Most Feasible Plan for Evaluation/Remediation

Vermilion Parish School Board (VPSB) Property
Section 16 T15S, R01E
East White Lake Oilfield
Vermilion Parish, Louisiana
State of Louisiana and the Vermilion Parish School Board v. Louisiana Land and Exploration, et al.
Docket No. 82,162, Division "D"
15th Judicial District Court, Parish of Vermilion (the "VPSB Litigation")

MP&A Project No. 07-47

Prepared for:

Louisiana Department of Natural Resources
Office of Conservation

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Executive Summary

This Most Feasible Plan for Evaluation/Remediation (Most Feasible Plan) is submitted pursuant to LA R.S. § 30:29 to evaluate and/or remediate "environmental damage", as defined in Section 29, related to past oilfield operations on Section 16 property within the East White Lake Oilfield (FC 9667) in Vermilion Parish, Louisiana. This Most Feasible Plan is prepared and submitted on behalf of the Union Oil Company of California (UNOCAL). UNOCAL (Operator ID U011) and others conducted oil and gas exploration and production (E&P) activities on the property for approximately 55 years with initial development of the field in approximately 1940. The property continues in active E&P operation today by the Peak Operating Co. (Operator ID P231).

The property is comprised of approximately 1,200 acres and is only accessible by water/boat. The property was developed by construction of canals and use of barge-mounted rigs. The property is surrounded by water that varies from fresh to brackish over time.

The Vermilion Parish School Board filed suit against UNOCAL and others claiming environmental damage on the property from E&P operations. A three-week jury trial was held in Abbeville, Louisiana in April/May 2015. Prior to trial, UNOCAL admitted that, pursuant to La. R.S. 30:29, it was a responsible party for "environmental damage", as defined in La. R.S. 30:29, on the property. The Jury awarded monetary damage consistent with the remediation proposal put forth by UNOCAL at trial and consistent with the Most Feasible Plan MP&A includes in this submission. The Jury rejected Plaintiffs' massive and complex multi-million dollar remediation proposal of sediment dredging, soil excavation, grout floor, grout walls, and groundwater pump and treat.

The plan put forth at trial by UNOCAL was based on the use of Statewide Order 29-B and the Louisiana Department of Environmental Quality (LDEQ) Risk Evaluation/Corrective Action Program (RECAP), supported by extensive data and study of soils, sediments, groundwater, surface water, crabs, and fish. The results of UNOCAL's crab study were consistent with the findings of an independent/separate Louisiana Department of Health and Hospitals (LDHH) crab study.

This Most Feasible Plan is for additional evaluation (e.g., further sediment and groundwater assessment) and remediation of the property. The existing data for the property are sufficient to assemble a plan with associated costs and schedule for remediation; the additional evaluation will serve to further refine the remediation plan. This Most Feasible Plan also incorporates current conditions, including UNOCAL's

remediation of the property (in cooperation with the current operator Peak), consisting of flowline removal, deck and piling removal, compressor removal, tankage removal, debris removal, and pit re-closure.

Pursuant to the requirements of Title 43, Part XIX (Order 29-B) Chapter 6 – 611.F, MP&A has prepared two plans:

1. This Most Feasible Plan that uses RECAP and other applicable standards, protocols, and procedures, as supported by site specific testing and aquatic species testing, to construct a plan to remediate constituents and environmental media at the site that exceed risk-based or aesthetic standards, and

2. A plan that complies with Statewide Order 29-B exclusive of Section 319 (e.g., without exceptions) [see Appendix D].

This Most Feasible Plan that utilizes the Louisiana RECAP standards, protocols, and procedures is the only feasible and reasonable plan for this site given its unique setting in an ecologically sensitive water/marsh environment.

Site Setting

The property is located in Vermilion Parish, Louisiana and consists of Section 16 of Township 15 South, Range 01 East. The property measures approximately 5,367 feet east to west and 9,718 feet north to south. The property is situated within the East White Lake Oil and Gas Field approximately 0.5 miles east of White Lake.

The property is located within a normally inundated natural marsh environment with a natural land surface elevation ranging from below to slightly above mean sea level (MSL). The land adjacent to constructed canals is elevated to as high as four feet above MSL as a consequence of historic placement of dredge spoils from construction of the canals. Access to the property is only achieved by boat via the Schooner Bayou Canal and/or oilfield canals.

The entire property lies within the 100-year flood plain and the entire area has been inundated by historical hurricane storm surges. The effect and duration of the seawater storm surges on surface water salinity is documented in the Corps of Engineers salinity monitoring station data recordings. It can take several or more years to flush the saltwater out of Schooner Bayou and the property following a hurricane storm surge.

The property has historically been mapped as a freshwater marsh but the most recent mapping indicates that most of the property has transitioned to an intermediate marsh. The potential for flooding, along with extremely-limited property access, restricts the reasonably anticipated future development of the property.

Geology and Groundwater

The surface geology of the area is described as Chenier Plains and Marsh. The region and the property are underlain by thick multi-layered sequences of unconsolidated sediments that alternate between clay, silt, sand, and gravel (in deeper layers). The soils and sediments on the property are continually submerged under the natural fresh to brackish surface waters on the property and in the region. As such, the water within the soils and sediments (referred to as porewater) will mirror the natural surface waters in salt composition, i.e., soluble chlorides ranging from less than 15 mg/L to over 5,000 mg/L.

Vertical movement (i.e., leakage) of the natural surface water and porewater into the uppermost shallow sand aquifer has been documented in the region by the USGS. U.S. Army Corps of Engineers' dredging of Schooner Bayou removed a portion of the clay within the upper confining unit overlying the shallow sand layers and amplified surface water communication with the underlying shallow sand layers.

The natural movement of surface water into the uppermost shallow sand aquifer in the area has caused chloride concentrations in the uppermost aquifer to increase and to exceed the US EPA Secondary Drinking Water Standards for chlorides and total dissolved solids (TDS). The natural increase of chlorides and other dissolved solids in the uppermost shallow sand aquifer has occurred and would have occurred regardless of oil and gas production in the region.

Oil and Gas Exploration and Production

UNOCAL or its predecessor companies began operations on the property in approximately 1940 with the successful completion of Vermilion Parish School Board B Well Number 1 (Serial Number 24764). A total of approximately 85 wells have been drilled on the property since UNOCAL first conducted E&P activities. In April of 1995, Resource Acquisitions Corporation (Resource Acquisitions) acquired UNOCAL's interest in the property. Resource Acquisitions operated on the property from 1995 until 2003, when it changed its name to Peak Operating Company (Peak). Peak is continuing to actively expand operations in the field and has drilled new wells as recently as 2015.

Existing Soil and Sediment Quality

Extensive testing of soil and sediment on the property, via the collection of approximately 430 samples from approximately 130 locations, has been performed. Exceedances of Statewide Order 29-B at a limited number of isolated areas on the property were documented. RECAP Management Option 3 (MO-3) standards for soil/sediment were exceeded in two locations: 1) a former pit near the former Tank Battery B and 2) in the middle of the current operations area (Tank Battery A).

Existing Surface Water Quality

Surface water samples were collected from approximately 24 locations in and around the property. Results of this testing document that surface water has not been impacted by oil and gas operations.

Existing Groundwater Quality

A total of about 40 groundwater monitoring wells and/or hydropunch locations have been installed and sampled on the property. These are completed within a RECAP Class 3, low-quality, low-yield peat zone (eight wells screened at depths of ten to 20 feet below ground surface (bgs)), a RECAP Class 2, naturally salty shallow sand zone (18 wells/samples at depths of 40 to 50 feet bgs), and a deeper RECAP Class 2, naturally salty sand zone (14 wells/samples at depths from 70 to 100 bgs). In addition, two existing wells (one abandoned) screened in the naturally salty shallow zone and two existing wells screened at depths of around 500 feet bgs in the Upper Sand Unit of the Chicot Aquifer, the only freshwater aquifer underlying the property, have been sampled.

Isolated pockets of groundwater have been impacted by benzene, barium, chloride and radium in the shallow sand zone (40 to 50 feet bgs). The deeper sand zone and the usable groundwater in the Upper Sand of the Chicot Aquifer are not impacted by these constituents.

