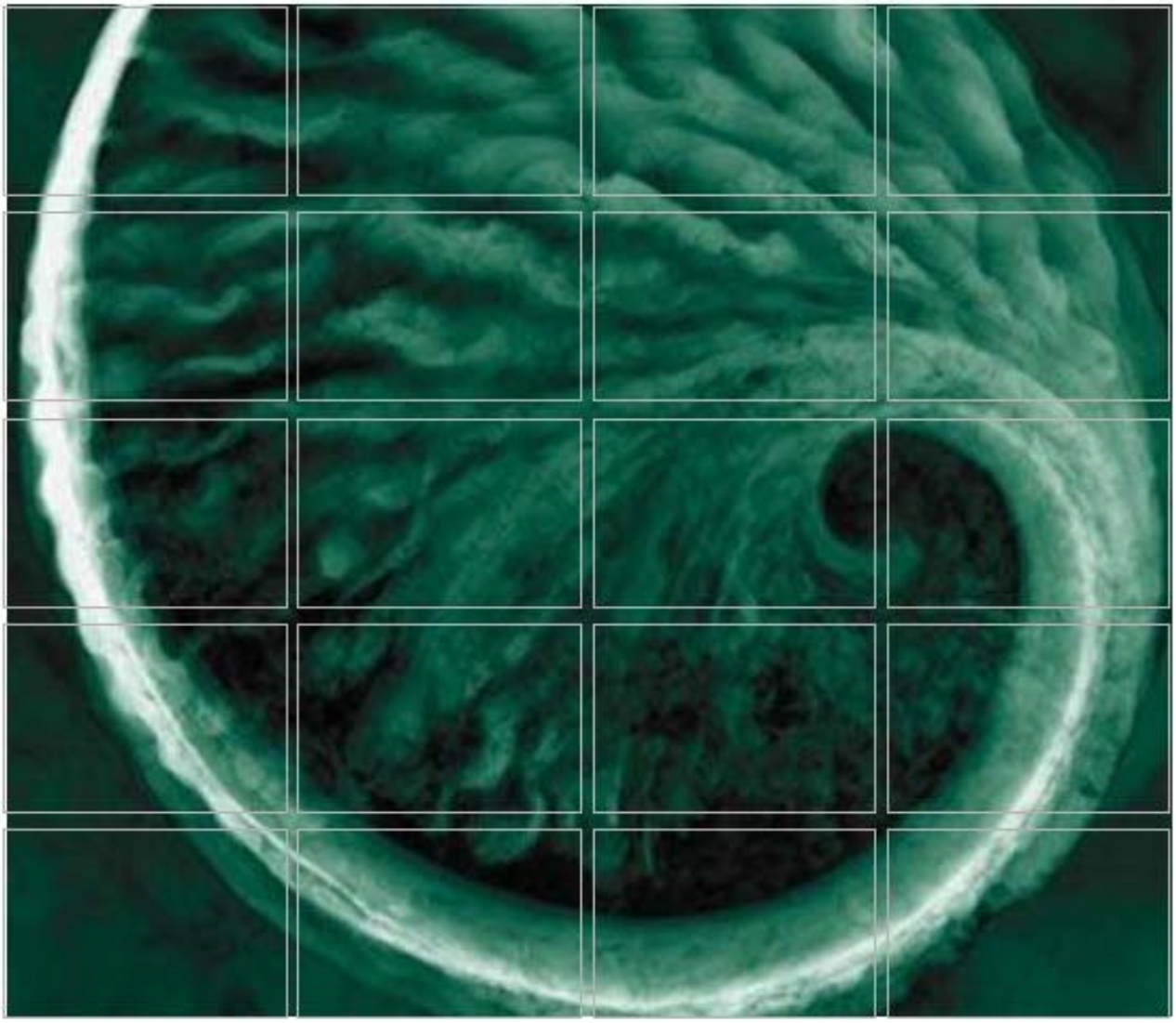

Expert Report of David G. Angle, P.G., CGWP & Michael E. Pisani, P.E. and Limited Admission Plan

Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al

OC Legacy Project No.: 025-010

8 September 2020

Project No.: 0494255

The business of sustainability

ERM

Signature Page

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Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al

Plaquemines Parish, Louisiana

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CONTENTS

TABLES

1. INTRODUCTION

Environmental Resources Management, Inc. (ERM) has prepared this expert report and Limited Admission Plan (Plan) pertaining to the Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc., et al. matter, in which ERM [formerly Michael Pisani & Associates, Inc. (MP&A)] was retained by Kean Miller LLP on behalf of defendant Chevron U.S.A. Inc. (Chevron). The lawsuit was filed on March 7, 2018. This report presents opinions based upon work conducted by ERM, other defense experts, and plaintiff's experts that was focused on the plaintiff's property (Property) located in Plaquemines Parish in Belle Chasse, Louisiana.

This Limited Admission Plan is submitted to the Louisiana Department of Natural Resources (LDNR) in support of Chevron's limited admission submittal to the court.

Chevron and other defendants are being sued for alleged environmental contamination that the plaintiff asserts has been caused by historical oil and gas exploration and production (E&P) activities.

In November 2017, plaintiff's experts, ICON Environmental Services (ICON), initiated an environmental investigation of the Property including soil and groundwater sampling. Beginning in August 2018, ERM personnel were onsite to observe, document and split samples during the ICON investigations. In December 2019, ERM initiated soil and groundwater investigations on behalf of Chevron.

We continue to develop and refine opinions to be presented in this case as additional information becomes available and will supplement this report with the additional information, if necessary.

1.1 Qualifications, Areas of Expertise, and Compensation

The following paragraphs present the qualifications, areas of expertise, and compensation of the report authors.

1.1.1 David G. Angle's Qualifications, Areas of Expertise, and Compensation

Mr. Angle is a registered professional geologist (Louisiana P.G. #69, Texas P.G. #513, Mississippi P.G. #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 32 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 brine/oilfield environmental issues. Appendix A contains a listing of cases in which Mr. Angle has provided expert testimony over the last five years, Mr. Angle's professional profile, and a publication list. ERM's hourly rate for Mr. Angle is $230.

1.1.2 Michael E. Pisani's Qualifications, Areas of Expertise, and Compensation

Mr. Pisani is a registered professional engineer (Louisiana P.E. #22342 and Texas P.E. #52907). Mr. Pisani has a Bachelor of Science degree in Civil Engineering from Auburn University and a Master of Science degree in Environmental Engineering from the Georgia Institute of Technology. Mr. Pisani has practiced as an engineer and environmental consultant in the Gulf Coast for over 40 years. Through education and practice, Mr. Pisani is a recognized expert in the areas of site assessment, site remediation, Statewide Order 29-B, and brine/oilfield environmental issues. Appendix A contains a listing of cases in which Mr. Pisani has provided expert testimony over the last five years and Mr. Pisani's professional profile. ERM's hourly rate for Mr. Pisani is $230.

1.2 Work Performed and Materials Relied Upon

A summary of the work performed by ERM and materials relied upon are provided in Appendix B. ERM has also relied upon data and information gathered during oversight of investigation activities conducted by ICON. Data and information gathered and evaluated as part of the tasks outlined in Appendix B were relied upon for the development of this report. ERM may supplement the opinions presented below based on receipt and review of any additional information.

1.3 Plaintiffs' Proposed Remedial Options and Cost Estimates

The following summary of plaintiff's remediation options and estimated costs was taken from the July 12, 2019, ICON Environmental Services, Inc. (ICON) report titled: *Expert Report and Restoration Plan*.

ICON Proposed Remediation Option	Estimated Cost
Soil Remediation to 29-B limits – Conventional excavation to maximum depth of 10 feet below ground surface. Excavated materials may be disposed of offsite as well as chemically amended. 206,970 yd^3 of soil will be removed and replaced; 59,182 yd^3 of soil will be treated onsite.	**$34,288,601**
Groundwater Remediation to EPA drinking water standards, RECAP MO-1 standards and ICON-derived standard for TDS in water for livestock. Plan includes pumping 421 recovery wells and treatment using air stripping, physical filtration, chemical dosing, anti-scaling, pH adjustment, and reverse-osmosis. Wastewater from the system will be either disposed of off-site or injected into an onsite disposal well.	**$28,448,968 to $89,762,707**
Total	**$62,737,569 to $124,051,308**

2. LISTING OF OPINIONS

Background/Site Setting

1. The approximately 155-acre property on which investigations were conducted consists of four tracts, two east and two west of Louisiana Highway 23 (Belle Chasse Highway). The Property is located within a primarily industrial area that is currently used for E&P activities. The Chevron Oronite plant, which was initially constructed in 1943, is between Belle Chasse Highway and the Mississippi River levee, immediately south of the southeastern Hero Lands tract. The storm water impoundment for the Oronite plant is located on Hero Lands property across LA Highway 23, at the southwestern corner of the southwestern tract.
2. The Property is zoned for heavy and light industrial and commercial uses by Plaquemines Parish Planning and Zoning and has been used almost exclusively for E&P activities for the last approximately 80 years. The adjacent Oronite plant property, including the storm water impoundment, is also zoned for heavy industrial use and is used as such.

Exploration and Production History and Regulatory Involvement

3. There are 45 LDNR SONRIS registered oil and gas wells listed in the plaintiffs' petition, with 39 of the wells located on or near the Property. The California Company and/or Chevron drilled 12 wells on the Property between 1940 and 1961. The first saltwater disposal well (SWD) began operations in 1984. There are currently 14 wells classified as active, including five active SWDs located on the Property.
4. E&P activities have been conducted on the Property for over 80 years. The required E&P facilities (well pads, roads, tank batteries, flow lines, etc.) have left an industrial footprint that was/is necessary to extract oil and gas from the Property for economic reasons and provide current and future access to the Property. The historical through current E&P activities have not affected the use of the Property.
5. Statewide Order 29-B, which provides a regulatory framework for pit closures and oil field cleanups, was not promulgated until 1986; therefore, there were no numerical pit closure standards prior to 1986.
6. Over the last approximately 30 years, the LDNR and Louisiana Department of Environmental Quality (LDEQ) have conducted numerous inspections of the E&P operations, including former pit areas, producing and SWD well locations, tank batteries, gas plant, etc. The vast majority of the inspections, compliance orders and lease facility inspection reports are related to recent operators and not historical Chevron operations, which ceased in 1971.

