to Enron's purchase of the facility reduced the volume of PSH on the groundwater, however, the residual PSH is still present in some wells.

Following Enron's and the National Park Service's approval of the initial scope of work, dated November 11, 1997, a field investigation was conducted on Enron's property by ARCADIS Geraghty & Miller. The investigation was conducted to determine if hydrocarbon-affected groundwater was present, and if so, to what extent.

In November 1997, ARCADIS Geraghty & Miller Inc. conducted a field investigation and groundwater sampling event at the Enron Oil & Gas South Sprint facility on Padre Island, Texas. During the investigation, hydrocarbon concentrations in groundwater were above background levels on the southwest portion of the property. Total benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations in the groundwater ranged from below detection to a high of 0.92 milligrams per liter (mg/L) at monitor well P-16. TPH concentrations in the groundwater ranged from below detection to a high of 556 milligrams per liter at monitor well P-16.

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In August, 1998, Enron and ARCADIS Geraghty & Miller personnel met with Mr. Paul Eubank of the U. S. National Park Service (USNPS) to discuss current field conditions and the recommended plan for Enron to maintain environmental controls and remedial actions acceptable to the National Park Service. At the meeting, the USNPS indicated that the continued presence of hydrocarbon in the soils and groundwater was a concern and recommended that an aggressive more proactive approach was needed to enhance the degradation of hydrocarbons.

The continued presence of PSH in some wells indicates that fluctuations of the water table are periodically mobilizing residual hydrocarbons from the unsaturated zone to the groundwater. As discussed with the USNPS at the meeting, more aggressive remediation that focused on treating the soil above the water table should speed up the removal of PSH from the unsaturated soil. By degrading the hydrocarbon in this zone, the dominant source of PSH and dissolved BTEX on and in the shallow groundwater will be removed and natural biodegradation will proceed at a more rapid rate.

Based on the results of groundwater monitoring/sampling in May 1996 and January 1998 during the recent field investigation, the extent of shallow groundwater impacted with hydrocarbons has gradually decreased, as has the average concentration of dissolved hydrocarbons. Generally, the dissolved hydrocarbon in the groundwater appears to be naturally attenuating over time with a consequent decrease in the size of the plume. Near the source area, however, some PSH still occurs on the groundwater. It is believed that hydrocarbon residual in the shallow soils is being remobilized periodically when the groundwater levels fluctuate. In order to remove the continuing source, the most effective remedial action is to excavate and treat the impacted soils under controlled conditions to optimize degradation of the hydrocarbons.

In order to minimize ecological impacts, the soils containing significant concentrations of hydrocarbon will be excavated with light equipment and treated in a non-impacted area at the Enron site. Following treatment and verification, the remediated soils will be replaced in the excavation and contoured to original grade.

Remedial Action Plan

General

The primary goal of the remediation is to reduce hydrocarbon levels in the shallow soils to prevent migration to the groundwater. Additionally, the treatment goal is to reduce levels of TPH and BTEX to concentrations that will be protective of human health and the environment for the current land use. It is proposed to initially delineate

the hydrocarbon-affected soils at the South Sprint property using TPH concentrations. Delineation will entail using a 500 parts per million (ppm) TPH concentration as the baseline for delineation. Following delineation of the TPH-impacted soils, selected soil samples with high, moderate, and low TPH concentrations will be analyzed for BTEX to characterize the initial BTEX concentrations of the soils to be treated.

Based on soil analytical results, areas of affected soil at the South Sprint facility will be excavated for treatment (see Figure 2). A preliminary estimate of the area of affected soil is approximately 40,000 square feet, with from 2 to 3 feet depth, and an estimated volume of about 3,000 cubic yards. The final excavation will be determined as outlined in the methodology section.

Technical Approach

The use of on-site bioremediation is planned for remediation of the TPH-impacted soils at the South Sprint facility for the following reasons:

- The extent of TPH-impacted soil is generally localized at the South Sprint facility;
- The soils are generally silty sands that are amenable to natural degradation methods;
- Climatic conditions of warm temperatures, high sunshine, sea breeze, and moderate precipitation are conducive to bioremediation methods; and
- Naturally occurring hydrocarbon-degrading microbe populations are believed to be active in the soils based on testing prior to Enron's purchase of the site.