Most Feasible Remediation Plan

This Most Feasible Plan has been developed to address environmental impacts on the property and is based upon the results of the investigation activities performed from 2006 through 2015, evaluation of the results of these investigations, a RECAP assessment by ERM, and the past, current and reasonably anticipated future land use for the property. In summary, the Most Feasible Plan proposes to:

- Reclose the former Tank Battery B pit area. This pit contains residuals with hydrocarbons exceeding Statewide Order 29-B and RECAP standards. This re-closure can be performed at an approximate cost of $600,000. The Coastal Use Permit Application has already been submitted for this work. Upon receipt of final permit approval from LDNR's Office of Coastal Management, MP&A proposes to excavate the Former Tank Batter B pit contents, dispose offsite at a commercial disposal facility, and backfill the location with appropriate backfill material.

- Install three additional monitoring wells (approximate depths of 60 feet) to complete assessment of benzene detected in the shallow groundwater and conduct three years of quarterly groundwater monitoring and reporting to demonstrate that groundwater conditions are continuing to improve and stabilize over different seasons (approximately $300,000). The Coastal Use Permit Application has already been submitted for this work.

- If ultimately deemed necessary by LDNR, install and operate a groundwater pump and disposal system to address benzene in the shallow groundwater zone (approximate well depths of 60 feet) which will include the conversion of an existing Salt Water Disposal Well (SWD) or drilling a new SWD, if required, and installing the necessary piping and tankage. This groundwater pump and disposal system is estimated to cost up to $1,700,000 to $2,200,000, as discussed in Section 6.0. The Coastal Use Permit Application for the installation of the pumping well and observation well for the pumping test has already been submitted.

Implementation of the groundwater recovery plan is intended to reduce benzene concentrations to RECAP GW2 standards; but it is not intended to render this 40-60 foot deep groundwater potable because of its naturally poor quality (i.e. naturally elevated salinity, metals, and sulfate).

Total Estimated Costs

Estimated costs to implement the proposed Most Feasible Plan ranges from approximately $900,000 to $3,100,000, depending on the necessity for active groundwater pumping and disposal.

Schedule and Reporting

Closure of the former Tank Battery B pit area is estimated to take approximately one to three months following receipt of the final Coastal Use Permit. Each quarterly groundwater monitoring event will take approximately one week and the monitoring will be conducted over a three year time period. The pilot testing, design and implementation of the active groundwater remediation is estimated to take approximately three years.

This Most Feasible Plan has been prepared to comply with Louisiana Administrative Code (LAC) Title 43: Part XIX. Chapter 6 – Procedures for Hearings and the Submission and Approval of Plans for the Remediation E&P Sites in Accordance with R.S. 30:29. Table ES-1 presents a summary of the requirements of this Chapter and identifies the corresponding section of the report where the conforming information can be found.

Table ES-1
Most Feasible Plan Compliance Cross-Reference

LAC 43:XIX.§609 and §611 Requirements for Plans for Remediation	***Portion of this Plan presenting required information***
§609.A Plan filed in a timely manner with copies delivered to each party	Cover Letter and Plan – filed before October 1, 2015 deadline
§609.A Plan outlines the purpose thereof	Section 1.0
§609.A.1 Statement that a reasonable effort has been made to obtain a complete list of parties	Section 1.0
§609.A.2 Statement that Commissioner's Conference has or has not been held, with a list of parties in attendance	Section 1.0
§609.A.3. Plat including technical data labeled	Figures 31-59
§609.A.4. A statement that the plan is to evaluate or remediate the environmental damage in accordance with the requirements of the applicable rules and regulations of the Office of Conservation or, if the plan seeks to apply rules and regulations of another Louisiana state agency/a citation to the specific rules and regulations of that state agency.	Section 1.0
§611.B. Sampling and testing shall be performed in accordance with Statewide Order 29-B.	Sections 4.0, 5.0 and 6.0
§611.B. Each plan shall fully delineate the vertical and horizontal extent of the environmental damage.	Sections 4.0, 5.0 and 6.0
§611.C. All Statewide Order 29-B sampling shall be in accordance with applicable guidelines as provided in the latest revision of the Department of Natural Resources laboratory procedures manual titled "Laboratory Procedures for Analysis of Exploration and Production Waste"	Sections 4.0, 5.0 and 6.0 Appendix E
§611.C. Shall contain a plat showing the physical location from which such samples were obtained.	Figures 31-38

Table ES-1
Most Feasible Plan Compliance Cross-Reference

LAC 43:XIX.§609 and §611 Requirements for Plans for Remediation	***Portion of this Plan presenting required information***
§611.C.1. In addition, information as to the identity of the person or company taking the samples, a copy of the certification of such person or company taking such samples (if applicable), and documentation showing the method of sampling, the chain of custody and all other such relevant information shall be included.	Sections 1.2, 4.0, and 5.0 and Appendix E
§611.D. All Statewide Order 29-B sample analyses shall be in accordance with applicable regulatory requirements and the latest revision of the Department of Natural Resources laboratory procedures manual titled "Laboratory Procedures for Analysis of Exploration and Production Waste" and shall be performed by a DEQ LELAP accredited laboratory holding current accreditation for each parameter and corresponding test method used.	Sections 4.0 and 5.0 Appendix E
§609.D.1. All Statewide Order 29-B test results shall also contain a report certified by the testing laboratory including, at a minimum, a description of the testing process or methodology, by whom such testing was conducted, a copy of the laboratory's accreditation to conduct the described test, and all applicable required quality assurance/quality control data.	Appendix E
§611.E. Each plan shall contain a separate section analyzing the sampling and testing as set forth in C and D above by comparison with the applicable Statewide Order 29-B criteria.	Sections 4.0 and 5.0 Tables 3-5
§611.F. Plan shall comply with the standards set forth in Statewide Order 29-B.	Sections 4.0, 5.0, and 6.0
§611.F For exceptions to Statewide Order 29-B • sufficient proof of cause to grant such exception • Sufficient proof that exception(s) do not endanger USDWs • Specific citation for standard in lieu of Order 29-B	Sections 2.0, 3.0, and 4.0
§611.G.1. All plans shall also contain a chronological work schedule or proposal for a chronological work schedule detailing all activities necessary for its implementation.	Section 7.0

Table ES-1
Most Feasible Plan Compliance Cross-Reference

LAC 43:XIX.§609 and §611 Requirements for Plans for Remediation	***Portion of this Plan presenting required information***
§611.G.2 All plans shall also contain a comprehensive itemized cost basis for each item listed in Paragraph G.1.	Sections 5.0 and 6.0 Tables 7-9 Appendix C
§611.G.3. A certification of review and approval by signature from an attorney licensed to practice law in Louisiana, or an attorney from another jurisdiction who has been authorized to appear before the commissioner, worded as follows: "I, _____ have reviewed the information submitted herewith and hereby attest that to the best of my knowledge, information and belief it is true and correct and is based on scientific data that has been obtained in a manner compliant with all applicable regulations."	Attorney transmittal letter for this plan

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1.0 Introduction

This Most Feasible Plan for Evaluation/Remediation (Most Feasible Plan) is submitted to the Louisiana Department of Natural Resources (LDNR) Office of Conservation for the Vermillion Parish School Board (VPSB) Section 16 property in Vermilion Parish, Louisiana. The VPSB and the State of Louisiana have sued Louisiana Land & Exploration (LLE) and UNOCAL, et al. alleging "environmental damage" as a result of historical oil and gas Exploration and Production (E&P) operations conducted on an approximate 1,200 acre parcel.

Numerous, extensive environmental investigations have been performed at the site from 2006 through 2015 by consultants working on behalf of Union Oil Company of California (UNOCAL), as well as by the plaintiffs' expert, Mr. Greg Miller of ICON Environmental Services, Inc. (ICON). This Most Feasible Plan presents the details of these investigations. In addition, this Most Feasible Plan has been prepared and submitted to present the details of remediation activities to be undertaken by UNOCAL to address the "environmental damage" caused by "contamination" as defined by LDNR and La. R.S. 30:29, arising from the release in accordance with applicable rules and regulations of the Office of Conservation, i.e. Statewide Order 29-B. The Most Feasible Plan has been prepared to comply with Louisiana Administrative Code (LAC) Title 43: Part XIX. Chapter 6 – Procedures for Hearings and the Submission and Approval of Plans for the Remediation E&P Sites in Accordance with R.S. 30:29.

A comprehensive Risk Evaluation/Corrective Action Program (RECAP) Site Investigation Report that presents an evaluation of the voluminous soil, sediment, surface water, groundwater, and crab and fish tissue data collected by both plaintiff and defendant experts has been prepared by Ms. Angela Levert of Environmental Resources Management, Inc. (ERM) and is provided in Appendix F. The results of this RECAP assessment have been utilized in the formulation of this Most Feasible Plan.