Groundwater Monitoring - Oronite Plant

7. LDEQ has been involved in regulating soil and groundwater conditions beneath Chevron's Oronite Plant and adjacent storm water impoundment for almost 40 years, recognizes the naturally poor water quality underlying the area, and has not required active groundwater remediation. It is reasonable to assume that the LDNR and LDEQ would evaluate and regulate groundwater beneath the Hero Lands property in the same manner as groundwater beneath the Oronite plant, since portions of the Property are located immediately adjacent to the plant, the plaintiffs' property is zoned for heavy industrial and/or commercial uses, and groundwater conditions do not change at the property boundaries.

Soil Conditions

8. Soils on the Hero Lands property consist primarily of silt loams on the historical natural levees near the Mississippi River, which grade to historical backswamp deposits (i.e., silty clays and clays) with distance from the river.

9. Soils exceeding Statewide Order 29-B limits for metals and hydrocarbons (oil & grease) are limited to relatively small areas where historical E&P operations occurred. No exceedances of final RECAP standards for soil were identified,

10. Exceedances of 29-B salt limits were reported in a number of samples collected on all four Hero Lands tracts. Because these are agronomic standards established to promote the growth of crops and other vegetation, it is appropriate to apply them only to soils within the effective root zone. The large portions or the northwest, northeast and southeast tracts currently used for E&P operations and access are maintained to be clear of vegetation.

11. All of the areas that exhibited exceedances of 29-B limits are on properties that are zoned commercial or industrial. Although these exceedances would need to be addressed to achieve regulatory standards, none of the documented soil impacts affect the current or reasonably-anticipated future use of the Property.

Groundwater Conditions

12. The groundwater underlying the majority of Plaquemines Parish, including beneath the Property, is naturally salty (chloride concentration > 250 mg/L) (Rollo, 1960 and USGS, 2013). The Gramercy aquifer, which underlies the Property at a depth of approximately 200 to 300 feet, contains slightly to moderately saline water with reported well yields ranging from 4 to 80 gallons per minute (USGS, 2013).

13. The Property and surrounding area are served by the Plaquemines Parish Water Works Belle Chase District public water system, which provides high quality and tested drinking water sourced from the Mississippi River. This water source is the only source of fresh drinking water to the Property since the groundwater underlying the Property is naturally salty and of poor quality. A Plaquemines Parish Water Works water main runs along the west side of Louisiana Highway 23.

14. Based on a review of the ERM boring logs, the soils and subsurface geology down to a depth of approximately 88 feet below ground surface (bgs) consists primarily of clays and silts. The tops of two shallow water bearing zones, designated by ICON as the A and B zones, were encountered at depths ranging from approximately 4 to 13.8 feet bgs and 16 to 25.5 feet bgs, respectively. The A zone consists of a laterally variable and discontinuous silt zone and the B zone consists of a silty, fine sand. The top of a third water-bearing zone, a silty sand encountered beneath a significant clay layer designated by ICON as the C Zone, was encountered at 76 to 80 feet bgs.

15. The Mississippi River channel is up to 100 feet deep in the vicinity of the Property and Mississippi River water interacts with the shallow groundwater underlying the Property. Mississippi River water contains various constituents including metals, hydrocarbons, pesticides, herbicides, fecal coliform, etc., since it receives permitted and non-permitted discharges of numerous contaminants from approximately two-thirds of the entire area of the continental United States. Mississippi River water is not potable without extensive treatment for use by Plaquemines, Parish, the City of New Orleans and other public water suppliers.

16. Groundwater within the A Zone is LDEQ Risk Evaluation/Corrective Action (RECAP) Class 3A based upon aquifer tests (slug tests). Available information indicates that the groundwater within the A zone has never been used and cannot be used due to its naturally poor quality, low yield, close proximity

to the ground surface and susceptibility to fecal coliform and other contamination from surface flooding.

17. Groundwater within the B Zone is LDEQ RECAP Class 2 based upon aquifer tests (slug tests) on the Property and on the adjacent Oronite Plant. Available information indicates that the groundwater within the B zone has never been used, is non-potable and of naturally poor quality, and has effectively been managed as RECAP Class 3. The LDEQ and its predecessor agency have been involved with the regulation of the groundwater beneath the Oronite Plan and active storm water impoundment for almost 40 years and have never required active remediation of the groundwater in either the A or B zones.
18. Testing of numerous monitoring wells completed by ERM and ICON within the A Zone demonstrate that constituents detected are below their respective RECAP MO-1 Class 3 Non-Drinking Water (NDW) standards with application of the appropriate Dilution Attenuation Factor (DAF), if necessary.
19. Testing of numerous monitoring wells completed by ERM and ICON within the B Zone demonstrate that several constituents including arsenic, barium, benzene, chloride, and total dissolved solids (TDS) exceed RECAP and/or EPA drinking water standards; however, the B zone groundwater quality is naturally salty and poor quality. The B zone contains poor quality groundwater that is not a viable future groundwater resource.
20. ICON's background monitoring wells, BC-17A, BC-17B, BC-18, BC-19, and BC-20, installed approximately 4,000 feet to the south of the southern edge of the Property in the A and B zones, demonstrate that the groundwater in both zones is naturally non-potable due to elevated concentrations of arsenic, chloride, iron, manganese, and total dissolved solids above their respective RECAP and/or EPA Maximum Contaminant Level (MCL) or Secondary Maximum Contaminant Level (SMCL) standards. ICON and ERM agree that the B zone is not a drinking water resource.
21. It is technically impracticable, not feasible and unnecessary to restore the groundwater in the A zone underlying the Property to a drinkable and usable state for the following reasons:
    - It is highly unlikely that the United States Army Corps of Engineers (USACE) would issue a permit for a massive groundwater water pumping remedy as proposed by ICON near Mississippi River levee system. The USACE has jurisdiction over activities near the levee and has strict requirements regarding any drilling within 1,500-feet of the Mississippi River levees. It should be noted that ERM was required to suspend the installation of monitoring wells when the Mississippi River stage was greater than 11 feet above mean sea level (amsl).
    - The A Zone is laterally variable in thickness and extent and contains RECAP Class 3A groundwater. Numerous monitoring wells went dry during the well development and purging process.
    - LDEQ has managed groundwater as Class 3 in the area (e.g., in the 2015-2016 LDEQ RCRA Comprehensive Groundwater Monitoring Evaluation report by LDEQ for the Oronite plant).
    - Pumping groundwater from the A zone in the vicinity of the Oronite plant would likely draw in groundwater from both the A and B zones beneath the facility.
    - Pumping water from the A zone will likely draw water upwards from the B zone due to the natural upward gradient.
    - Chloride, barium, and radium concentrations have been well above their respective EPA/RECAP standards adjacent to the Oronite plant storm water impoundment since the mid-1980s. The LDEQ has been involved in permitting and monitoring Oronite plant for over 40 years and has not required groundwater remediation.
    - The approximately eight-acre Oronite storm water impoundment located on the plaintiff's property is approximately six feet deep with a natural clay liner. Pumping water from the A

zone at shallow depths in the immediate vicinity would likely draw water from the impoundment into the A zone.
- The extensive pumping proposed by ICON would potentially result in the interaction of naturally poor quality Mississippi River surface water with shallow groundwater.
- The Property is served by Plaquemines Parish Water Works Belle Chasse District public water supply.

22. It is technically impracticable, not feasible and unnecessary to restore the groundwater in the B zone underlying the Property to a drinkable and usable state for the following reasons:
    - It is highly unlikely that the USACE would issue a permit for a massive groundwater water pumping remedy as proposed by ICON near Mississippi River levee system. The USACE has jurisdiction over activities near the levee and has strict requirements regarding any drilling within 1,500-feet of the Mississippi River levees. It should be noted that ERM was required to suspend the installation of monitoring wells when the Mississippi River stage was greater than 11 feet amsl.
    - Pumping the B zone, as proposed by ICON, would likely draw in naturally poor quality Mississippi River surface water.
    - The B zone is naturally non-potable, ICON is only proposing to use the water in the future to provide water for cattle.
    - The Property is served by Plaquemines Parish Water Works Belle Chasse District public water supply.

RECAP Evaluation

23. Ms. Angela Levert with ERM has conducted a RECAP evaluation of the soil and groundwater data obtained from the Property. This evaluation will be presented in a separate report authored by Ms. Levert.

Ecological Evaluation

24. Dr. Helen Connelly and Dr. John Rodgers have conducted an Ecological Risk Assessment for the Property. The results of this assessment will be presented in a separate report authored by Drs. Connelly and Rodgers.

NORM Evaluation

25. Dr. John Frazier has conducted an evaluation of the Naturally Occurring Radioactive Materials (NORM) data (including radium-226/-228 groundwater data). This evaluation will be presented in a separate report authored by Dr. Frazier.

Soil Remediation Plan

26. If the LDNR ultimately determines that soils exhibiting Statewide Order 29-B and/or RECAP exceedances require remediation, then ERM's plan will consist of targeted soil removal with offsite disposal and replacement, along with onsite land treatment with surface amendments. Approximately 8,600 in-place cubic yards of soil in seven areas have been identified for proposed excavation and offsite disposal at a Louisiana-licensed commercial disposal facility. In addition, approximately 32 acre-feet of the Property are proposed to be land treated utilizing soil mixing and blending and addition of surface amendments (e.g., gypsum, hay, etc.). The estimated cost to conduct the soil removal and land treatment remediation is approximately $2.18 million.

Water Supply Plan for Cattle

24. If a source of fresh water is required in the future to provide water for cattle over ICON's proposed B zone groundwater remediation area (maximum of approximately 25 acres; however only approximately 20 acres are currently available due to active E&P operations), ERM would propose either of these viable and reasonable alternatives to ICON's proposed massive groundwater pump and dispose remedy:

    - Tap into the Belle Chasse District's public supply. The estimated cost to provide water for up to 18 cows on 25 acres on the northwestern tract and the portion of the northeastern tract outside the Mississippi River levee for 30 years is approximately $133,000 based upon information on tap and water use fees obtained from the Plaquemines Parish Water Works. The Net Present Value of this alternative is approximately $63,000.
    - Retain a Louisiana-licensed water well driller to drill an approximately 250- to 300-foot water well into the brackish water Gramercy aquifer historically used in the area for oil well rig supply purposes. This well will be used to provide water for up to 18 cows on 25 acres of the northwestern tract and portion of the northeastern tract outside the Mississippi River levee. The estimated cost of drilling this well and providing the necessary pump, pressure tank, piping, etc. and operate and maintain the well and include the cost of electricity to run the pump for 30 years is approximately $41,000. The Net Present Value of this alternative is approximately $28,000.