We believe that employing a controlled bioremediation system will maximize flexibility, minimize overall cost, and give assurance of meeting cleanup goals. The following phases of work are anticipated:

- The first phase of this project will be to collect fluid levels and water samples from three monitor wells and to conduct soil sampling to better delineate the areal and vertical extent of soils containing greater than 500 ppm TPH. This survey will be used to construct a map of the soils requiring treatment and to calculate the volume of soils requiring treatment.
- The next phase of this project will be to conduct the soil excavation/treatment. The impacted soils will be placed in a plastic-lined and bermed treatment cell.

The soils will then be actively bioremediated by a combination of periodic tilling and nutrient and moisture addition, as required to reduce the TPH levels to less than 500 ppm.

- The final phase of the project will involve intermediate and final verification soil sampling to monitor the treatment. Final soil sampling will involve collection of one composite soil sample for every 200 cubic yards of soil being treated. The soil samples will be analyzed at a commercial laboratory to confirm that the target cleanup concentrations have been achieved.

Initial Groundwater and Soil Sampling

The first phase of this project will be to conduct additional sampling of the groundwater and soils.

Fluid levels will be measured in the accessible monitor wells and piezometers on the site to verify the hydraulic gradient, depth to groundwater, and current thickness and general extent of PSH. Approximately nine existing wells will be purged and groundwater samples collected. Sampling will be conducted at three well locations in the vicinity of the production area and six wells in peripheral areas of the site to evaluate the current impact of hydrocarbons on the shallow groundwater (see Figure 3). Groundwater samples will be analyzed for TPH using U.S. Environmental Protection Agency (EPA) Method 418.1, and BTEX using EPA Method 8021 B.

The initial soil sampling for the RAP, estimated to be from approximately 10 to 12 locations on the property, will be conducted to determine the extent, both horizontal and vertical, of TPH concentrations in the soil.

The soil borings will be advanced using a stainless steel hand auger. Each soil boring will be advanced to a depth of approximately three feet below ground level, and soil samples will be collected continuously at intervals of 0-1 feet, 1-2 feet, and 2-3 feet. If the 2-3 feet sample at a location appears to contain greater than 500 ppm TPH based on visual and / or photoionization organic vapor detector (PID) measurements, additional samples will be collected up to a depth of six feet. Immediately following sample collection, each soil sample will be described using the Unified Soil Classification System and then placed in a glass jar and sealed. The glass jars will be labeled, and placed in a cooler with ice. The samples will be shipped with chain-of-custody forms to an independent laboratory for TPH analysis using EPA Method 418.1.

Prior to each use, all down hole sampling equipment will be cleaned using a laboratory-grade detergent wash, water rinse, and distilled water after final rinse to prevent cross-contamination. The purge and decontamination fluid will be placed into labeled containers and will be managed at the South Sprint facility in accordance with applicable local, state, and federal regulations.

Prior to the initial sampling, areas will be mapped and staked off in the field. During the soil sampling program, samples will be evaluated with a combination of evaluation methods including a PID, visual observations, and laboratory analysis of TPH using EPA Method 418.1. A PID will be utilized in the field during the soil sampling to allow rapid delineation of the TPH-impacted areas. Laboratory analysis will be conducted to verify the field screening data and to more precisely define the horizontal and vertical limits of the TPH concentration in soil in each of the areas of investigation.

Soil Excavation

Based on soil analytical results from a previous investigation and the proposed additional soil samples, the delineated TPH-affected soil will be excavated using a front-end loader or backhoe. The excavated soils will be placed into a lined and bermed soil treatment area on Enron property (see Figure 2). The soil treatment area will be constructed with a 10 mil high density polyethylene liner. The liner will be bermed to prevent precipitation run-on and run-off. All work will be completed by personnel health and safety trained as defined by 29 CFR 1919.120. A health and safety plan for the remedial activities will be submitted to Enron Oil & Gas Company in advance of conducting the RAP field work.

Soil Bioremediation

As mentioned earlier, soils containing greater than approximately 500 ppm TPH will be bioremediated on-site. Prior to transportation of soils to the remediation area, a berm will be constructed surrounding the areas. The berm construction will have a height-to-width ratio of one to three, with a minimum height of two feet above the surrounding grade. This berm will be constructed with fill material and will be maintained at a minimum height of one foot above the treated soil level.

The aerobic form of bioremediation will be employed on this project. This process will consist of spreading the impacted soils evenly, then adding nutrients and water to enhance the growth of hydrocarbon-degrading microorganisms. The soils will be mixed, thereby exposing a larger surface area to the atmosphere for aeration. Proper

Remediation
area

soil moisture levels will be maintained during treatment of the soil to prevent soil desiccation that could prevent bacteria growth and potentially kill hydrocarbon-degrading bacteria in the soil. Therefore, on an as-needed basis, water will be added to the soil to maintain soil moisture levels between 30 and 80 percent of the soil holding capacity.