A reasonable effort has been made to obtain a complete list of parties germane to this Most Feasible Plan. This list includes:

- Louisiana Land & Exploration Company;
- Peak Operating Company;
- UNOCAL;
- The State of Louisiana; and
- The Vermilion Parish School Board.

UNOCAL is not aware of any other parties involved in this matter other than those listed above. A Commissioner's Conference has not yet been held.

1.1 Scope and Objectives

This Most Feasible Plan discusses the extensive investigation and remediation activities conducted in 2006-2015, followed by a proposed evaluation and remediation plan.

The scope and objectives of this Most Feasible Plan include the following:

- Summarize the available data gathered to date;
- Discuss applicable remediation standards;
- Present the most feasible plan that includes re-closure of a former pit and monitoring to establish and confirm site groundwater conditions;
- Present a groundwater remediation plan, if ultimately deemed necessary by the regulatory agencies. The Most Feasible Plan includes this potential groundwater recovery and disposal in a targeted area of the property; and
- Present a plan that complies with all standards set forth in Statewide Order 29-B (exclusive of §319, Exceptions) as required under *LAC 43:XIX.§611.F.1* (see Appendix D);

1.2 Qualifications and Areas of Expertise

Mr. Angle is a registered professional geologist (Louisiana P.G. #69, Texas P.G. #513, Mississippi RPG #0808, and American Institute of Professional Geologists P.G. #09874) and a Certified Groundwater Professional (CGWP #113646) through the National Groundwater Association. Mr. Angle has a Bachelor of Science degree in Geology from the University of Delaware and a Master of Science degree in Geology from North Carolina State University. Mr. Angle has practiced as a geologist and environmental consultant in the Gulf Coast for over 27 years. Through education and practice, Mr. Angle is a recognized expert in the areas of site assessment, groundwater, groundwater fate and transport, aquifer characterization, site remediation, and oil field environmental issues. Appendix A contains a listing of cases in which Mr. Angle has provided testimony over the last five years and a publication list.

Mr. Pisani is a professional engineer licensed to practice in Louisiana and Texas. Mr. Pisani has a Bachelor of Science degree in Civil Engineering from Auburn University and a Master of Science degree in Environmental Engineering from Georgia Tech. Mr. Pisani has practiced environmental engineering in the state of Louisiana for over 30 years. Through education and practice, Mr. Pisani is a recognized expert in the areas of site assessment, groundwater, surface water hydrology, risk assessment, remediation, cost estimating, feasibility studies, the Louisiana Risk Evaluation/Corrective Action Program (RECAP), oilfield environmental issues, oilfield waste regulations and construction management. Appendix A contains a listing of cases in which Mr. Pisani has provided testimony over the last five years and a publication list.

1.3 Basis of Suit and Summary of Plaintiffs' Remediation Plan

UNOCAL and Louisiana Land and Exploration Company (LL&E) produced oil and gas from Section 16 of the East White Lake Field ("the property") from 1940 to 1995. Peak Operating Company of Lafayette, Louisiana currently produces oil and gas from the property.

UNOCAL and others were sued for alleged soil, sediment, and groundwater contamination said to be caused by past oil and gas production on the property. The Plaintiffs and their experts sought money to remediate the property. The Plaintiffs' April 2010 Expert Report, and subsequent Supplemental Reports, prepared by Mr. Greg Miller of ICON Environmental Services, Inc. (ICON) proposed remediation activities for the property. The Plaintiffs' "trial plan" included dredging and excavation of soils and sediment from over 75 acres of the property, installation of grout floors and slurry walls for approximately 35 acres of the property and extraction and treatment of groundwater for a period of 7 years at an estimated cost of approximately $95.2 million.

The plaintiffs' trial plan for this property was rejected by the jury and was not the most feasible. The LDNR has determined that a similar plan put forth by ICON (i.e. the ICON Tensas Poppadoc Plan) in the first Louisiana Act 312 Public Hearing is "unreasonable" (See April 17, 2009 LDNR Evaluation/Remediation Plan for the Tensas Poppadoc property). The LDNR stated that "Based on the information available on the record it appears that the Tensas Poppadoc's Plan (ICON's plan) is not the most reasonable plan and would require overly intrusive and expensive actions to be undertaken."

1.4 Supporting Expert Reports

The Most Feasible Plan presented herein has been developed based on the extensive work performed by MP&A and other experts. A listing of the experts' submittals that support this Most Feasible Plan and have been previously submitted to LDNR is presented in Table 1. Table 1A lists additional materials that have been used to support this Most Feasible Plan and Table 1B presents prior reports from other experts for this property that have been included in Appendix F.

2.0 Site Setting

The property is located in Vermilion Parish, Louisiana and consists of Section 16 of Township 15 South, Range 01 East (Figures 1 and 2). The property consists of approximately 1,200 acres and measures approximately 5,367 feet east to west and 9,718 feet north to south. The property is situated within the East White Lake Oil and Gas Field approximately 0.5 miles east of White Lake.

The property is located within a normally inundated natural marsh environment as shown on the United States Geological Survey (USGS) map provided as Figure 2. The natural land surface elevation of the property is from below to slightly above mean sea level (MSL). The land adjacent to canals is elevated to as high 4 feet above MSL as a consequence of placement of dredge spoils from construction of the canals (see Figure 3). There is no access road to the property. Access to the property is achieved by boat via the Schooner Bayou Canal and/or oilfield canals. The closest boat launch is Hebert's Boat Launch located at the intersection of Schooner Bayou Canal and LA Highway 82 just south of the bridge crossing the Intracoastal Waterway.

2.1 Surface Water Features

The surface water features in the vicinity of the property are shown on Figure 4. Surface drainage from the property is received by oilfield canals, Schooner Bayou Canal, and adjacent waterways. Historical U.S. Army Corps of Engineers' dredging of Schooner Bayou near the property has resulted in a bayou bottom elevation of up to approximately minus 17 feet MSL. Historical opening and deepening of Schooner Bayou facilitated water communication between Vermilion Bay, White Lake, and the Mermentau River, and exchange of both freshwater and saltwater throughout the Bayou and the property. The nearest major water body is White Lake which is immediately west of the property.

The property lies within the LDEQ Drainage Basin Subsegment #050703 (Figure 4). The only LDEQ-designated water uses for this Subsegment are Primary Contact Recreation, Secondary Contact Recreation, Fish and Wildlife Propagation, and Agriculture. Subsegment #050703 is impaired for fish and wildlife propagation by naturally-occurring chlorides, sulfates, total dissolved solids (TDS) and turbidity as documented in the 2014 Louisiana Water Quality Integrated Report (LDEQ, 2015). The numerical chloride and TDS concentration water quality criteria for this Subsegment are 250 and 500 mg/L, respectively. However, the measured background surface water chloride and TDS concentrations are up to over 10 times these standards. This Subsegment is not designated for use as a drinking water source.

The property lies within the 100-year flood plain based upon the Federal Emergency Management Agency (FEMA) Flood Zone Map shown as Figure 5. The entire area has been inundated by historical hurricane storm surge. The depth of storm surge observed for Hurricane Rita is shown in Figure 6. It can take several or more years to flush the saltwater out of the Schooner Bayou and the property following a hurricane storm surge.

The natural salinity of surface waters in the region and surrounding the property are continually measured and recorded by the US Army Corps of Engineers. The natural

salinity in Schooner Bayou that cuts through the property ranged from approximately 150 to 440 grains per gallon from September 2008 to September 2009, which is roughly equivalent to a chloride concentration of 1,420 to 4,170 mg/L. Grains per gallon salinity is converted to mg/L or ppm salinity by multiplying grains per gallon by a factor of 17.1. One mg/L salinity contains approximately 0.55 mg/L of chloride. The U.S. Army Corps of Engineers surface water monitoring stations are shown on Figure 7. Estimated chloride concentrations for the four closest stations to the property are provided in Figure 18.

The most recent United States Department of Agriculture (USDA) map of surface soils underlying the property is provided as Figure 12. In general, the USDA defines the soils at the property as Allemands mucky peat with lesser amounts of frequently flooded Aquents. The typical soil profile of the Allemands mucky peat is characterized by the USDA as follows: 0-12 inches of mucky peat, 12-48 inches of muck, 48-60 inches of mucky clay, and 60-80 inches of clay.

The surrounding land surface is used for recreational hunting, fishing, and in support of oil and gas activities. According to the USDA Natural Resources Conservation Service online soil survey manuscript for Vermilion Parish, farming, grazing, wildlife habitat development, and/or residential development of the property are precluded because the area is periodically inundated and the soil types are unsuitable for propagation of crops and support of animals.