    Other potential alternatives could include the collection of rainwater or use of surface water and/or Mississippi River water; however, either of the above are technically practical and reasonable alternatives as compared to ICON's massive pumping remedy.

Groundwater Monitoring Plan

25. Based upon the results of the groundwater investigation, the naturally poor groundwater quality, and the location of the Property, ERM does not recommend any remedy for groundwater. The A Zone is RECAP Class 3 and poor quality and the B Zone is of naturally poor quality and has effectively been managed as RECAP Class 3. Both of the A and B zones have not and are not being used, and are not viable future groundwater resources due to their naturally poor quality and their proximity to industrial property.

26. If the LDNR ultimately determines that the groundwater on the Property requires a remedy, a quarterly groundwater monitoring plan for the B zone is proposed based on the past, current and reasonably anticipated future land use. No monitoring is proposed or recommended for the Class 3, naturally poor quality A Zone. It is anticipated that groundwater monitoring for up to three years would generate sufficient data to demonstrate that the constituent concentrations are decreasing and/or in steady-state conditions. The estimated cost of up to three years of groundwater monitoring and reporting and plugging and abandonment of the ERM monitoring wells at the completion of the monitoring is approximately $141,000.

Critique of ICON's Remediation Plans

27. The excessive dig and haul proposed by ICON (i.e., the removal and replacement of 207,000 cubic yards of soil over 20 acres to depths up to 10 feet bgs) is not necessary to meet applicable and appropriate regulatory standards. It is also impracticable in that much of the area where soil excavation would occur is beneath active E&P production facilities and/or in close proximity to the Mississippi River levee. Finally, ICON's proposed remedy would provide little benefit, as the soils ICON proposes to remove and replace do not impact the current or reasonably-anticipated future use of the Property. Targeted removal and replacement of soils to address non-salt regulatory

exceedances soils containing highly-elevated salt levels and treatment with surface amendments to address salt in shallow soil, as proposed by ERM, would provide the same benefits at a small fraction of the cost.

28. ICON's groundwater remedy is not feasible and will do nothing to improve the naturally poor quality groundwater underlying the Property. In fact, ICON's A Zone remedy would likely draw groundwater in from beneath the Oronite plant onto the Plaintiffs' property. ICON's B Zone remedy will likely draw in Mississippi River water and saltier water from the west and would therefore do nothing to improve the groundwater quality.

29. A complete critique of ICON's report and remediation plans is provided in Section 14.

3. SITE SETTING

Investigation of the Hero Lands property focused on four tracts that comprise approximately 155 acres in the town of Belle Chasse in Plaquemines Parish, Louisiana. The tracts are located within the Stella Oil and Gas Field and are a mixture of undeveloped land, Mississippi River levee and batture areas, land used for oil and gas exploration E&P (i.e., industrial use) and the Chevron Oronite Plant (also industrial).

The subject property is bisected by LA Hwy 23. The eastern tracts of the Property are bordered by Hwy 23 to the west, the Mississippi River and its levee to the east, and the Chevron Oronite Plant to the south. The northwestern tract is bordered by Hwy 23 to the east and residential areas to the west and south. The southwestern tract is bordered by Hwy 23 to the east, a residential area to the north, and undeveloped forested lands to the west and south. The Property is located immediately southeast of the U.S. military's Naval Air Station Joint Reserve Base (NAS JRB).

The location of the Property is shown on Figure 1. The Property is situated in Sections 16, 17, and 18 of Township 14 South, Range 24 East and Sections 2 and 3 of Township 15 South, Range 24 East. The Property is situated along the western bank of the Mississippi River, as depicted on a United States Geological Survey (USGS) topographic map (Figure 2).

The four property tracts are zoned by the Plaquemines Parish Zoning and Planning Department as follows (Figure 3):

- SW Tract – I-3: Heavy Industrial
- SE Tract – I-3: Heavy Industrial
- NW Tract – C-2: General Commercial
- NE Tract – I-2: Light Industrial and I-3: Heavy Industrial

ERM communications with the Plaquemines Parish Zoning and Planning Department are provided in Appendix C. The Chevron Oronite plant located immediately adjacent to the SW and SE tracts is also zoned heavy industrial.

3.1 Land Use and Ground Surface Topography

Portions of the Property have been used for oil and gas E&P activities beginning in the 1940s, which continue today under the current operator, McGowan Working Partners, Inc. Current uses of the Property include oilfield operations, a barge cleaning facility (Evergreen Resource Recovery), a maritime transportation business (Port Ship Services), a portion of the Chevron Oronite Plant (an industrial facility that specializes in lubricants, fuel additives, and other chemicals) and its associated water treatment impoundment, a gas transmission pipeline, and at least two residences (one residence on the northwestern tract along LA 23 and one trailer on SW tract along Mullins Rd). The undeveloped portions of the western tracts are largely forested while the undeveloped portions of the eastern tracts are typically shrubby vegetation or dirt/gravel roads/work areas.

A large military base (the Belle Chasse NAS JRB) is located to the north and west of the Property. There are residential areas to the west of the northwest tract and between the northwest and southwest tracts.

Except for the man-made Mississippi River levees, the surface topography of the Property is generally flat, with natural elevations typically ranging from zero to 6 feet amsl, based on a review of the USGS topographic map (Figure 2) and the Light Detection and Ranging (LIDAR) Digital Elevation Model (DEM) provided as Figure 4. Due to historical Mississippi River flooding and the creation of natural levees, ground surface elevations gradually decrease towards the west from the man-made levees. The man-made Mississippi River levee has elevations up to 18 feet above amsl.

The eastern portions of the two eastern-most tracts of property are located within the 100-year floodplain based upon Federal Emergency Management Agency (FEMA) mapping (Figure 5). The rest of the Property is located within the 500-year floodplain.

The portion of the Property on the Mississippi River batture as well most of the southwestern tract are mapped by the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory as Freshwater Forested/Shrub Wetland (Figure 6). Potions of the Property were frequently flooded during ERM's and ICON's investigations of the Property.

3.2 Surface Water

The site is adjacent to the Mississippi River and nearby surface water bodies are shown on Figure 7. The Property is located within two Louisiana Department of Environmental Quality (LDEQ) drainage basin subsegments shown on Figure 8 and identified below:

- 020601 – Intracoastal Waterway-From Bayou Villars to Mississippi River (Estuarine); and
- 070301 – Mississippi River from Monte Sano Bayou to Head of Passes.

The Mississippi River drainage basin subsegment has designated uses of Primary and Secondary Contact Recreation, Fish and Wildlife Propagation, and Drinking Water Supply. It has numerical criteria for chloride of 75 mg/L and TDS of 400 mg/L.

The Mississippi River is hydraulically separated from the Intracoastal Waterway Drainage Basin subsegment (i.e., the portion of the Hero Lands property where E&P operations are present) by the Mississippi River levee system. Because it is estuarine, there are no chloride or TDS numerical surface water quality criteria for Subsegment 020601.

The Plaquemines Paris Water Works Belle Chasse District public water supply system, which utilizes surface water from the Mississippi River, serves the Property and the surrounding area. The Mississippi River surface water is fresh but contains numerous chemical and biological contaminants that are removed during treatment [see Table 1 for a summary of chemicals detected in surface water at the USGS Site No. 07374525 in Belle Chasse (Figure 7)]. Figure 9 provides Mississippi River gage height and chloride concentrations from USGS Site No. 0737525 for the 1976 through recent time period. The chloride concentration of Mississippi River surface water is less than 50 mg/L based upon the available USGS data.

3.3 Surface Soils

The U.S. Department of Agriculture (USDA) soil map (Figure 10) shows four primary surface soils types are present on the property. The northwestern and southwestern tracts consist of Schriever silty clay loam (Sh) soils and Schriever clay (Sk) soils. These soils are level and gently sloping, and poorly drained. They are located on backswamp deposits and are poorly suited for urban development, well-suited for pastureland and moderately well-suited for crops (where drained).

The portions of the northeastern and southeastern tracts to the east of Hwy 23 and west of the Mississippi River levee are classified as Cancienne silt loam (Cm, formerly known as Commerce silt loam). These soils are located on natural levees and are somewhat poorly drained and moderately slowly permeable. They are well suited for pastureland and cultivated crops.

The portion of the tracts to the east of the Mississippi River levee are classified as Carville, Cancienne, and Schriever soils, frequently flooded. These soils are located on natural levees and are somewhat poorly drained and frequently flooded.

The portion of the Property occupied by the Chevron Oronite plant is mapped as "Urban Land."

3.4 Geology

The geology underlying the Property is comprised of Quaternary age (Holocene) alluvial-deposited sediments. The New Orleans 30 x 60 Minute Geologic Quadrangle Map (LGS 2011) identifies the surface geology beneath the Property to be “Deposits of the Plaquemine delta lobe, Mississippi River” and “Natural levee complex of the Plaquemine delta lobe, Mississippi River” (Figure 11). Deposits of the Plaquemine delta lobe are composed of cyclically interbedded interdistributary peat and clay; natural levee silt and clay; distributary sand; and delta-front and prodelta mud and clay. The Natural levee complex of the Plaquemine delta lobe, Mississippi River unit consists of predominantly silt, silty clay, and clay (LGS 2011).

3.5 Hydrogeology and Groundwater Use

Nearly all (>99%) of the water use in the parish is obtained from surface water sources. Of the limited groundwater use that does occur, 92% of groundwater usage is industrial.

There are no major sources of fresh groundwater in Plaquemines Parish. The uppermost approximately 200 feet of soils beneath the Property are identified by USGS (2013) as mostly clay and silt. Along the Mississippi River, natural levee deposits consist of silts and sands. Groundwater in natural levee deposits is hydraulically connected to the Mississippi River and water levels in these deposits fluctuate with the stage of the Mississippi River.

The Gramercy and Norco Aquifers contain saline water in Plaquemines Parish. Historical USGS chloride data from water wells in the area also indicate that the groundwater is saline in the vicinity of the Property (Figure 12).