The soil will be disk tilled using a tractor-pulled disk tilling implement or a large rototiller. The tilling method will allow a turnover depth of up to 18 inches in loose soil and will be conducted twice monthly during the first quarter, and monthly thereafter. The soils will be supplemented with water and nutrients on an as-needed basis. The amount of water to be added will be dependent on the amount of rainfall received at the site during the bioremediation process, which will be monitored by ARCADIS Geraghty & Miller. The nutrient levels to be applied will be based upon the average levels of TPH and the existing levels of nutrients in the soils. Phosphorous, nitrogen, and other nutrients will be applied as necessary in quantities that will maximize the growth of TPH-degrading microbial populations.

Depending upon the final volume of soil to be treated and the available space for constructing the treatment cell, more than one treatment cycle may be necessary. In this case, the soils for the second treatment cycle will be stockpiled and kept segregated from the soils remediated during the initial treatment cycle. After completion of the first cycle, the clean treated soils will be replaced in the original excavation prior to placing the second stockpile in the treatment cell.

Contingencies

During and following the excavations of hydrocarbon-impacted soils, groundwater may occur in the bottom of the excavation. If this occurs and a visible PSH layer is present, a temporary sump may be constructed and minor pumping from the sump used to control migration of the PSH. This fluid will be routed to the Enron produced water tank.

If significant rains occur, excess water within the treatment cell berm will be pumped to the Enron produced water tank for disposition or, if needed, used in the bioremediation process.

Schedule

Following approval of the plan by the USNPS, the project can be initiated within approximately three weeks. Project initiation activities will include preparing a health

and safety plan, obtaining field soil screening equipment, coordination with an analytical laboratory, and scheduling of soil remediation equipment. A more precise schedule will be prepared following delineation of impacted soil, when the volume of soil to be bioremediated and the number of remediation cycles is determined.

Closure and Monitoring

Introduction

Groundwater pumping prior to Enron's purchase of the facility reduced the volume of PSH on the groundwater, however residual PSH is still present in some wells. Groundwater monitoring at the site indicates that natural degradation of the dissolved hydrocarbon constituents is occurring and the areal extent of the dissolved plume is decreasing. The proposed monitoring plan for both soil remediation and continuing groundwater monitoring is presented below.

During the soil remediation program, the treatment will be monitored by sampling soil in the treatment cell and groundwater will be monitored at designated key wells. It is proposed that three wells in the vicinity of the most impacted area of the site and approximately six wells in peripheral areas of the site be selected as key wells. These wells will be sampled during quarterly groundwater monitoring events to monitor the progress of the soil treatment affect on the groundwater as well as natural degradation of the dissolved hydrocarbons in the shallow groundwater system.

Based on the decline in concentrations of BTEX in the shallow groundwater over the past two years, it is anticipated that remediation of residual hydrocarbons in the soil and the consequent increase in hydrocarbon degrading microbe populations will also significantly enhance cleanup of the groundwater. It is proposed in this RAP that closure of the active soil remediation will occur when the verification samples of the treated soil contain at or below the concentrations listed below for BTEX. The groundwater monitoring program will be closed when samples from the key wells contain concentrations at or below the concentrations listed below for BTEX for two consecutive sampling events. After soil remediation, the concentrations of BTEX constituents in the groundwater are anticipated to decline at an increased rate following the removal of the residual source. The concentrations below are believed to be conservative and below any level that would have a negative impact on the local environment. The facility location is not generally accessible to the public, impacted groundwater is not migrating from the site vicinity, and there is no apparent potential for potable groundwater development in the future. Therefore the proposed cleanup

concentrations for BTEX in groundwater are believed to be reasonable and protective of the local environment.

<u>Constituent</u>	<u>Soil Limit</u>	<u>Groundwater Limit</u>
Benzene	0.5 mg/kg	0.050 mg/L
Toluene	100 mg/Kg	10 mg/L
Ethylbenzene	70 mg/Kg	7 mg/L
Xylenes	300 mg/Kg	30 mg/L

Soil Remediation Monitoring

It is anticipated that the active soil remediation project be continued for approximately three months per treatment cell. One month after startup of treatment and each month thereafter, three intermediate composite samples will be collected from random locations in the treated soil area. The samples will be analyzed for TPH using EPA method 418.1. If the samples contain less than 500 ppm TPH, they also will be analyzed for BTEX. When the intermediate composite sample results indicate the treated soils are below the cleanup goal, final verification samples will be collected and analyzed. If the verification sample analyses are below the cleanup limits, the clean treated soil will be moved from the treatment area and placed back in the general area from which it was excavated.