The USGS has historically mapped the property area as a freshwater marsh but the 2007 USGS Coastal Vegetation Map indicates that most of the property has transitioned to an intermediate marsh (see Figure 13).

In the March 1973 Bulletin No. 672 *The Coastal Marshlands of Louisiana – Chemical Properties of the Soil Materials*, LSU researchers reported on the soil sampling of a north-south transect located to the east of the property (but remote from the oilfield). The nearest samples were numbered 13-059 and 13-069 and the approximate locations are provided in Figure 14. These soils were classified as mucky peats and peaty mucks, respectively. Surface soil samples (0 to 8 inches) were collected and analyzed from these locations and were found to contain 11,200 and 4,800 mg/kg of soluble chlorides on a dry weight basis.

2.2 Site Geology

The surface geology of the area is described as Chenier Plains and Marsh (see Figure 15). The region and the property are underlain by thick multi-layered sequences of unconsolidated sediments. The Louisiana Geological Survey (Water Resources Bulletin No. 10) and the USGS (Water Resources Technical Report No. 73) differentiate the upper 800 feet of sediments in the area into the following units:

- Surficial confining unit and the shallow sand
- Upper sand of the Chicot Aquifer system
- Lower sand of the Chicot Aquifer system

A Louisiana Geological Survey cross-section through the area and including the property is provided as Figure 16. The following stratigraphic units are shown on the cross section for the property:

Approximate Elevation	Soil Type
MSL to -60 feet	Clay
-60 feet to -290 feet	Shallow sand containing salt water
-290 feet to -400 feet	Clay (with sand lenses)
-400 feet to -600 feet	Upper Sand Unit of the Chicot Aquifer containing freshwater
-600 feet to -780 feet	Upper Sand Unit of the Chicot Aquifer containing saltwater
-780 feet to depth	Clay

2.3 Groundwater Use and Quality

The soils and sediments on the property are continually submerged under the natural brackish surface waters present in the canals, adjacent Schooner Bayou and in the region. As such, the water within the soils and sediments (referred to as porewater) will mirror the natural surface waters in salt composition, i.e., soluble chlorides ranging from less than 15 mg/L to over 5,000 mg/L. Vertical movement (i.e., leakage) of the natural surface water and porewater into the uppermost shallow sand aquifer has been documented in the region by the USGS. Dredging of Schooner Bayou removed a portion of the clay within the upper confining unit overlying the shallow sand layers and amplified surface water communication with the underlying shallow sand layers.

The natural movement of surface water into the uppermost shallow sand aquifer in the area has caused chloride concentrations in the uppermost aquifer to increase and to exceed the US EPA Secondary Drinking Water Standards for chlorides and TDS. The increase of chlorides and other dissolved solids in the uppermost shallow sand aquifer has occurred, and would have occurred, regardless of oil and gas production in the region. The US Army Corps of Engineers has been working on this issue since at least the late 1940s with construction or improvement of saltwater weirs, locks, and other control structures.

MP&A has conducted regional and 1-mile radius searches of LDNR's on-line Strategic Online Natural Resources Information System (SONRIS) database to identify registered water wells located within the area (Figures 17 and 18). No public water supply wells were identified on the property or within a 1-mile radius of the perimeter of the property. Six monitor wells are located within the boundaries of the property.

The shallow sand from a depth of approximately 35 feet to 290 feet is naturally salty throughout the region and this shallow sand is separated from the freshwaters of the Chicot Aquifer by a substantial clay confining unit. Freshwater (chloride content less

than 250 ppm) beneath the property is only found in the Upper Sand of the Chicot Aquifer at an approximate elevation of -400 to -600 feet MSL. Natural saltwater is encountered within the sands and gravels encountered from -600 to -800 feet MSL beneath the property. The TDS and total iron are above secondary drinking water standards in the Chicot Aquifer (See Figures 19 and 20).

A facility water well is completed at a depth of approximately 470 feet below ground surface and draws freshwater from the Upper Sand of the Chicot Aquifer. This is the only extraction and use of groundwater occurring on the property to the south of Schooner Bayou. Testing of this well demonstrates the well water meets EPA Primary and Secondary Drinking Water Standards with exception of the naturally occurring iron, manganese, and TDS. The Upper Sand of the Chicot Aquifer is the water supply aquifer for this property.

2.4 Aerial Photograph Review

Development of the property and oil and gas production began in approximately 1940 and is documented over time through historical aerial photographs. Aerial photography of the property spanning the years 1935 to 2009 is provided in Figures 21 through 29. The approximate boundaries of the property have been annotated on each of the photographs to aid in interpretation.

2.5 Exploration and Production Activities in Area

A summary of the oil and gas production activities on the property was developed from the Louisiana Department of Natural Resources (LDNR) SONRIS data base and is provided on Table 2. Approximate locations of the oil and gas wells (from SONRIS) are shown on Figure 30. UNOCAL or its predecessor companies began operations on the property in 1940 with the successful completion of Vermilion Parish School Board B Well Number 1 (Serial Number 24764). A total of approximately 85 wells have been drilled on the property since UNOCAL first conducted exploration and production activities. In April of 1995, Resource Acquisitions Corporation (Resource Acquisitions) acquired 36 wells from UNOCAL and drilled six additional wells. Resource Acquisitions operated on the property from 1995 until 2003 when it changed its name to Peak Operating Company (Peak). Peak has operated on the property from 2003 to the present. Peak is continuing to actively expand operations in the field and has drilled new wells as recently as 2015 and reportedly has plans for additional wells in the field.

A timeline of operator and well history is provided as Table 2.

3.0 Applicable Remediation Standards

The property is located within a normally inundated natural marsh environment and has been primarily an active oil and gas field since its initial development in 1940. In addition, the property is used for recreational hunting and fishing. Other than these uses, there was/is little potential for development or other economic use of the property. There is no access road to the property; access is via surface water by boat via the Schooner Bayou Canal and/or oilfield canals.

The oil and gas E&P operations that have been conducted on the property are regulated by the LDNR Office of Conservation. LDNR rules for environmental protection are presented in Louisiana Administrative Code, Title 43, Part xix (LAC 43:XIX), Subpart I, commonly referred to as Statewide Order 29-B. Environmental damage, as defined by Louisiana Revised Statute 30:29 (La. R.S. 30:29, commonly referred to as Act 312 of 2006), means "any actual or potential impact, damage, or injury to environmental media caused by "contamination" resulting from activities associated with oilfield sites or exploration and production sites. Environmental media shall include but not be limited to soil, surface water, groundwater, or sediment."

The LDNR defines contamination in *Title 43, Natural Resources, Part, XIX, Subpart 1, Statewide Order No. 29-B, Chapter 3; Pollution Control - Onsite Storage, Treatment and Disposal of Nonhazardous Oil field Waste (NOW) Generated from Drilling and Production of Oil and Gas Wells (Oil field Pit Regulations)* as follows: "the introduction of substances or contaminants into a groundwater aquifer, a USDW or soil in such quantities as to render them unusable for their intended purposes." "Contamination" is defined in Statewide Order 29-B as "the introduction of substances or contaminants into a groundwater aquifer, a USDW or soil in such quantities as to render them unusable for their intended purposes." With minor exceptions (discussed in Section 4), the environmental conditions on the property do not meet this definition, in that the residual constituent concentrations do not render the environmental media (i.e. wetland soil and shallow groundwater) unusable or unsuitable for their current or reasonably anticipated future purposes.

3.1 Soil

The applicable standards within Statewide Order No. 29-B for soils addressed in this Most Feasible Plan are those prescribed in *Title 43, Part, XIX, Subpart 1, Statewide Order No. 29-B, Chapter 3; Pollution Control - Onsite Storage, Treatment and Disposal of Nonhazardous Oil field Waste (NOW) Generated from Drilling and Production of Oil and Gas Wells (Oil field Pit Regulations- Section 313 A-D).*

Specifically, the soil data gathered from the property have been compared to the following Statewide Order 29-B criteria (adopted in 1986):

1. Range of pH: 6-9
2. Total metals (mg/kg wet weight)

Arsenic	10
Barium	20,000 (Submerged or Elevated Wetland Area)

	Cadmium	10
	Chromium	500
	Lead	500
	Mercury	10
	Selenium	10
	Silver	200
	Zinc	500
3.	Oil and Grease	<1 percent (dry weight)
4.	Electrical Conductivity	No standard (Submerged Wetland)
5.	Sodium Adsorption Ratio	No standard (Submerged Wetland)
6.	Exchangeable Sodium	No standard (Submerged Wetland)

The property is characterized as an inundated or submerged wetland, with the possible exception of man-made elevated spoil banks that resulted from the construction of the navigation canals. There are no salt standards (EC, SAR or ESP) for submerged wetlands.