A generalized USGS hydrogeological cross-section of the area to a depth of 600 feet bgs is provided as Figure 13.

There are two rig-supply water wells located on the Property, based on the results of a search of LDNR’s Strategic Online Natural Resources Information System (SONRIS) database. The two wells, which were presumably installed and used during the drilling of oil and gas wells, have been plugged and abandoned.

There are 15 LDNR registered water wells within one-mile of the Property (1 domestic, 2 test hole, 5 rig supply, 1 irrigation, and 6 piezometers. There is currently only one active, non-monitoring (including piezometers) water well located within an approximate one-mile radius of the Property (Figure 14) which is used for irrigation. The abandoned domestic water well was screened at 250’ and likely contained saltwater.

4. HISTORICAL E&P OPERATIONS

The Property is located within the Stella oil and gas field, which was discovered in 1940. The discovery well, the Delta Minerals 7 #1, was drilled by the California Company to a total depth (TD) of 10,246 feet. There are 45 LDNR-registered oil and gas wells listed in the plaintiffs' petition, 39 of which are located on or near the Property (Figure 15). The California Company, a predecessor to Chevron, drilled 12 wells on the Property between 1940 and 1961. Chevron became the operator of record for those wells in 1965, and operated until 1971, when Energy Corp of America took over operations.

The first SWD began operations in 1984. Prior to the drilling and operation of the first SWD, produced water was discharged via pre-existing drainage ditches to the Gulf Intracoastal Waterway (GIWW) (Barnhill, 2020). Table 2 provides a summary of the operator history for each oil and gas and SWD well located on the Property developed using information from the SONRIS historical well files. There are currently 14 wells classified as active on the Property, including five active SWDs. The LDNR historical well files are provided in Appendix D.

A map showing the underground pipelines beneath the Property in the National Pipeline Mapping System (NPMS) database is provided as Figure 16. There are other underground lines beneath the Property (e.g., oil and gas flow lines) that are not listed in the NPMS database. Future development and use of the Property atop these pipeline corridors would be limited by their easements/rights-of-way.

Figures 17 through 42 are historical aerial photographs of the Property from 1936 through present time showing the development associated with E&P operations and other activities conducted on the Property.

The majority of the oil and gas infrastructure development and E&P activities have been conducted well before modern-day environmental regulations (e.g., Statewide Order 29-B and RECAP).

5. REVIEW OF AGENCY RECORDS

5.1 LDNR and LDEQ Records

The following sections summarize ERM's review of the available LDNR and LDEQ records related to E&P activities conducted on the Property.

5.1.1 LDNR Records

A summary of LDNR's regulatory involvement, as documented in its Pit Records and Inspection Reports, Lease Facility Inspection Reports (LFIR), and Compliance Orders (CO) and Notices is presented below.

5.1.1.1 Pit Records

LDNR has conducted numerous inspections of former pits on the Property since at least the early 1990s. There are seven LDNR-registered pits in the SONRIS GIS database (Figure 15), six of which are identified as reserve pits and one as a test pit. There is one former registered production pit (38P0189) associated with SN 83189, based on a review of LDNR's electronic records in SONRIS, LDNR's paper records and plaintiff produced documents.

A review of historical aerial photography identified a number of small, unregistered pits were used in E&P operations from the 1940s until the 1980s. Aerial photographs show that all visible pits were closed prior to the promulgation of Statewide Order 29-B in January 1986.

5.1.1.2 Lease Facility Inspection Reports

Over 330 lease facility inspections of 46 producing/SWD well locations and associated production equipment have been conducted by LDNR from 1986 through 2019 (Table 3). Only two of those lease facility inspection reports pertained a well for which Chevron or the California Company was the operator of record (SN 27226), and both of those indicated that the well site was in compliance. Most of the well locations have been inspected numerous times and the vast majority of the inspection reports document regulatory compliance. Subsequent inspections of the few minor violations reported on Table 3 document that the violations were corrected. Copies of LDNR documents reviewed, including those which contain LDNR lease facility inspection reports, are provided in Appendix E.

5.1.1.3 Compliance Orders

Forty-eight Compliance Orders have been issued by the LDNR to various operators over the last approximately 28 years (Table 4). Only one Compliance Order pertaining to wells operated by Chevron or the California Company has been issued. Compliance Order E-I&E 06-0103 was issued to the California Company on April 6, 2006 to plug and abandon SN 27226 and restore the location. A July 27, 2009 LDNR Lease Facility Inspection Report documented that the location is "In Compliance". Copies of the LDNR documents reviewed, including those which contain Compliance Orders, are provided in Appendix E.

5.1.2 Louisiana Stream Control Commission Records

The 1967-1971 Louisiana Stream Control Commission (LSCC) records document that Chevron applied for and receive approval to discharge produced water via hand dug drainage ditches on the Property. The water flowed into a larger ditch which then flowed to the west where the water was pumped into the Gulf Intracoastal Waterway (GIWW). A summary of the relevant LSCC documents is provided in Table 5 and the records are provided in Appendix F.

5.1.3 LDEQ EDMS Records

ERM conducted a review of LDEQ's Electronic Document Management System (EDMS) records associated with Agency Interest Nos. (AI) for the Chevron Oronite plant (AI No. 1708) and other industrial/commercial facilities located within the Property boundary and nearby (Figure 43). The LDEQ records for the AIs located on the Property primarily consist of air and water related permit and discharge documents for E&P facilities.

There are eight industrial facilities (AI#14414, AI#72424, AI#70956, AI#1002, AI#8268, AI#75431, AI#167120 and AI#1708 (A zone), the Oronite facility) in the vicinity of the Property where the shallow water-bearing zone underlying the facilities has been classified as RECAP Class 3A (Figure 44), which is consistent with the ERM's and ICON classification of the A zone underlying the Property. The B zone has been classified as RECAP Class 2 underlying the adjacent Chevron Oronite plant.

The shallow aquifer underlying the Oronite plant (AI#1708) is reported to be poor quality and low yield (2015-2016 RCRA Comprehensive Groundwater Monitoring Evaluation report by LDEQ, pg. 9)..

The shallow groundwater beneath the Belle Chasse NAS JRB, which is located to the west of the Property, is reported to be non-potable for the NAS and surrounding community due high salinity, chloride and mineral content. (AI#8268 – 4/30/88 Malcolm Pirnie Draft Final Addendum Preliminary Assessment Report pgs. 5-7).

Copies of the relevant LDEQ EDMS documents are provided in Appendix G.

6. GROUNDWATER MONITORING – ORONITE PLANT

The groundwater monitoring plan for the Chevron Oronite Plant was initiated in 1982 and has been ongoing under LDEQ oversight since then (see EDMS Records for AI#1708 in Appendix G); however, the first monitoring wells were installed in 1979 (Geraghty & Miller, July 1985). The first monitoring wells were screened in what was considered to be the uppermost aquifer, “30-foot aquifer” (ICON’s B-Zone) (Annual Groundwater Monitoring Report, March 1985). An extensive groundwater quality database has been established over the approximate 40-year time period since groundwater monitoring commenced. The historical groundwater monitoring data dating back to 1982 document the naturally poor quality groundwater underlying the plant and storm water impoundment (see 8/30/82 Chevron groundwater data submittal, 1/9/85 LA HW Permit Application, 3/1/85 Annual Groundwater Monitoring report and 6/28/16 LDEQ 2015-2016 RCRA Comprehensive Groundwater Monitoring Evaluation Report). The reported groundwater flow direction is typically to the west, i.e., away from the Mississippi River, starting as early as 1982 (1/9/85 LA HW Permit Application).

The LDEQ has been involved in regulating the soil and groundwater conditions beneath the Oronite plant and storm water impoundment for almost 40 years, recognizes the naturally poor water quality underlying the area, and has not required active groundwater remediation. Therefore, it is reasonable to assume that the LDNR and LDEQ would evaluate and regulate groundwater underlying the Hero Lands property in the same manner as beneath the Oronite plant, since portions of the Property are located immediately adjacent to the plant, the plaintiff’s property is zoned for heavy industrial and/or commercial uses, and the groundwater conditions do not change at the Property boundaries.

Copies of the relevant documents cited above are provided in Appendix G.

7. REGULATORY FRAMEWORK

7.1 Soil

The applicable and relevant and appropriate standards for soils are Statewide Order 29-B Chapter 3 pit closure criteria and LDEQ RECAP standards. The Statewide 29-B pit closure regulations establish standards for metals, salts, and hydrocarbons (oil & grease) in soils at E&P sites. RECAP was developed by LDEQ, based on EPA guidance, to provide a framework for evaluating risks to human health and the environment from chemical constituents in impacted media (e.g., soil and groundwater).

The soil data obtained from the Property have been compared to the following Statewide Order 29-B criteria (adopted in 1986) and to RECAP standards (adopted in 2003) where appropriate:

1. Range of pH: 6-9
2. Total metals (mg/kg wet weight, unless noted)
    a. Arsenic: 10
    b. Cadmium: 10
    c. Chromium: 500
    d. Lead: 500
    e. Mercury: 10
    f. Selenium: 10
    g. Silver: 200
    h. Zinc: 500
    i. True Total Barium: 40,000 (Upland) 20,000 (Wetland) (dry weight)
3. Oil and Grease: <1% (dry weight)
4. Electrical Conductivity (EC): < 4 mmhos/cm (Upland), < 8 mmhos/cm (Wetland)
5. Sodium Adsorption Ratio (SAR): < 12 (Upland), <14 (Wetland)
6. Exchangeable Sodium Percentage (ESP): <15% (Upland), < 25% (Wetland)

Soils within the root zone, defined by Dr. Luther Holloway as the uppermost two feet of surface soils, were compared to Statewide Order 29-B standards for land treatment in upland and elevated wetland areas, as appropriate. In addition to the promulgated LDNR salt standards, LDEQ established guidelines for salt parameters in a 2012 document entitled, “How should a release of brine (sodium chloride) be addressed under RECAP?”

The agronomic and RECAP evaluation of the vegetation and soil data are addressed in separate reports being prepared by Dr. Luther Holloway and Ms. Angela Levert of ERM, respectively.