Groundwater Monitoring

The proposed groundwater monitoring program includes periodic fluid level measurements at all accessible wells and piezometers, and groundwater sample collection at pre-designated key wells. Groundwater samples will be collected from the key wells that do not contain PSH. The initial groundwater event will occur prior to startup of the soil treatment project to determine baseline conditions. Subsequent groundwater monitoring events will follow on a quarterly basis until groundwater samples from the designated key wells contain concentrations less than or equal to the target concentrations for BTEX and the soils are remediated.

Fluid levels will be measured at each monitoring event prior to purging and sampling. Wells that are accessible and have overall integrity will be measured. The depth-to-water and depth-to-PSH (if present) will be measured to determine the groundwater elevation at each well. These data will be tabulated and a groundwater contour map prepared after each event.

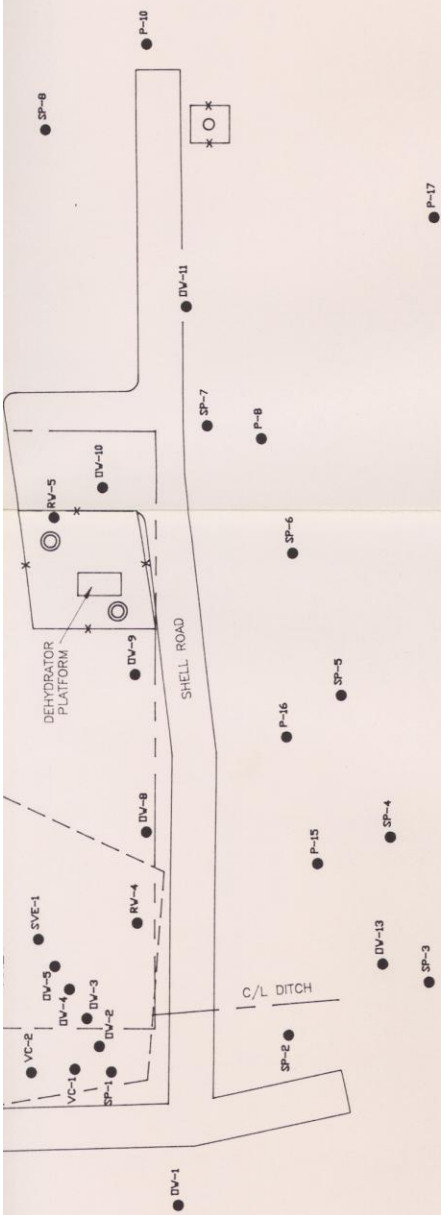
Water samples from the key site monitoring wells will be collected by ARCADIS Geraghty & Miller personnel using either a stainless steel, teflon, or disposable polyethylene bailers. Groundwater samples from the wells will be analyzed for TPH using EPA Method 418.1 and BTEX analysis using EPA Method 8021B.

Reporting

After groundwater level and sample results have been compiled, summary event reports will be submitted to Enron for review and consequent submittal by Enron to the USNPS. In addition, periodic reports detailing the progress of the soil remediation process will be prepared after the initial treatment cell soils have reached the target levels of TPH and BTEX. These reports will summarize the results of any intermediate and verification sampling and a description of the soil tilling and any additions of water or nutrients during the treatment period. It is planned to submit a combined groundwater monitoring and remediation status report to the USNPS on a quarterly basis.

FIGURES





LEGEND

- OW-1 OBSERVATION WELL
- RW-1 RECOVERY WELL
- SVE-1 SOIL VAPOR EXTRACTION WELL
- P-1 PIEZOMETER WELL
- SP-1 AIR SPARGE WELL
- VC-1 VERTICAL CONTAMINATION WELL



0 40'