Where appropriate, the soil data have also been compared to RECAP standards. A complete RECAP evaluation has been prepared by others and the results are utilized in the design of the remedy for the property.

3.2 Groundwater

Since there are no published numerical standards for groundwater in Statewide Order 29-B, MP&A has compared the available groundwater data to the United States Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) and Secondary Maximum Contaminant Level (SMCL) standards and the LDEQ RECAP standards, where applicable. The EPA MCLs and LDEQ RECAP standards are health-based standards. The EPA SMCL standards are aesthetic-based standards.

3.3 Request for LAC 43:XIX.319 Exceptions

The exceptions to Chapter 3 standards requested as part of this Most Feasible Plan include the use of LDEQ's RECAP procedures and standards for addressing soils and shallow groundwater. The information provided herein, along with the RECAP evaluation demonstrate proof of good cause that the constituent concentrations above the Statewide Order 29-B Chapter 3 numeric standards are protective of human health and the environment in accordance with the RECAP regulation. RECAP evaluation is recognized by LDNR and LDEQ as the "statewide environmental and health risk-based soil and groundwater evaluation and remediation standards and protocol" (as discussed in the LDNR/LDEQ Memorandum of Understanding, February 2011).

RECAP is predicated on preventing unacceptable risk to human health and the environment. Compliance with the Chapter 3 standards for these constituents and media is not necessary to achieve public health protection objectives or compliance with applicable regulatory requirements under the RECAP regulation and, therefore, is not the

most feasible way to protect human health and the environment in accordance with Act 312.

Additionally, constituents remaining in soil will not endanger the Underground Source of Drinking Water (USDW), since the protection of groundwater has been incorporated into the RECAP assessment. Compliance with RECAP standards, considering current representative soil characterization data, is therefore protective of the USDW.

Furthermore, good cause exists to grant a RECAP exception because strict application of a Statewide Order 29-B plan (fully discussed in Appendix D) is (1) unnecessary given the current condition of the property, which meets RECAP and USEPA human health and ecological standards and that the property continues to be used for its highest and best use; (2) is technically impracticable because it would result in significantly more damage than benefit to the environment and public health; (3) will disrupt current E&P operations on the property; (4) ignores LDNR's approval of risk-based standards in the 2011 MOU; and (5) is not the most feasible plan to protect the health, safety and welfare of the people of Louisiana.

4.0 Summary of Investigation Results

Soil, groundwater, surface water, sediment and biota investigations of the VPSB property have been conducted by MP&A (on behalf of the defendants) and ICON (on behalf of the VPSB) from 2006 through 2015. The results of these investigations have been documented in reports by MP&A and ICON and are summarized here. Descriptions of MP&A sampling methods are provided below. The locations of soil and sediment samples collected by MP&A and ICON are presented on Figure 31. Expanded areas with identifying sample location labels for the four quadrants of the property are shown in Figures 32-35. The locations of MP&A and ICON surface water samples and groundwater samples are shown in Figures 36 and 37, respectively. Samples that have been collected from suspect former pits and to delineate former pits are depicted on Figure 38.

4.1 Description of MP&A Sampling Methods

Surface Water Sampling

Surface water samples were collected from the approximate middle of the water column within oil and gas field canals, Schooner Bayou Canal, and White Lake. Sampling methods were selected to collect representative samples from tidally influenced water bodies in and around the property. All samples were collected from a boat. At each sample location, the boat was anchored to minimize drift and maintain the desired position. The depth of water, in feet, was measured with a graduated pole. A peristaltic pump and tubing were used to collect surface water samples. The tubing intake was positioned and secured on a graduated pole at the midpoint of the water column. The pump was run to clear the tubing of any water that may have entered on the descent prior to sample collection. Water chemistry measurements, including dissolved oxygen (DO) (mg/L), temperature (^{o}C), pH, conductivity (µS/cm), oxidation-reduction potential (ORP)(mV), and turbidity (NTU) were collected using cleaned, calibrated hand held instruments and recorded in the log book. Samples were collected in laboratory provided sample jars with as little agitation or disturbance as possible. Samples were submitted to a LELAP-certified laboratory for analysis.

Sediment Sampling

Sediment samples were collected from canals on the property, Schooner Bayou Canal, and White Lake. Two methods/samplers were utilized for the collection of sediment samples; 1) Vibra-core and 2) modified Coliwasa Sampler. The sampling method for each location was selected based on required analysis, depth of water, location, and sampling interval. Sediment samples were collected from boats anchored or positioned at the desired location.

Vibra-core sediment sampling

Vibra-core sampling employed the use of dedicated aluminum tubes approximately 3 inches in diameter and a weighted, gas powered vibrating clamp. The length of tube was determined based on depth of water and sampling interval required. Sampling tubes were

advanced using the Vibra-core by affixing the clamp and vibrating head around the tubing which vibrates down vertically when the motor is initiated and running. Once the desired depth was reached; the tubing was extracted, cut open, and observations were recorded for the collected core (texture, color, consistency, odor, oil sheens, etc.). Samples were collected from desired intervals, placed in laboratory provided sample jars and submitted to a LELAP-certified laboratory for analysis.

Modified Coliwasa sediment sampling

Dedicated, disposable Coliwasa tube samplers made of poly-ethelene tubing approximately one inch in diameter and 3-feet long and equipped with a syringe were used. MP&A modified the sampler by cutting off the small intake inlet and affixing a rubber washer on the back end of the syringe plunger to create a tighter seal during sample collection and extraction. This method was determined to be most appropriate for soft, shallow sediments (6 inch). All samples were collected from a boat. The boat was anchored to minimize drift and maintain the desired position. The depth of water, in feet, was measured with a graduated pole and surface water field parameters and samples were collected. After surface water sampling was completed, the Modified Coliwasa samplers were advanced into the sediment and extruded on a table covered with aluminum foil. Multiple pushes were made to obtain the required volume necessary for analysis. Samples were composited from the top 6-inches that were collected within a 1' x 1' area. Sample were collected from desired intervals, placed in laboratory provided sample jars and submitted to a LELAP-certified laboratory for analysis.

Soil Sampling

Soil samples were collected from upland, wetland, and underlying canal bottom locations within the property boundary. Two methods were utilized for the collection of soil samples; 1) Vibra-core sampling and 2) hydraulic, dual tube direct-push technology (e.g. Geoprobe). The sampling method selected for each location was based on the depth of water, location, accessibility, and sampling interval. Soil samples were collected in wetland areas and underlying canal bottoms utilizing a Geoprobe rig operated off a liftboat and/or a Marsh Master. Additionally, soil samples located in upland areas and underlying canal bottoms were collected using the Vibra-Core as needed. New, clean, dedicated acetate liners and aluminum tubing were used to collect soil samples utilizing the methods described. The liner and tubing were advanced to the desired sampling interval, extracted, cut open, and observations recorded for the collected core (texture, color, consistency, odor, oil sheens, etc.). Samples were collected from the desired intervals; placed in laboratory provided sample jars and submitted to a LELAP-certified laboratory for analysis.

Groundwater Sampling

Groundwater samples were collected from discrete sample depths using screen point samplers (hydropunch), installed monitoring wells, and existing water wells, as follows;

- Depth-discrete, grab groundwater samples were collected from multiple depths using a retractable 4-foot-long well screen pushed with a hydraulic Geoprobe rig operated off of a liftboat;
- Monitoring wells were installed in the boreholes advanced for the collection of soil samples using a Geoprobe rig operated off a liftboat;
- Each monitoring well was constructed of 2-inch diameter PVC casing and 10-foot long screen (0.01' slot). A piece of four-inch diameter protective PVC casing with a slip cap was placed over each monitoring well;
- Existing water wells were located and sampled using the pump, lines, faucets, and all plumbing present at the time of sampling.

The retractable well screens and monitoring wells were developed and the ground water samples were collected with a peristaltic pump and disposable tubing. After development, low flow sampling protocols were followed including the measurement of field parameters. Samples were collected in laboratory provided sample jars and submitted to a LELAP-certified laboratory for analysis. Samples that were collected directly from the retractable well screens at hydropunch locations exhibited high turbidity. Samples that were analyzed for metals were field filtered because of the high turbidity. The dissolved metals, and not unfiltered or total, concentrations are representative of groundwater quality.