7.2 Groundwater

There are no direct comparative groundwater standards provided in Statewide Order 29-B; therefore, the groundwater data have been evaluated in accordance with LDEQ’s RECAP regulations. In addition to RECAP standards, groundwater concentrations were compared to EPA’s Maximum Contaminant Levels (MCLs) and Secondary Maximum Contaminant Levels (SMCLs), where appropriate. MCLs are enforceable standards established by EPA to protect the public against consumption of drinking water contaminants that present a risk to human health. An MCL is the maximum allowable concentration of a

contaminant in drinking water which can be delivered to the consumer. SMCLs are non-enforceable standards that are used as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. MCLs and SMCLs do not apply to RECAP Class 3 groundwater.

LAC 43.XIX.303.C states that "Contamination of a groundwater aquifer or a USDW with E&P Waste is strictly prohibited." However, a February 25, 2011 Memorandum of Understanding (MOU) between LDNR and LDEQ establishes a mechanism for the use of RECAP procedures for the evaluation or remediation of groundwater at E&P sites. This interagency agreement recognizes that RECAP contains ground water evaluation and remediation standards and protocols that are applicable and appropriate for E&P sites.

Ms. Angela Levert of ERM has conducted a RECAP evaluation of the groundwater data obtained from the Property and this evaluation will be presented in a separate report authored by Ms. Levert.

Dr. John Frazier has conducted an evaluation of the groundwater radionuclide data and this evaluation will be presented in a separate report authored by Dr. Frazier.

7.2.1 Radionculides Rule

The Radionuclides Rule (65 FR 76707), promulgated on December 7, 2000, specifies a MCL of 5 pCi/L for Combined radium-226/-228 in Community Water Systems (CWS) (See relevant regulations provided in Appendix H). The Radionuclides Rule applies to all CWSs; however, the regulations do not apply to non-community water systems (US EPA, 2002, page I-4). A CWS is defined as:

"…a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents."

The Radionuclides Rule is not applicable to the following two types of Non-Community Water Systems (NCWS) as defined in 40 CFR Part 141 – National Primary Drinking Water Regulations (Appendix H).

"Non-transient non-community water system or NTNCWS means a public water system that is not a community water system and that regularly serves at least 25 of the same persons over 6 months per year."

"Transient non-community water system or TWS means a non-community water system that does not regularly serve at least 25 of the same persons over six months per year."

Due to naturally poor water quality and very low yield, the A and B zones are not a suitable source for a CWS or NCWS. Consequently, the Radionuclides Rule regulations (i.e., 5 pCi/L MCL for combined radium-226/-228) are not applicable to the groundwater in the A and B zones underlying the Property.

7.2.2 Louisiana Title 51 Public Health-Sanitary Code and LAC Title 56 Regulations

Any attempts at potential future use of groundwater in the Class 3A shallow water-bearing zones underlying the area for potential potable supply use could/would result in non-compliance with the Louisiana Title 51 Public Health-Sanitary Code regulations as outlined below:

> Part XII. Water Supply §347.A of the regulations state: "All inhabited premises and buildings located within 300 feet of an approved public water supply shall be connected with such supply, provided that the Property owner is legally entitled to make such a connection."
>
> The Part XII. Water Supply §327.A regulations further specify the following regarding all potable water supplies:

- "Every potable water well, and the immediate appurtenances thereto that comprise the well, shall be located at a safe distance from all possible sources of contamination, including but not limited to, privies, cesspools, septic tanks, subsurface tile systems, sewers, drains, barnyards and pits below the ground surface." (No. 2)
- "The earth formations above the water-bearing stratum shall be of such character and depth as to exclude contamination of the source of supply by seepage from the surface of the ground." (No. 5)
- "Private supply wells shall be cemented from a minimum depth of 10 feet to the ground surface." (No. 8)

Furthermore, Louisiana Administrative Code (LAC) Title 56 Part I. Section 319 regulations pertinent to small diameter (<4-inches) water wells located in coastal areas prone to flooding as a result of direct impact of storm surge events shall be constructed with:

"5. grouting down to a depth of at least 50 feet below ground surface."

The top of the A zone is as shallow as four feet below the ground surface on the Property. Potable water could not be obtained from this zone based upon the Sanitary Code and LAC Title 56 regulations cited above.

8. INVESTIGATION ACTIVITIES AND RESULTS

ICON conducted soil and groundwater investigations on the Property from November 2017 through June 2019. ERM conducted soil and groundwater investigations on the Property from November 2019 through August 2020. ERM's investigations were suspended from December 2019 until June 2020 when the water level in the Mississippi River stage rose above 11 feet amsl, as stipulated in the USACE Permit. This section describes investigation methodologies and presents the results of both ICON and ERM soil and groundwater investigations.

Appendix I contains ERM boring logs. Laboratory reports are provided in Appendix J. Field notes and photographs/photologs from ERM's investigation of the Property are provided in Appendices K and L, respectively.

8.1 Field Activities

8.1.1 Soil Sampling

Beginning in November 2017, ICON advanced 48 soil borings, 28 conductivity probes, and 5 hydraulic profiling tool (HPT) probes both on and off the Property. Soil samples were collected by hand auger or using hydraulic direct-push (i.e., Geoprobe) methods. ERM collected splits of the samples, unless limited sample volume did not allow for splits. Split samples were placed directly into containers and submitted to Element Laboratory (Element) in Lafayette, Louisiana for 29-B salts, metals and oil & grease testing and to Pace Analytical Laboratory (Pace) laboratory in Baton Rouge, Louisiana for analysis of total petroleum hydrocarbons (TPH) by fractionation methods, with a limited number of samples also analyzed for dioxins/furans. ICON's samples were submitted to Element for analysis. A summary of ICON and ERM's results from ICON's soil sampling is provided in Table 6, and a summary of dioxin/furan data is provided in Table 7. The locations of ICON soil borings are shown on Figure 45.

ICON conducted a survey for Naturally Occurring Radioactive Materials (NORM) in May 2019. ICON collected five samples from three locations which were analyzed for Radium 226 and Radium 228. ICON NORM sample and ERM split results are presented in Table 8. The locations of ICON NORM samples are shown on Figure 46.

In December 2019 through August 2020, ERM collected 149 soil samples from 60 soil borings to further characterize and delineate the extent of affected soils. Soil samples were collected by hand auger or by Geoprobe. Subsurface activities were suspended after the water level in the Mississippi River reached an elevation of 11' amsl, the threshold set by the USACE. Work was resumed in July 2020 when ERM collected 25 soil samples from 9 additional soil borings, and also re-sampled at select previous soil boring locations.

As with splits of ICON samples, ERM samples were submitted to Element for 29-B analysis and to Pace for RECAP parameters, this time including polycyclic aromatic hydrocarbons (PAHs). Three samples were submitted to Core Mineralogy, Inc. in Lafayette, Louisiana and analyzed for barium speciation using X-Ray Diffraction (XRD) methodologies. A summary of ERM's soil sampling results is provided in Table 9, with XRD barium results presented in Table 10. The location of ERM soil borings are shown on Figure 47.

8.1.2 Well Installation and Groundwater Sampling

From August 2018 through February 2019, ICON installed and sampled 42 monitoring wells at 28 locations both on and off the Property. ICON field personnel directed the installation of between one and three wells at each location. Well boreholes were advanced and sampled using hydraulic direct-push methods and each well was constructed of ¾-inch PVC with 5- to 10-foot screens. Wells were typically screened within water-bearing zones encountered between 8 and 38 feet bgs; however, two wells were

screened from 76 to 86 feet bgs, one well was screened from 42 to 52 feet bgs, and four wells were screened such that the top of screen was less than 8 feet bgs. ICON monitoring well locations are shown on Figure 48.

ICON monitoring wells were purged using a peristaltic pump with dedicated polyethylene tubing. Water quality parameters were measured using a Myron UltraMeter water quality meter and specific conductivity (SC), oxidation reduction potential (ORP), pH, and temperature were recorded. A log of water quality parameters for monitoring well sampling is included in Table 12. During ICON's sampling, ERM collected split groundwater samples in laboratory-provided containers and submitted the samples to Pace for analysis of metals (total and dissolved), benzene, toluene, ethylbenzene, and xylenes (BTEX), TPH, and water quality parameters including bromide, chloride, sulfate, bicarbonate/carbonate alkalinity, and TDS. Split samples were also sent to Eberline Analytical (Eberline) in Oak Ridge, Tennessee and analyzed for radium-226/-228. ICON's groundwater samples were submitted to Element for analysis. A summary of ICON and ERM's analytical data from ICON's groundwater sampling is shown in Table 13. ICON's monitoring wells were surveyed for top of casing (TOC) elevation and adjacent ground elevation in May 2019 by S.J. Langlinais & Associates (Langlinais).

In December 2019, ERM began installing monitoring wells, but work was suspended within certain distances of the Mississippi River levee when river levels rose above permitted levels, as required by ERM's USACE permit. Work was resumed in July 2020. ERM installed a total of 11 monitoring wells at nine locations. Wells were installed by hydraulic direct push methods and each well was constructed of one-inch diameter PVC casing with 5- to 10-foot pre-packed screens. Wells were screened in Zone A within the 10-24' depth interval or in the B Zone within the 38-51' depth interval. ERM monitoring well locations are shown on Figure 49.

ERM monitoring wells were developed using a peristaltic pump with dedicated polyethylene tubing until sediment was removed and water quality parameters stabilized. Water quality parameters were measured using a Myron UltraMeter water quality meter and SC, ORP, pH, and temperature were recorded. A log of water quality parameters for monitoring well sampling is included in Table 12. Prior to sampling, wells were purged until water quality parameters stabilized and groundwater samples were collected into laboratory-provided containers. Samples were submitted to Pace for analysis of metals (total and dissolved), BTEX, TPH, and water quality parameters, including bromide, chloride, sulfate, bicarbonate/carbonate alkalinity, and TDS. Samples were also submitted to Eberline for analysis of radium-226/-228. A summary of ERM's analytical data from ERM's groundwater sampling is shown in Table 14. ERM's wells were surveyed by Hydro Consultants, Inc., a Louisiana-licensed surveyor.

8.1.3 Aquifer Characterization

Slug tests were performed by ICON on eight wells in May 2019. ICON performed three rising head slug tests each on BC-1, BC-9, BC-14, BC-3B, BC-7B, BC-8B, BC-22B, and BC-28B. The recovery of water levels was automatically monitored in each well during the tests with hydraulic pressure transducers.