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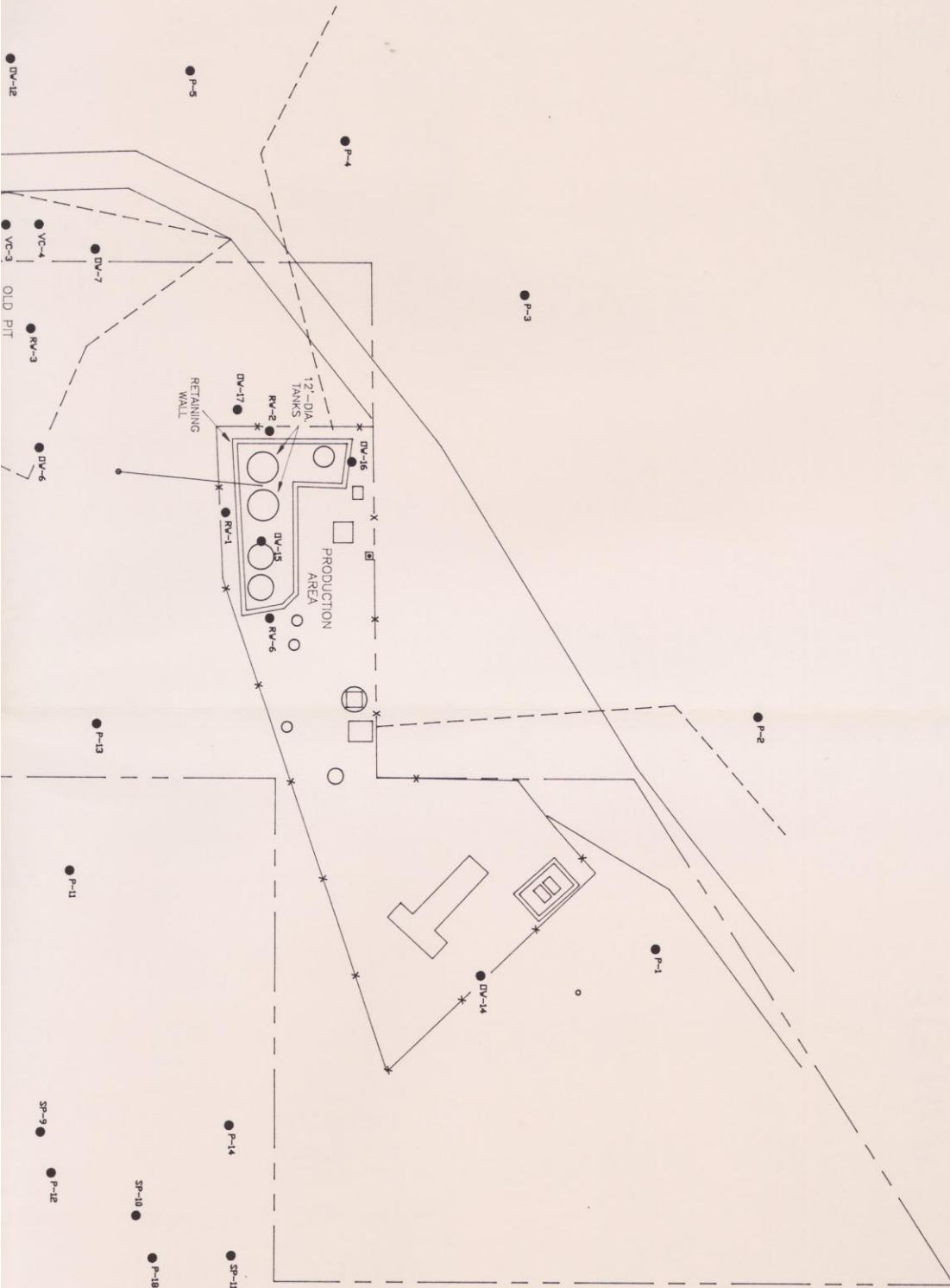
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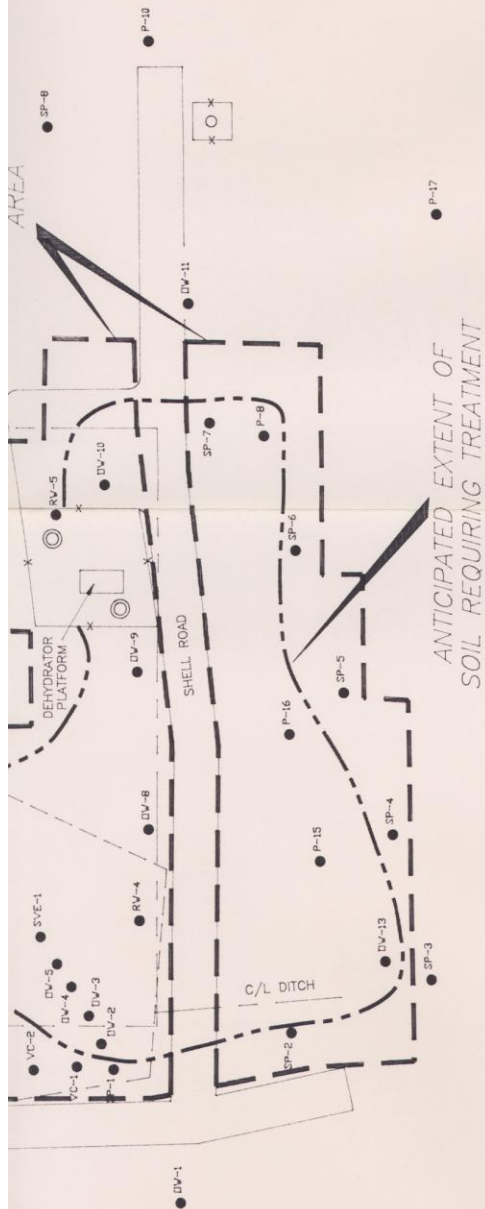
SITE MAP