QA/QC Procedures

- A clean pair of new, non-powdered, disposable nitrile gloves was worn each time a different location was sampled.
- Gloves were changed between samples and any time during sample collection when their cleanliness may have been compromised.
- All samples were collected in new, clean, laboratory provided sample jars and placed in ice chests on ice (when required), under chain of custody and delivered/shipped to laboratory for analysis.
- All equipment used was new and/or cleaned and decontaminated prior to the collection of each sample.
- QC samples, including field duplicates and blanks, were collected and analyzed.

4.2 Existing Soil and Sediment Quality

Approximately 430 samples of soil and/or sediment have been collected from approximately 130 locations by MP&A or ICON during the previous site investigations. A summary of the soil and sediment analytical data is presented in Table 3.

The soil/sediment concentrations reported above the Statewide Order 29-B standards for pit closure are shown on Figure 39. Oil and grease concentrations above the Statewide Order 29-B standard of 1% are generally located in former pit locations and active production areas within the field. In addition, the following metals were reported above the Statewide Order 29-B standard in at least one sample; arsenic [B-2 (10-10.5 feet), B-9

(8-9 feet), B-13 (7.5-9.5 feet) and AB-18 (10-12 feet), mercury [SS-8 (2-4 feet)], and zinc [WL-3 (0-2 feet)].

Soil and sediment concentrations were also compared to RECAP standards and the results are shown on Figure 40 (for RECAP Direct Contact Screening Standards), Figure 41 (RECAP Groundwater Protection Screening Standards), and Figure 42 (RECAP Site-specific MO-3 Standards, calculated by others). As shown in Figure 42, there are only two areas that exhibit exceedances of site-specific MO-3 RECAP standards:

- Tank Battery B South Pit Area (sample location WL-4). It is recommended that this former pit be re-closed to meet RECAP MO-3 standards.
- The current, active Tank Battery A Area (sample location WL-3). Since this is in the heart of the active production area currently operated by Peak, it is not recommended that this area be remediated at this time. It is appropriate to address residual hydrocarbons in this area at the end of the life of oil and gas operations on the property.

Each of the remaining areas that exhibit concentrations above the Statewide Order 29-B closure standards or RECAP screening standards have concentrations below the site-specific RECAP MO-3 standards. Accordingly, there is not an unacceptable risk posed by any of the soils or sediments and remediation of these areas is not appropriate.

Remediation has already been performed by UNOCAL at the location of a former pit (SED-15 Area). The re-closure of this pit, as well as the removal of unused flowlines and oilfield equipment, is described in Section 5 of this plan.

4.3 Existing Groundwater Conditions and Quality

A total of approximately 40 groundwater monitoring wells, existing wells, and hydropunch sample locations were installed/sampled by MP&A and ICON. Eight (8) of these were completed in the low-quality, unusable, RECAP Class 3 peat zone and were generally screened from depths of 10-20 feet below ground surface (bgs). Eighteen (18) were completed in the RECAP Class 2 shallow sand zone and screened at depths of approximately 40 to 50 feet bgs. Fourteen (14) were completed in the sand zone and screened at depths of approximately 70 to 80 feet bgs. The groundwater sampling locations are shown on Figure 37.

ICON sampled the peat zone monitoring wells in 2006. The constituents within the porewater in the peat zone on the property were found at widely varying concentrations. The constituent concentrations likely reflect both historical surface activities (examples: rainfall, storm surges, discharges) and local impounding characteristics. The porewater in the peat zone at a depth of less than 12 feet is not useable groundwater. This porewater is technically a Class 3 groundwater under the Louisiana RECAP classification. This porewater can contain in excess of 10,000 mg/L TDS as a result of storm surges.

The shallow sand zone was sampled at two depths: (1) the uppermost saturated zone occurring at a depth beginning approximately 40 to 45 feet below land surface, and (2)

beneath clay lenses that were encountered beginning at a depth of approximately 45 to 64 feet below ground surface. Groundwater within the shallow sand zone is classified as RECAP Class 2 based on yield and the natural occurrence of Total Dissolved Solids (TDS) exceeding a concentration of 1,000 milligrams per liter (mg/L) and the absence of any public supply water wells completed in the shallow sand within one mile of the property. MP&A evaluated data from a slug test performed on MW-3R in 2010. The results of this evaluation are presented in Table 4 and confirm the Class 2 designation of the shallow sand zone.

Existing water wells on the property are completed either in shallow sands at depths of less than 50 feet below ground surface or within the Upper Sand of the Chicot Aquifer at depths of 460 feet below ground surface or greater. Two existing wells (one working) are completed within the Shallow Sand (less than 50 feet) whereas two existing wells (both working) are completed in the Upper Sand of the Chicot Aquifer (greater than 460 feet) on the property. Sampling of the Chicot Aquifer upper sand unit (WW-1) indicates this water supply zone beneath the property meets all primary drinking water standards including those for hydrocarbons, benzene, and barium. Sampling of the Chicot Aquifer upper sand unit also shows that the chloride standard is met.

MP&A developed site specific cross-sections for the property using boring logs generated during the completion of soil borings and monitoring wells. The locations of the cross sections are shown on Figure 43 and the cross sections (west to east and north to south) are shown on Figures 44 and 45, respectively.

A summary of the groundwater data for the property is presented in Table 5. Groundwater concentrations for the property are also depicted on the following figures:

- Figure 46 – Barium concentrations in the Peat Zone;
- Figure 47 – Chloride concentrations in the Peat Zone;
- Figure 48 – TPH fraction concentrations in the Peat Zone;
- Figure 49 – Radium-226 and -228 concentrations in the Peat Zone;
- Figure 50 – Barium concentrations in the shallow sand zone (40-foot zone);
- Figure 51 – Chloride concentrations in the shallow sand zone (40-foot zone);
- Figure 52 – Benzene concentrations in the shallow sand zone (40-foot zone);
- Figure 53 – Radium-226 and -228 concentrations in the shallow sand zone (40-foot zone);
- Figure 54 – RECAP GW2 standard exceedances in the shallow sand zone (40-foot zone);
- Figure 55 – Chloride concentrations in the 70- to 90-foot zone;
- Figure 56 – Radium-226 and -228 concentrations in the 70- to 90-foot zone;
- Figure 57 – Chloride concentrations in the Upper Sand of the Chicot Aquifer.
- Figure 58 – Radium-226 and -228 concentrations in the Upper Sand of the Chicot Aquifer.

Figure 54 also depicts the Areas of Interest (AOIs) that have been identified by ERM in their RECAP assessment and shows that only barium and benzene are present at concentrations above the RECAP GW2 risk-based standard and only in three isolated

areas. There are no exceedances of RECAP standards in either the 70- to 90-foot zone or the Upper Sand of the Chicot Aquifer.

The occurrence of benzene in the shallow sand zone beneath a small portion of the property has been vertically and horizontally delineated to RECAP screening standards. There is no current exposure to the trace levels of benzene and practically no potential for future exposure to the trace levels of benzene. The trace levels of benzene are expected to naturally degrade with time. Barium has also been vertically and horizontally delineated on the property. Barium above a concentration of 2 mg/L is located within three relatively small pockets of impact within active areas of the oilfield. There is no current exposure to groundwater in the impacted areas and practically no potential for future exposure to the shallow groundwater. Evaluation of the vertical delineation data indicates that the shallow sand unit is able to attenuate the constituents leaking into the shallow sand unit over a vertical distance of less than 30 feet. The data from the MW-1 area indicates the groundwater is attenuated by a fourfold decrease in chlorides from a depth of approximately 50 feet to 100 feet.

MP&A has developed Stiff and Piper diagrams shown on Figures 60-64 that demonstrate that the shallow groundwater underlying the property is similar to, and likely influenced by the overlying surface water quality. The water quality of the fresh water samples collected from the approximately 500-foot deep drinking water wells is clearly much better and different than the surface water and naturally poor quality shallow groundwater.

A further demonstration of the quality of water in the shallow sand zone can be seen in Figure 65, a photograph of water samples from the shallow (~40 foot) zone and water samples from the Upper Sand of the Chicot Aquifer (approximate depth of 400 feet).

4.4 Existing Surface Water Quality

Surface water quality data have been collected from approximately 24 locations, including 11 from reference locations. The surface water data are compiled in Table 6 and chloride concentrations in surface water are depicted on Figure 59. The surface water on the property has not been impacted by oil and gas operations. As discussed earlier, the natural salinity in Schooner Bayou within several hundred feet of the property is monitored by the U.S. Army Corps of Engineers and chloride concentrations have been shown to range from approximately 1,400 to over 4,000 mg/L from the period from 1998 through 2014. In fact, data from the east Schooner Bayou Control Structure (Station S3) shows chloride peaks as high as 10,000 mg/L.