Slug tests were performed by ERM on five wells in March 2020. ERM performed three rising head and three falling head slug tests each on MW-1A, MW-1B, MW-5A, MW-6A, and MW-8B. The recovery of water levels was automatically monitored in each well during the tests with hydraulic pressure transducers.

The horizontal hydraulic conductivity of each slug test was estimated by ERM using the software package AqtesolvTM Pro by HydroSOLVE, Inc. Aqtesolv is capable of interpreting slug tests with a suite of analytical solutions for confined, unconfined, leaky confined, and fractured aquifers. Each slug test was interpreted with both the Bouwer & Rice (1976) and Cooper, et al. (1967) solutions. The horizontal hydraulic conductivity (and transmissivity for the Cooper, et al., 1967 solution) for each slug test was estimated using Aqtesolv's automatic curve-matching algorithms, which compute statistical best-fit

parameters for each solution. A summary of the slug test results is provided in Table 15 and the slug test data are provided in Appendix M.

8.2 Site Specific Geology/Hydrogeology

The lithology in the uppermost 100 feet beneath the Property is variable, due to its proximity to the Mississippi River. Geologic cross-sections based upon boring logs prepared by ERM are provided as Figures 50 through 52, and a cross-section location map is provided as Figure 53.

8.2.1 Lithology

Beneath the northern end of the Property, the geology is characterized by three deep boreholes: MW-1B, MW-8B, and BC-2D. The uppermost 10 feet bgs generally consists of clay to silty clay followed by ’a layer of silts and sands interbedded with clays to approximately 50 feet bgs. Another clay layer is present from 50 to 80 feet bgs. From 80 to 86 feet bgs, silts and sands were encountered. In BC-2D, the 10 to 50-foot interval containing the A and B Zones was heavily interbedded by clays.

Beneath the central portion of the Property, primarily around Mullins Road, the geology is characterized by seven boreholes: BC-9, BC-10, BC-11, BC-12, BC-22B, BC-23, and MW-5A. Boreholes in this area were advanced to depths between 20 and 28 feet bgs. The uppermost 5 to 10 feet consists of clay to silty clay, underlain by a layer of silt (and sometimes sand) to approximately 16 to 20 feet bgs, underlain by a thin (less than 5 feet) layer of clay, which is underlain by a layer of silt, generally to the termination of the borehole.

Beneath the southern portion of the Property, the geology is characterized by four boreholes: BC-21, BC-24, MW-6A, and MW-7A. The uppermost 10 feet bgs generally consists of clay to silty clay followed by ’a layer of silts and sands interbedded with clays to approximately 52 feet bgs. Another clay layer is present from 52 to 76 feet bgs. From 77 to the base of the boring at 92 feet bgs, silts with interbedded clays were encountered.

8.2.2 Groundwater Flow

Depth to water gauging data, survey elevations, and density-adjusted groundwater elevation data are presented in Table 16. The survey data are provided in Appendix N. Potentiometric surface maps from the gauging events conducted on May 7, 2019 (ICON wells) and July 29, 2020 (ERM and ICON wells) are plotted on Figures 54-57 for the shallow zone (ICON’s A zone) and Figures 58-61 for the deep zone (ICON’s B zone).

The groundwater elevation data from both water level gauging events show groundwater in both the A and B zone wells flows to the west. Based on an evaluation of the gage height from the USGS station from the Mississippi River at Belle Chasse (USGS 07374525), typical gage height has ranged from 8 to 18 feet over the last five years. The water level gauging event in 2019 was performed while the river was between 17 to 18 feet and the water level gauging event in 2020 was performed while the river was between 9 to 10 feet.

8.2.3 RECAP GW Classification

For the purposes of risk evaluation under RECAP, LDEQ recognizes three classifications of groundwater (GW1, GW2, and GW3). RECAP groundwater classification is based on the current and potential use of the groundwater as indicated by maximum sustainable yield and indicators of natural quality (i.e., TDS). Based on slug tests completed on site and the estimation of maximum sustainable yield, the uppermost water-bearing zone (ICON’s A zone) is RECAP Class 3 (GW3) with average potential yields less than 800 gallons per day (GPD), while the second water-bearing zone is RECAP Class 2 (GW2) with average

potential yields between 800 and 4,800 GPD. Although the B zone exhibits a yield within the Class 2 range, the B zone in the area (i.e. underlying the adjacent Oronite plant) is effectively managed by LDEQ as a Class 3 groundwater due to its naturally poor quality.

8.3 Summary of Soil Analytical Results

Soil results from each location were initially compared to 29-B Pit Closure standards and were further evaluated under RECAP. Additional RECAP results in areas without 29-B exceedances will be addressed in a report authored by Ms. Angela Levert. Any mention to RECAP soil limits in the sections below refer to the final RECAP limits in Ms. Levert's report.

ICON's soil results for metals were reported in dry weight. Per LDNR policy, wet weight or "as received" results should be compared to 29-B limits, except for True Total Barium (TTBa), which should be evaluated on a dry weight basis. This is also true of evaluations under RECAP. For the purpose of this evaluation, ICON metal results were converted to wet weight by adjusting for moisture content.

In instances where both TPH fractions data and TPH mixture data (i.e., TPH-GRO, TPH-DRO and TPH-ORO results) are available, the fractions data were used to evaluate hydrocarbon impacts, in accordance with the stated preference in Appendix D of RECAP.

Soil results for 29-B parameters from the northwestern, northeastern and southeastern tracts were compared to the 29-B Land Treatment standards for Upland areas. Per the USFWS wetland map, results from the southwestern tract were compared to standards for Elevated Wetland areas.

8.3.1 Soil Analytical Results - Northwest Tract

On the northwestern tract, ICON location BC-1 exhibited an arsenic concentration above the 29-B limit in the 4 to 6-foot interval. Additional sampling was performed by ERM to confirm and delineate the arsenic exceedance. Arsenic results from the northwest tract are plotted on Figure 62.

The soil samples beneath and adjacent to the production facilities for well SN 228392 exhibited exceedances of the 29-B salt limits. 29-B salts results from the northwestern tract are plotted on Figures 63-65.

Barium concentrations in soil samples collected on the northwestern tract are plotted on Figure 66.

8.3.2 Soil Analytical Results - Northeast Tract

Samples from the northeastern tract contained no metals or hydrocarbons results above 29-B limits or RECAP standards. One location sampled by ICON on property not owned by Hero Lands immediately south of the northeastern tract (BC-8/8R2) exhibited results above 29-B limits for oil and grease in the 2- to 6-foot depth interval. This location also contained TPH fraction results above the RECAP standard in the 2- to 6-foot interval. Oil and grease and TPH results from the northeastern tract are plotted on Figures 67 and 68, respectively.

Soil samples on the northeastern tract exhibited 29-B salt exceedances, except in the wooded area in the northernmost portion of the tract. 29-B salts results for the northeastern tract are plotted on Figures 69-71.

Barium concentrations in soil samples collected on the northeastern tract are plotted on Figure 72.

8.3.3 Soil Analytical Results Southeast Tract

On the southeastern tract, ICON location SB-4 exhibited results above 29-B limits for oil and grease in the zero- to two-foot interval. Additional sampling was performed by ERM to further evaluate the

hydrocarbons in this area under RECAP. Oil and grease results from the southeastern tract are plotted on Figure 73.

ICON location BC-14 exhibited results above the 29-B limit for arsenic in the 4- to 8-foot interval in the ICON split, but below the 29-B limit in the ERM split. Arsenic results from the southeastern tract are plotted on Figure 74.

29-B salts results for the southeastern tract are shown in Figures 75-77.

Barium and TPH fractions concentrations in soil samples collected on the southeastern tract are plotted on Figures 78 and 79, respectively

8.3.4 Soil Analytical Results Southwest Tract

On the southwestern tract, three locations (SB-6, SB-6R2, and SB-7) exhibited results above the 29-B limit for oil and grease in the two- to four-foot interval. Oil and grease results from the southwestern tract are plotted on Figure 80.

Two ICON locations (SB-13 and SB-14) exhibited results for True Total Barium (TTBa) above the 29-B limit. The zero- to two-foot sample from SB-14 barely exceeded the elevated wetland limit while ICON's split was well below the limit. Samples from SB-14R, collected to confirm and replicate samples from SB-14, did not contain TTBa above the 29-B limit. SB-13 exhibited TTBa results above the 29-B limit. ERM performed additional delineation for TTBa; the results indicated that samples to the west and north contained TTBa concentrations below the 29-B limit but samples to the south and east exceeded the TTBa limit. TTBa results from the southwestern tract are plotted on Figure 81.

Two ICON locations (SB-13 and BC-9) exhibited arsenic results exceeding the 29-B limit. The zero- to two-foot sample from BC-9 exceeded the arsenic limit while ICON's split did not. Arsenic results from resample location BC-9R were below the 29-B limit. SB-13 exhibited results for arsenic exceeding the 29-B limit in the zero- to two-foot interval. Arsenic results from the southwestern tract are plotted on Figure 82.

Twelve soil samples on the southwestern tract exhibited 29-B salt exceedances; one location exhibited EC results above 29-B wetland limits, one location exhibited ESP results above 29-B wetland limits, and twelve locations exhibited SAR results above 29-B wetland limits. 29-B salts results for the southwestern tract are plotted on Figures 83-85.

Barium and TPH fractions concentrations in soil samples collected on the southwestern tract are plotted on Figures 86 and 87-91, respectively

8.4 Groundwater Analytical Results

Fifty-five groundwater samples, not including splits, were collected by ERM and ICON from the A, B, and C zones from monitoring wells both on and near the Property. There are no direct comparative groundwater standards in Statewide Order 29-B; therefore, the groundwater data were initially evaluated in accordance with LDEQ's RECAP regulations. Based on RECAP groundwater classification, results from the A Zone were compared to RECAP GW3NDW standards and the results from the B and C Zones were compared to RECAP Screening Standards. Exceedances of these preliminary comparative standards do not indicate that remedial action is necessary, but instead that further site-specific evaluation under RECAP is warranted.

Exceedances of preliminary comparative standards for arsenic, barium, benzene, chloride, and combined radium-226/-228 are plotted on Figures 92 through 104. Parameters for which further RECAP groundwater evaluation is warranted are arsenic, barium, zinc, benzene, TDS and chloride. Additional RECAP evaluation of the groundwater will be addressed in Ms. Angela Levert's report.

The distribution of combined radium-226/-228 in the A and B zones shown on Figures 100 and 101 are being evaluated by Dr. John Frazier.