ENRON OIL & GAS - SOUTH SPRINT FACILITY
PADRE ISLAND - KLEBERG COUNTY, TEXAS

FIGURE

1





LEGEND

- OW-1 OBSERVATION WELL
- RW-1 RECOVERY WELL
- SVE-1 SOIL VAPOR EXTRACTION WELL
- P-1 PIEZOMETER WELL
- SP-1 AIR SPARGE WELL
- VC-1 VERTICAL CONTAMINATION WELL

FIGURE
2

PROPOSED BIOREMEDIATION AREA

ENRON OIL & GAS — SOUTH SPRINT FACILITY
PADRE ISLAND — KLEBERG COUNTY, TEXAS

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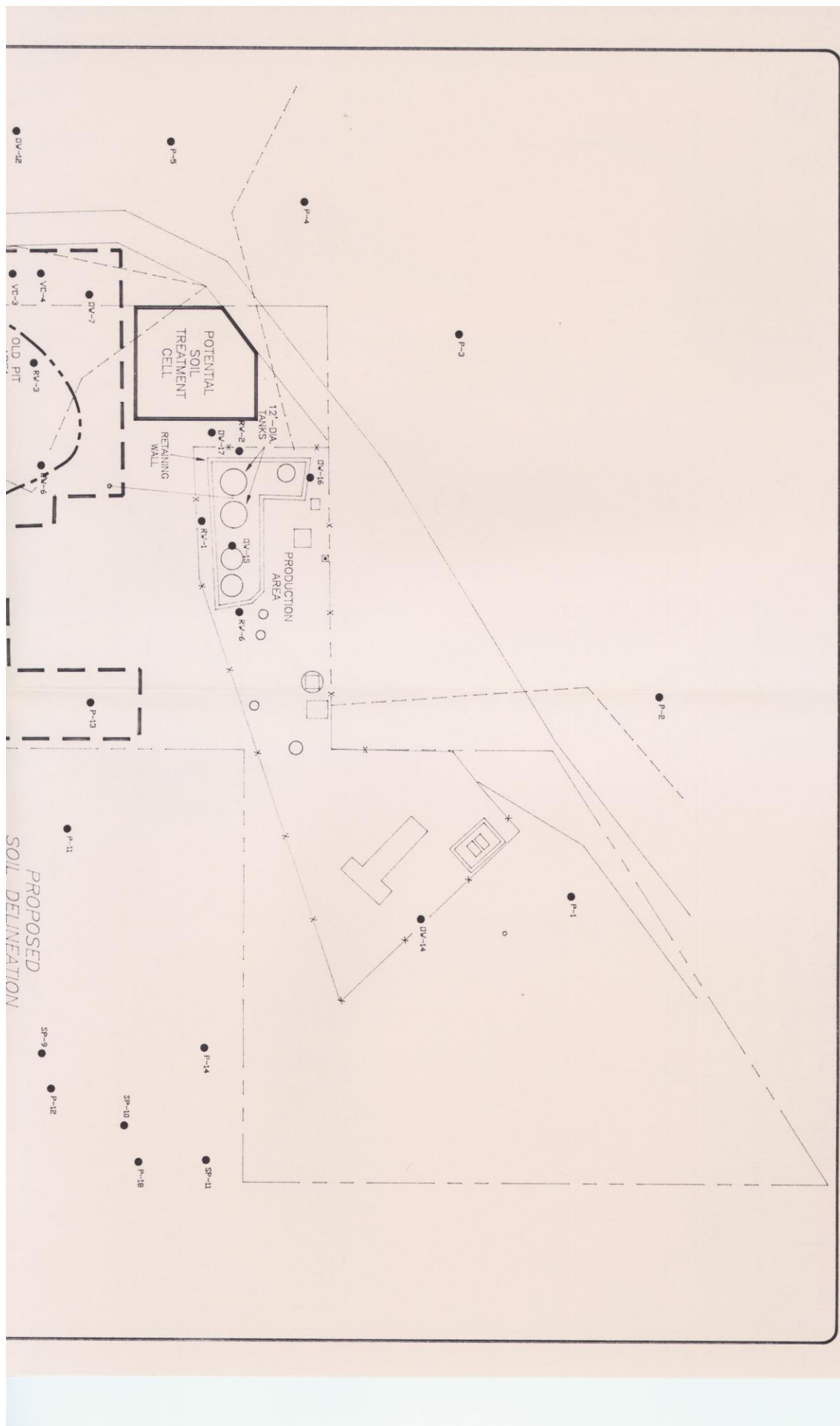
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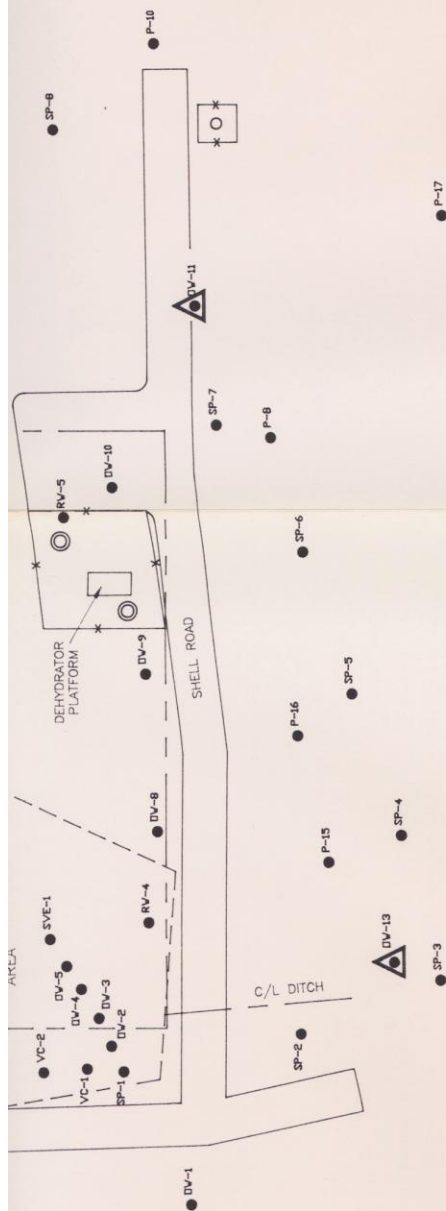
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LEGEND

- OW-1 OBSERVATION WELL
- RW-1 RECOVERY WELL
- SVE-1 SOIL VAPOR EXTRACTION WELL
- P-1 PIEZOMETER WELL
- SP-1 AIR SPARGE WELL
- VC-1 VERTICAL CONTAMINATION WELL
- GROUNDWATER QUALITY MONITORING LOCATION



0 40'