5.0 Remediation Performed to Date

Site remediation activities have been performed on the property including the removal of existing and unused oilfield equipment and structures and the re-closure of a former pit near Tank Battery B (referred to as the SED-15 area).

Peak (in cooperation with UNOCAL) undertook a site restoration program in 2010 through 2011 to remove abandoned/obsolete oilfield structures, equipment, pilings, and flowlines. The work consisted of the following elements:

- Removal of Tank Battery B vessel, platform, pilings and associated lines.
- Flowlines were removed from three canal crossings (six to eight lines per crossing were cut and capped on the backside of spoil bank). Residuals from within the lines were collected and recycled/disposed. Flowlines were removed from the canals, cut into manageable sizes, and transported off site for recycle or disposal.
- Above-ground flowlines were removed from marsh areas, cut, and loaded onto a barge for off-site disposal and recycle.
- Unused piles in canals were removed by pulling the entire pile or cutting and removing to ten feet below mudline. The removed piles were recycled or disposed offsite.
- An unused barge and compressor were removed, scrapped, and disposed/recycled off site.

The above work was performed by Peak Energy and its subcontractors between September 2010 and June 2011. The cost of the completing this work was approximately $2.0 million dollars.

On behalf of UNOCAL, MP&A performed closure activities in 2014 to remediate the former pit located west of the Former Tank Battery B that exhibited exceedances of both Statewide Order 29-B oil and grease standards and RECAP standards for TPH fractions. In addition, the location of this pit is near ICON's sediment sample SED-15 location. Pit closure activities included the following:

- Applied for and received Coastal Use (CUP) Permit No. P20140606 from the LDNR Office of Coastal Management and Wetlands Permit No. MV-N-2014-01579-W00 from the U.S. Army Corps of Engineers (USCOE);
- Performed delineation sampling and analysis in October 2014 to define the area to be remediated and complete plans for pit closure;
- Collected surface water samples from three (3) locations in the nearby canal to document water quality prior to initiation of pit closure activities;
- Cleared the existing small trees and brush from the site and removed the brush for offsite disposal;
- Excavated the upper approximately 2 feet of clean topsoil and stockpiled onsite for use as near surface fill after pit closure;
- Excavated soils and sediments from the location of the former pit. Excavation was performed on the spoil bank and extended out into the canal within the general footprint of the former pit;

- Placed sheet piling at the approximate location of the original bank of the land mass to assist in removal of impacted soil and the placement of clean backfill;
- Loaded excavated soil, sediment and storm water that collected in the excavation area to barges and transported the materials to a Louisiana-licensed commercial disposal facility, ECOSERVE, located in Intercoastal City, Louisiana, for disposal. A total of approximately 4,000 barrels of solid waste and 1,300 barrels of storm water and barge wash water were sent for disposal;
- Performed confirmatory sampling at the bottom and sidewalls of the excavation;
- Backfilled the excavation with a clayey soil from an offsite borrow area to within approximately 2-3 feet of the original land surface. The clean overburden was returned to the upper 2-3 feet of the excavation area to provide an organic-rich topsoil for the area. The backfill source was sampled and analyzed prior to shipping the soil to the site;
- Disposed of residuals from the pit closure (primarily debris and oil absorbent booms) at a Louisiana-licensed solid waste disposal facility, Waste Management - Reliable Landfill, located in Livonia, Louisiana;
- Spread winter rye grass seed and a balanced fertilizer on the backfill area and covered the entire area with a heavy coconut-based erosion matting to protect the area until the seeds germinate and begin to grow; and
- Demobilized all barges, tugboats and equipment from the site.

The approximate cost for performance of this pit closure effort was $700,000. The details of the previous remediation efforts, including tables and figures are included in Appendix B.

6.0 Most Feasible Plan

MP&A has developed a Most Feasible Plan to address remaining environmental impacts on the property. The plan is based upon the results of the extensive investigation activities performed from 2006 through 2015, our assessment of the results of these investigations, a RECAP assessment performed by ERM, and the past, current and reasonably anticipated future land use of the property. We propose the following remediation plan:

- Reclose the former Tank Battery B pit area (Figure 64). This pit contains residuals with hydrocarbons exceeding Statewide Order 29-B and RECAP standards. This re-closure can be performed at an approximate cost of $600,000, as detailed in Table 7. The Coastal Use Permit Application has already been submitted for this work. Upon receipt of final permit approval from LDNR's Office of Coastal Management, MP&A proposes to excavate the Former Tank Batter B pit contents, dispose offsite at a commercial disposal facility, and backfill the location with appropriate backfill material.
- Install three additional monitoring wells (Figure 65) to approximate depths of 60 feet to complete assessment of benzene detected in the shallow groundwater and conduct three years of quarterly groundwater monitoring and reporting to demonstrate that groundwater conditions are continuing to improve and stabilize over different seasons (approximately $300,000, see Table 8). The Coastal Use Permit Application has already been submitted for this work.
- If ultimately deemed necessary by LDNR, install and operate a groundwater pump and disposal system to address benzene in the shallow groundwater zone (approximate well depths of 60 feet) which will include the conversion of an existing Salt Water Disposal Well (SWD) or drilling a new SWD, if required, and installing the necessary piping and tankage. This groundwater pump and disposal system is estimated to cost up to $1,700,000 to $2,200,000. This includes approximately $800,000 for installation and operation of the system as detailed in Table 9. Additional costs will include approximately $450,000 for the installation of tankage and piping for disposal and approximately $400,000 to $1,000,000 for a salt water disposal well (depending on whether an existing well can be converted or a new well must be drilled). The Coastal Use Permit Application for the installation of the pumping well and observation well for the pumping test has already been submitted.

Re-closure of Former Tank Battery B pit area will consist of the following:

- Receive a CUP from LDNR Office of Coastal Management (OCM) [Application filed];
- Perform delineation sampling to refine area of remediation;
- Excavate the Former Tank Battery B pit contents and load onto barges;
- Transport and dispose offsite at a commercial disposal facility;
- Backfill and grade the excavated area; and
- Restore vegetation.

The groundwater monitoring program will include the following;

- Receive a CUP from the LDNR OCM (Application filed);
- Install 3 additional shallow monitoring wells to a depth of approximately 40-60 feet below the ground surface to supplement the three existing, properly constructed permanent monitoring wells on the property;
    - Due to the remote site setting, i.e. only access is via boat; these wells will be installed with a barge- or airboat-mounted geoprobe rig equipped with dual tube sampling equipment and the appropriate sized well-setting barrels;
    - Each small diameter monitoring well will be constructed of either ¾ or 1-inch PVC casing and a 10-foot long well screen;
    - Each well will be screened in the top of the sand zone at depths of approximately 40 to 60 feet below the ground surface like the existing three wells;
    - The stickup for each well will be extended approximately 3-feet above the ground surface/top of water and two or four-inch diameter PVC protective casings will be installed around each well;
    - Installation and completion of each will follow the procedures outlined in the LDEQ/LDOT Construction of Geotechnical Boreholes and Groundwater Monitoring Systems Handbook, dated December 2000;
- Each monitoring well will be properly developed and purged prior to sampling;
- Groundwater samples will be collected using low flow purging and sampling techniques utilizing a peristaltic pump and dedicated polyethylene tubing;
- Each groundwater sample will be collected in laboratory supplied jars and analyzed for benzene, toluene, ethylbenzene, xylene(s) (BTEX), barium, chloride, and total dissolved solids (TDS) by Gulf Coast Analytical Laboratory (GCAL), a Louisiana Environmental Laboratory Accreditation Program (LELAP) approved laboratory;
- Soil residuals and well development and purge water will be containerized and properly disposed;
- Each new and existing MP&A monitoring well will be surveyed by a Louisiana-licensed professional surveyor;
- Water levels will be measured in each well using an electronic water level indicator during each quarterly sampling event;
- The 3 new and 3 existing MP&A monitoring wells will be sampled on a quarterly basis for three years. A brief letter report will be submitted to the LDNR following receipt of the final analytical laboratory report for each sampling event. The letter report will include tabulated summaries of the water level measurements and sampling results, a potentiometric surface map and figure displaying the quarterly data trends;

- MP&A proposes to conduct a review of each four quarters of data on an annual basis and provide any additional interpretations/recommendations in the 1st quarterly report following the completion of each four quarters of monitoring.