9. PROPOSED REMEDIATION PLAN

The remediation plan proposed in this document complies with Statewide Order 29-B with exceptions and RECAP regulations. As required by LAC 43:XIX.611.F.1, a hypothetical remediation plan for both soil and groundwater that complies with all the provisions of Statewide Order 29-B, exclusive of Subchapter 319 (referred to hereinafter as a “Hypothetical 29-B Plan”), along with a detailed discussion regarding why such a plan is impracticable, unreasonable and unnecessary, is included in Appendix O.

10. SOIL REMEDIATION PLAN

A comparison of soil results to applicable and appropriate regulatory standards identified exceedances of 29-B limits, but no exceedances of the final RECAP standards. Areas that exhibited exceedances of 29-B limits are on properties that are zoned commercial or industrial. Although these exceedances would need to be addressed to achieve regulatory standards, none of the documented soil impacts affect the current or reasonably-anticipated future use of the Property. Nonetheless, ERM has developed a plan to remediate/restore soils to meet 29-B limits.

10.1 Soil Removal and Replacement

Soils exceeding Statewide Order 29-B limits for metals and hydrocarbons (oil & grease) are limited to relatively small areas where historical E&P operations occurred. In order to achieve compliance with 29-B regulations, targeted removal and replacement of soils will be performed at the four areas shown on Figure105. In addition, three areas contain soils with highly elevated EC levels that are not amenable to treatment with surface amendments. Targeted soil removal and replacement will also be performed in these areas (Figure 106). Note that one of the proposed remediation areas on the northwestern tract is beneath an active E&P production facility, and that soil remediation could not be undertaken at that location until operations there ceased.

A summary of ERM's proposed removal and replacement volumes by tract is provided here:

Tract	Area (sq. ft.)	Volume (cu. yd.)
Northwest	21,889	1,621
Southeast	60,919	4,513
Southwest	32,854	2,434
Total	115,662 (2.66 acres)	8,581

Additionally, ICON advanced boring BC-8 within a former pit area that is actually not on Hero Lands property. Removal and replacement of 489 in-place cubic yards beneath 3,302 square feet in the BC-8 area would be required to meet 29-B limits and final RECAP soil standards. Because the BC-8 area is not on land in the lawsuit, soil remediation in this area is not included in our Hero Lands soil remediation plan.

Pre-construction activities associated with soil remediation will consist of the following:

- Prepare and file with the LDNR Office of Coastal Management a Joint Permit Application (JPA) for work in the Louisiana Coastal Zone;
- Prepare a site-specific health and safety plan;
- Perform a One-Call and conduct subsurface clearance activities; and
- Clear trees and vegetation, where necessary, to access work site.

Soil removal and replacement activities will include the following:

- Mobilize all necessary equipment and personnel to the site;
- Excavate soils with a track-mounted excavator and load directly into 20-yard dump trucks;
- If clean overburden is present, soils will be excavated and stockpiled onsite for later use as backfill;
- Transport soils to the Republic Services Colonial Landfill in Sorrento, Louisiana for disposal;
- Collect confirmation samples from excavations to confirm 29-B compliance;
- Test and purchase backfill from offsite source;

- Transport, place and compact backfill in lifts in excavations; and
- Seed backfilled excavation areas.

ERM obtained a bid from Diversified Enviro Products and Services (DEPS) for the removal and replacement of 8,600 in-place cubic yards of soil. The DEPS bid for this task, which is provided in Appendix P, was $1,207,657. The cost of remediation of the offsite pit area was estimated to be $75,000.

The costs associated with permitting, planning, remediation oversight, sampling and reporting are estimated to be $114,500, making the total cost of the soil removal and replacement component, excluding the offsite area, is $1.32 million (Table 16).

10.2 Soil Treatment

Exceedances of 29-B salt limits were reported in a number of samples collected on all four Hero Lands tracts. Because these are agronomic standards established to promote the growth of crops and other vegetation, it is appropriate to apply them only to soils within the effective root zone. The application of 29-B salt limits to soils within the root zone is consistent with LDNR's position at a number of other similar oilfield sites (e.g., the MAR Services Site, LDNR 2000).

To address slightly saline and sodic soils within the root zone in the approximately 16 acres shown on Figure 106, ERM recommends treatment with surface amendments and mixing and blending. Significant portions of the proposed treatment areas are beneath active E&P production facilities, and soil treatment could not be undertaken in those areas until operations there ceased. Based on the recommendations of Dr. Luther Holloway, the uppermost two feet of soil within the proposed treatment area will be restored to meet 29-B standards for land treatment in an upland area (the southwestern tract will be restored to elevated wetland standards) utilizing the following procedures:

- Using the soluble sodium data, calculate the appropriate volume of gypsum to treat the soil in each one-foot interval (i.e., 0-1 foot and 1-2 feet);
- Cut and clear the vegetation within the work area;
- Broadcast the prescribed volume of gypsum and hay for the 0 to 1-foot depth interval in the area to be treated;
- Gypsum will be broadcast using a spreader for even distribution;
- Using an excavator and bulldozer and/or other appropriate equipment, thoroughly mix the gypsum and hay with the 0 to 1-foot soil interval;
- Using a bulldozer or other appropriate equipment, set aside in stockpiles or wind-rows the 0 to 1-foot treated soils;
- Repeat the previous steps for the 1 to 2-foot interval; and,
- Place, lightly compact and water the 1 to 2-foot treated soils, then the 0 to 1-foot treated soils.

ERM obtained a bid from DEPS for treating 36 acre-feet (16 acres to a depth of 2 feet) of soil. The DEPS bid for this task, which is provided in Appendix P, was $620,840. The costs associated with planning, remediation oversight, sampling and reporting are estimated to be $235,000, making the total cost of the soil treatment remedy, excluding the offsite area, is $855,840 (Table 17).

11. GROUNDWATER SUPPLY PLAN FOR CATTLE

ICON's B Zone groundwater remediation plan suggests that the landowner plans to use the two northern tracts for cattle grazing; however, it technically impracticable to restore groundwater underlying the plaintiff's property for the reasons enumerated in Section 14.

As an alternative to ICON's technically impracticable and costly B Zone groundwater remedy, we propose two practical and cost-effective water supply alternatives to provide water for cattle for an assumed 30-year time period. We have assumed that the entire northern track and the portion of the northeastern track on the west side of the Mississippi River levee will be used for cattle grazing, a total of a maximum of approximately 25 acres. We have further assumed that the conversion of these two tracts to cattle pasture will occur immediately even though there are active oil and gas operations on both the tracts and it is our understanding that there are no plans to discontinue those operations. Finally, we have assumed the following based upon information provided by Dr. Luther Holloway:

- 1.4 acres per cow or approximately 18 cows on a maximum of 25 acres.
- 15 gallons of water per cow per day or approximately 450 gallons of water per day or 164,250 gallons of water per year for 18 cows

Supporting documentation from by Dr. Holloway is provided in Appendix P. Descriptions of the two alternatives are described below.

11.1 250- to 300-Foot Water Well Alternative

Based upon USGS groundwater quality data from the Gramercy Aquifer underlying the area, a water well installed in the Gramercy Aquifer at a depth of approximately 250 to 300 feet deep can supply brackish groundwater with a TDS concentration less than 3,000 mg/L. ICON identified a TDS concentration of 3,000 mg/L as their B zone remediation goal and a water quality threshold that is appropriate for cattle. ERM has obtained a cost estimate from a Louisiana licensed water well driller to install a four-inch diameter water well to a depth of 250 to 300 feet and provide a submersible pump and pressure tank. We have also obtained a cost estimate to purchase a metal 1000-gallon cattle water tank and estimated the piping and connections costs. In addition, we obtained operation and maintenance cost estimates from the driller to operate the well for 30 years. The estimated cost to install and operate one water well to supply ground water for 18 cows on a maximum of 25 acres for 30 years is approximately $41,000 as shown on Table 18. The Net Present Value (NPV) of this alternative is approximately $28,000 (Table 19). Contractor cost estimates and supporting documentation are provided in Appendix P.

11.2 Belle Chasse Public Supply Alternative

The area in which the plaintiff's property is located is served by the Plaquemines Parish Water Works Belle Chasse District public water supply system. A water main runs along the west side of Louisiana Highway 23 (Figure 107). ERM obtained information on tapping fees and water usage rates from the Belle Chase District. Based on this information, we have prepared a cost estimate to provide city water for 18 cows on 25 acres for a 30-year time period. The estimated cost to provide city water for 30 years is approximately $133,000 dollars, as shown on Table 20. The NPV of this alternative is approximately $63,000 (Table 21). Cost information provided by the Water Works and supporting documentation are provided in Appendix P.

12. GROUNDWATER MONITORING PLAN

Based on the results of the groundwater investigations and considering the location of the Property, ERM does not recommend any further action for groundwater. The A zone is RECAP Class 3 and the B zone, although GW2, contains water that is of naturally poor quality and has effectively been managed as a Class 3 zone. Neither of the shallow water bearing zones have been used, nor does either represent a viable future groundwater resource due to their naturally poor quality and their proximity to industrial property. If LDNR ultimately determines that the groundwater beneath the Property requires a remedy, the following monitoring plan is proposed based on the past, current and reasonably anticipated future land use:

- Purge and sample six B zone monitoring wells located on the northern tracts (Figure 108) on a quarterly basis to evaluate chloride and barium concentration trends over time and monitor the stability of the groundwater conditions;
- Measure water levels in each of the B zone wells and prepare a potentiometric surface map for each quarterly sampling event to evaluate groundwater flow conditions and possible seasonable variability in flow direction and gradient; an
- Prepare quarterly and annual groundwater monitoring reports to document the results of the monitoring activities and submit to LDNR.

It is expected that conducting the groundwater monitoring program for up to three years will generate sufficient data to demonstrate that the constituent concentrations are decreasing and/or in steady state conditions. The estimated cost of up to three years of groundwater monitoring and plugging and abandoning the ERM monitoring wells following the completion of the monitoring is approximately $141,000 (Table 22).