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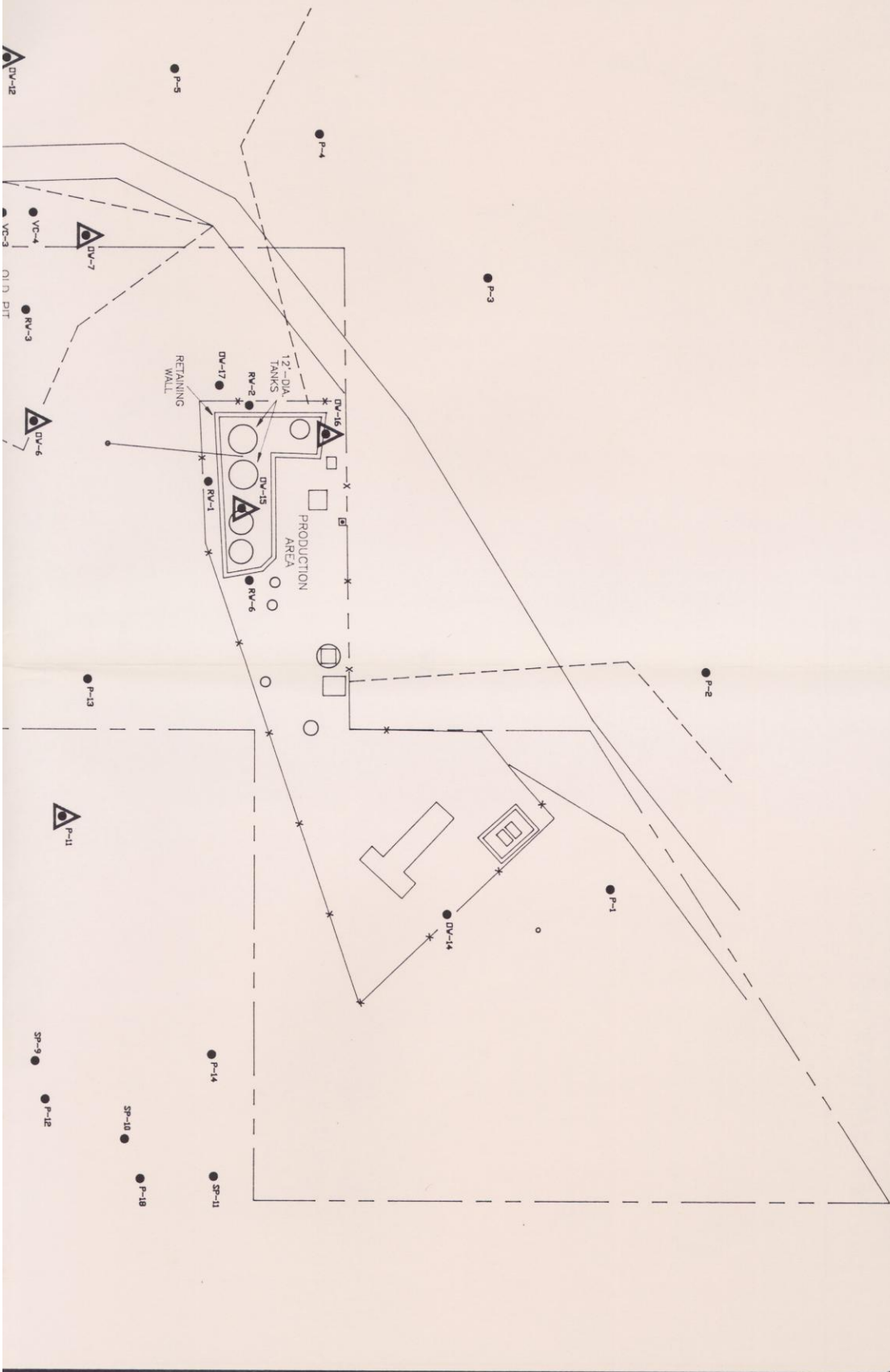
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APPROVED BY:	R. REINA	DATE:	

PROPOSED GROUNDWATER QUALITY MONITORING LOCATIONS

ENRON OIL & GAS - SOUTH SPRINT FACILITY
PADRE ISLAND - KLEBERG COUNTY, TEXAS

FIGURE
3



Texas Cleanup Guidelines

Compound	USNPS		TRRS-II				TNRCC-PST GW Targets	
	GW mg/L	Soil mg/Kg	GW-Res. mg/L	GWP-Res. mg/Kg	SAI-Res. mg/Kg	SAI-Ind. mg/Kg	I & D mg/L	Time ave. mg/L
Benzene	0.005	0.5	0.005	0.5	0.86	1.5	3.42	20.1
Toluene	1	3	1	100	1700	2400	9.76	48.8
Ethylbenzene	0.7	5	0.7	70	4300	6900	4.55	21.7
Xylenes	10	5	10	1000	2600	3600	25.4	127
Napthalene	na	5	0.73	73	180	270	1.92	8.35

Notes:

TRRS-II = Texas Risk Reduction Standard II cleanup levels
TNRCC-PST = Petroleum Storage Tank Groundwater Target Concentrations for Construction Worker Exposure
GW-Res. = Groundwater Residential Standard (water)
GWP-Res. = Groundwater Protection Residential Standard (soil)
SAI-Res. = Soil/Air and Ingestion Residential Standard (soil)
SAI-Ind. = Soil/Air and Ingestion Industrial Standard (soil)
I and D = Combined Inhalation and Dermal (water)
Time Ave. = Target Concentration based on time averaging (water)
mg/L = milligrams per liter
mg/Kg = milligrams per kilogram