If the LDNR determines that active groundwater remediation is necessary, in addition to ongoing natural attenuation, a pilot, 24 to 72-hour groundwater pumping test to further evaluate the hydraulic properties of the approximate 40 to 60-foot sand zone and feasibility of implementing a groundwater pumping remedy will be conducted prior to initiating any full scale groundwater pumping program. The specific activities that would be conducted for the pumping test are as follows:

- Install one 4-inch diameter PVC pumping well screened from 40 to 60-feet;
- Install one 1-inch diameter observation well;
- Mobilize and spot a temporary moveable tank;
- Provide temporary power to pumping well;
- Conduct a step test on pumping well to determine pumping rate for 24 to 72-hour test and conduct test;
- Record water levels at the pumping and observation wells; and
- Properly dispose of recovered groundwater in Peak SWD.

MP&A has conducted preliminary capture zone modeling to evaluate the potential for groundwater pumping. The capture zone modeling has been used in conjunction with contractor estimates and an estimate of the volume of water removal required to reduce the benzene concentrations to below the RECAP standard to develop an estimate of the total cost of a full scale groundwater pumping and on-site reinjection of the recovered groundwater into a salt water disposal (SWD) well remedy.

Information on the preliminary groundwater modeling conducted to support the full-scale groundwater recovery system described above and the modeling inputs are provided below:

- United States Geological Survey (USGS) three-dimensional finite-difference groundwater flow model, MODFLOW 2000, utilized to conduct the groundwater modeling [GMS Version 9.0 - groundwater modeling software interface developed by Aquaveo™]
- USGS particle-tracking package, MODPATH, a postprocessing package that was developed to compute three-dimensional particle flow paths and capture zones using output from MODFLOW simulations
- Model inputs and assumptions are as follows:
    1. Shallow sand zone is confined with a porosity of 30 percent
    2. Approximate thickness of shallow sand zone is 35 feet
    3. Shallow sand zone is of infinite aerial extent, homogeneous, and isotropic
    4. The model grid was developed with constant head boundaries on the eastern (1.0 ft) and western (-1.5 ft) edges, and no-flow boundaries on the northern and southern edges
    5. Recharge is negligible
    6. Pumping rates are constant

7. Hydraulic conductivity of zone is approximately 6 feet/day
8. Horizontal gradient is approximately 0.00044 and groundwater flow is towards the west.

The components of the full-scale groundwater pumping system, if it is determined by LDNR to be necessary to treat shallow groundwater to RECAP GW-2 standards, would consist of the following based upon the preliminary modeling assumptions presented above:

- Installation and operation of two 4-inch diameter PVC recovery wells screened from 40- to 60-feet below the ground surface and equipped with electric submersible pumps to achieve total pumping rates of 50 gallons per minute (GPM) [25 GPM per well]. Proposed well locations are provided on Figure 65;
- Installation and monitoring/sampling of two one-inch diameter PVC monitoring wells screened from 40- to 60-feet below the ground surface. Proposed well locations are provided on Figure 65. Pressure transducers and data loggers will be installed in the wells to continuously monitor groundwater elevations to evaluate changes as a result of long term pumping. Samples will be collected and analyzed on a quarterly basis for benzene to evaluate constituent concentration changes over time.
- Conveyance of extracted water via pipeline to the Peak Salt Water Disposal (SWD) well; and
- Blending and disposal of the extracted water in the SWD.

It should be noted that implementation of the groundwater recovery and treatment plan is not intended to render the shallow groundwater potable. The shallow groundwater cannot be used for potable purposes due to its naturally poor quality (i.e. naturally elevated metals, salinity, and sulfate). If a local source of potable water is needed on the property then MP&A recommends the installation of a 400- to 500-foot deep water well into the fresh Chicot Aquifer (~$20,000). Alternatively, if treatment of the naturally poor quality shallow groundwater to meet potable standards is required then a Reverse Osmosis well head treatment system could be installed and operated (~$70,000). Estimated costs to implement that proposed Most Feasible Plan range from approximately $900,000 to $3,100,000, depending on the necessity of active groundwater pumping and disposal. Cost detail information is provided in Appendix D.

6.1 Justification for the Feasible Plan

MP&A believes that the remediation and monitoring activities presented above present the Most Feasible Plan based upon the following:

- The existing soil, sediment, surface water and groundwater quality has not affected the use of the property;
- The extensive, site-specific Human Health and Ecological Risk Assessment and Crab and Forage Fish Studies demonstrate that the site poses no harm to human health and does not pose unacceptable risks to the environment due to the presence of residual substances in the sediment, soil and groundwater;
- The availability of a fresh, potable water source starting at approximately 400 to 500 feet;

- The reasonably anticipated future uses of the property;
- Potential future risks are addressed in accordance with RECAP, which is accepted by LDNR and LDEQ as an appropriate manner in which to design response activities at E&P sites; and
- There exists just cause for the use of exceptions and/or alternate standards under Statewide Order 29-B.

7.0 Schedule

Following LDNR approval of this plan, the activities listed below will be completed within the approximate estimated times provided below.

- Closure of the Tank Battery B South Pit – Can be initiated within 3 months of approval and will take approximately 6-8 weeks to complete;
- A Pit Closure Report will be submitted within 2 months of receipt of final laboratory data and certified disposal manifests;
- Installation and development of monitoring well network – approximately two weeks duration; to be performed within 45 days of approval of this plan;
- Groundwater monitoring events – duration of less than one week. The first event will be performed immediately after well installation and development and once per calendar quarter for a period of up to three years;
- Quarterly Groundwater Reports – submitted within 45 days of receipt of final laboratory data reports;
- Annual Groundwater Monitoring Reports – submitted within 45 days of receipt of final laboratory data reports for the 4th quarterly event;
- Groundwater recovery system detailed design – will be initiated within 45 days of approval and can take approximately 3 months to complete;
- Groundwater system reports – will be submitted quarterly within 45 days of the end of each calendar quarter; and
- Final Remediation Report – will be submitted with 90 days of achieving the targeted cleanup goals for benzene.

8.0 Reporting

A Pit Closure Report will be submitted according to the schedule in Section 7. The report will include the following information:

- Copies of the final Coastal Use Permit (CUP) and Corps of Engineers Wetlands Permit;
- Tabulated results of delineation sampling;
- Tabulated results of confirmation sampling;
- Tabulated results of backfill sampling;
- Copies of laboratory analytical reports;
- Copies of waste manifests for all material shipped for offsite disposal; and
- Representative photographs of the pit area before, during and after closure.

Quarterly groundwater monitoring letter reports will also be prepared and submitted to LDNR. Each report will include the following:

- A brief discussion of the results;
- Potentiometric surface maps demonstrating groundwater flow directions;
- A summary of field measurements recorded at the time of sampling;
- A tabulation of laboratory analytical data; and
- Laboratory data reports.

Annual groundwater monitoring letter reports will be prepared following the completion of four quarterly monitoring events to document the changes in groundwater conditions. These reports will include the same information as the quarterly reports and will also include an analysis of trends in benzene concentrations. The annual reports will also provide recommendations for additional monitoring or other action, or a reduction in monitoring frequency, etc. as warranted by the results.

Quarterly groundwater recovery system reports will be prepared and submitted to LDNR. The reports will include:

- A tabulation of the estimated volume of groundwater recovered and disposed in the SWD;
- Tabulated results of analytical data from groundwater sampling and analysis;
- A summary of systems operation, downtime and corrective measures, if any; and
- Copies of laboratory data reports.

Figures

Most Feasible Plan for Evaluation/Remediation

Vermilion Parish School Board (VPSB) Property
Section 16 T15S, R01E
East White Lake Oilfield
Vermilion Parish, Louisiana
State of Louisiana and the Vermilion Parish School Board v. Louisiana Land and Exploration, et al.

Tables

Most Feasible Plan for Evaluation/Remediation

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David G. Angle's & Michael E. Pisani's Testimony and Publication Lists

Appendix A

Most Feasible Plan for Evaluation/Remediation

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Information on Previous Remediation Activities
SED-15 Area Pit Closure and Site Restoration

Appendix B
Most Feasible Plan for Evaluation/Remediation

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Cost Backup Information
MP&A's Most Feasible Plan for Evaluation/Remediation

Appendix C
Most Feasible Plan for Evaluation/Remediation

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Statewide Order 29-B Compliant Plan (*LAC 43:XIX.§611.F.1)* and Estimated Costs

Appendix D

Most Feasible Plan for Evaluation/Remediation

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Lab Reports

Appendix E

(Electronic CD)

Most Feasible Plan for Evaluation/Remediation

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Additional Supporting Materials

Appendix F

(Electronic CD)

Most Feasible Plan for Evaluation/Remediation

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