13. SCHEDULE AND REPORTING

The implementation schedule for the proposed remediation activities is provided below:

- Submit a JPA for a Coastal Use Permit approximately 60 days after receipt of LDNR approval of the proposed remediation plan;
- Review of JPA by all agencies and issuance of CUP typically requires 3 to 6 months;
- Begin proposed remediation activities within 60 days of receipt of the CUP;
- Submit a report to LDNR documenting soil remediation activities completed within 60 days following completion and receipt of final analytical laboratory reports. The report will include a description of work performed, remediation and sample location figures, data summary tables, copies of manifests, and analytical laboratory reports;
- Begin proposed quarterly groundwater monitoring within 60 days after approval of the proposed plan; and
- Submit quarterly and annual letter reports containing the results of each monitoring event within 45 days following receipt of final analytical laboratory reports. Each report will include a description of the sampling activities, sample location figure, data summary table, and analytical laboratory reports.

14. CRITIQUE OF ICON'S EXPERT REPORT AND RESTORATION PLAN

ERM has reviewed the July 12, 2019 Expert Report and Restoration Plan for the landowner prepared by ICON. We present here a critique of ICON's interpretations and suggested remediation/restoration plan.

1. ERM reviewed ICON's terrain conductivity survey (GEM survey) of the Property. The GEM is a non-intrusive, battery operated, hand-held electromagnetic instrument that is manually carried or pulled around via vehicle or on foot. ERM does not believe the GEM screening surveys provide a reliable indicator of subsurface impacts based upon our review of GEM data from numerous sites. The GEM instrument only provides screening level data that cannot be used to compare to Statewide Order 29-B or RECAP cleanup standards or be relied upon for remediation cost estimates.
2. ICON's property "Track B-N" inaccurately includes part of Highway 23 and a series of residential properties along S. Concord Rd. It also extends southward of the actual boundary for the northeastern tract to encompass a former pit that is not on the Hero Lands property (the BC-8 pit). The most current and accurate property records can be found through the Plaquemines Parish Tax Assessor's Office (https://plaqueminesparishmaps.azurewebsites.net/).
3. ICON's soil remediation plan does not account for the presence of ongoing E&P operations in a number of areas where soil removal and replacement and/or treatment is proposed. In currently active areas, the responsibility for site restoration lies with the operator of record when E&P activities cease and the lease is terminated. Therefore, ICON's plans for soil remediation in a number of areas are premature.
4. ICON's soil remediation plan calls for the removal and replacement of 207,000 in-place cubic yards of soil, much of it in areas in close proximity to the Mississippi River levee. A large-scale excavation in the vicinity of the levee could cause structural instability. For this reason, it is highly unlikely that the USACE would issue a permit for such and excavation.
5. ICON's proposed $34 million soil remedy is excessive, impracticable and unnecessary. The ICON remedy provides no greater benefit and is no more protective of human health and the environment than ERM's proposed targeted soil removal and replacement combined with onsite treatment of salt-impacted surface soils.
6. ICON identified the A-zone aquifer as EPA Class II drinking water source rather than evaluating the zone using Louisiana RECAP Guidance. RECAP states that a well yielding less than 800 gallons per day is Class 3. ICON estimated 164 to 517 gallons per day yield in the A zone, making it a RECAP Class 3 aquifer.
7. ICON used a single well to assert that the A Zone is fresh water because they could not find any other locations where the A-zone contained fresh water. Background values cannot be statistically verified from one sample.
8. ICON's B Zone groundwater remediation standard of 3,000 mg/LTDS is six times the EPA SMCL of 500 mg/L and demonstrates that the B zone groundwater is naturally non-potable.
9. ICON's TDS equals 3,000 mg/L line in the B-Zone is highly speculative/interpretive and based on a weak statistical analysis. The four "background" wells are approximately one mile from the Property and these four points are not statistically significant in determining the location of where background TDS equals 3,000 mg/L throughout the Property.
10. ICON's use of the groundwater SMCL chloride standard of 250 mg/L is inappropriate for the A zone since it is classified by RECAP as Class 3.

11. ICON's proposed groundwater remediation zones extend beyond the property boundaries:

Description	Total Remediation Area (acres)	Inside Property Remediation Area (acres)	Outside Property Remediation Area (acres)
GW Zone B	25.9	19.1	6.8
GW Zone A AOI 1	26.9	18.9	7.9
GW Zone A AOI 2	9.8	8.9	0.9
GW Zone A AOI 3	61.6	53.1	8.5
GW Zone A AOI 4	49.8	46.2	3.6
Total	**174.0**	**146.3**	**27.7**

12. ICON proposes to install and operate 421 groundwater recovery wells for up to 20.1 years to attempt to recover approximately 759,962,956 gallons of RECAP Class 3 and/or naturally poor-quality groundwater from the A and B zones (Figures 109 and 110). The demonstrated low yield of the A and B zones indicates that ICON's proposed groundwater pump and treat remedy will more likely than not be infeasible to implement. ICON proposes to install recovery wells in each shallow water bearing zone as follows:

    - A-Zone – 416 wells, 18' deep
    - B-Zone – 5 wells, 50' deep

    A review of the remediation areas shown on ICON's figures indicates that many of the recovery wells may be installed and operated off the Property and in some cases in residential property. Furthermore, if all 421 wells were to be installed, the ground surface could be rendered unusable for the 20.1-year duration of the proposed remedy.

13. ICON proposes to spend approximately $28.4 to $89.7 million to recover approximately 759,962,956 gallons (or approximately 37,998 average 20,000-gallon backyard swimming pools) of naturally poor-quality, unusable groundwater. Once recovered, ICON proposes transporting and disposing of the water offsite or injecting it onsite into two saltwater disposal (SWD) wells after processing the water through a reverse osmosis (RO) system. ICON's proposed groundwater cleanup to remediate naturally poor, Class 3 groundwater is not necessary, not cost effective, unprecedented, and not consistent with EPA's National Contingency Plan (NCP).

14. ICON proposes to haul and dispose of approximately 70% of the recovered groundwater (531,974,069 gallons, equivalent to 106,395 truckloads at 5,000 gallons per truckload) to the R360 Environmental Solutions in Bourg, LA facility located approximately 67 miles away. Each truck will travel approximately 134 miles each roundtrip, which will result in approximately 14.3 million road miles traveled. A total of approximately 14.3 million road miles will require burning 1,430,000 gallons of diesel fuel (~10 mpg), wear out approximately 2,566 tires (~100,000 miles each with 18 tires on 18-wheeler) and result in approximately 13 injuries and a 17% chance of a fatality based upon United States Department of Transportation (USDOT) statistics (Large Truck Crash Causation Study Interim Report, September 2002, pg. 58).

15. Approximately 68% of ICON's proposed $89.7 million dollar groundwater remediation plan (offsite disposal) is for the transportation and offsite disposal of millions of gallons of naturally poor-quality groundwater. Furthermore, ICON proposes to spend $2.36 million dollars for electricity to power the 421 recovery well pumps and the RO unit for up to 20.1 years.

16. ICON's proposed groundwater recovery well pumping rates for the A zone of 0.23-0.30 gallons per minute (GPM) are below the RECAP Class 3 standard of approximately 0.55 gallons per

minute GPM (800 gallons per day), further demonstrating that ICON is proposing to remediate Class 3 shallow groundwater underlying the Property.

17. The massive ICON groundwater remedy will likely limit the future use of the Property throughout the duration of their operation as a result of the operation and maintenance of 421 recovery wells, extensive piping, installation and operation of two SWDs, etc. for 20.1 years.
18. ICON's time estimate to remediate groundwater to ICON's alleged remediation goals ranges from 4.5 to 20.1 years. The Net Present Value (NPV) of ICON's hypothetical groundwater offsite disposal remedy would be approximately $25 million dollars lower than ICON's cost estimates, based upon standard EPA FS guidance (EPA 540-R-00-002, July 2000). The typical EPA FS alternative cost estimate is based upon a 30-year time period. Thus, if ICON's alleged groundwater remedy was ultimately deemed necessary by the LDNR (which is highly unlikely based on past experience with LDNR) and was feasible to implement (which ERM does not consider to be the case), the actual amount of money that would be required, approximately $64.5 million dollars, is substantially less than ICON's $89.7 million-dollar estimate (Table 23).
19. Since ICON has not conducted any pilot testing or long-term aquifer testing, there is no way to determine if ICON's proposed groundwater remedy will actually be able to achieve their stated cleanup goal. Long-term aquifer tests would need to be conducted to acquire field-scale measurements of hydrogeologic properties that are critical to a groundwater recovery system design [EPA (1997) - Design Guidelines for Conventional Pump-and-Treat Systems (EPA/540/S-97/507)]. Without additional comprehensive aquifer testing, individual well yields and zone yields are highly speculative based upon the variability in the composition, thickness, and depth of the shallow water-bearing zones.
20. The results of several long term (many years) pump and treat/disposal remedies for chloride that have been attempted in Louisiana have not been successful in significantly reducing the chloride concentrations in shallow groundwater (Appendix Q). The LDNR and LDEQ have been involved in regulating these remediation attempts and approved the shut-down of the recovery systems.
21. To our knowledge, ICON has never designed, installed, and operated a reverse osmosis (RO) unit for treating massive volumes of recovered groundwater. ICON has historically relied on RO unit cost estimates provided by a Canadian company, ERE, and GE Power Water & Process Technologies. ICON has used RO system quotes from these companies for multiple previous remediation cost estimates on similar legacy oilfield cases; however, they have not implemented one of their proposed projects. For this case, ICON is relying upon an RO unit cost estimate provided by Pure Aqua, Inc. based in Santa Ana, California for a completely different project that they never implemented. ICON continues to display a pattern of relying upon the same RO unit estimates that they have prepared for different legacy oilfield cases but have never implemented.
22. ICON has not considered/evaluated human health risks, current or future land use, feasibility, cost/benefit analyses, impact of their remedy on the environment, public input, regulatory review, and other factors that are considered by the LDNR and LDEQ in the remedy selection process.
23. ICON does not acknowledge that LDNR has a role in the remedy selection process, and ultimately has the authority for selection and approval of the appropriate remedy.
24. Implementation of the plaintiff's proposed remedy would:
    - Affect use of the Property by eliminating use of portions of the Property throughout the duration of the cleanup;
    - Require use of adjacent property that plaintiff has no right to use;

- Potentially damage the roads due to extensive amount of truck traffic;
- Potentially cause significant instability in the vicinity of the Mississippi River levee; and
- Endanger the lives of local residents though increased traffic and accidents.

The risk of implementing the plaintiff's remedy would result in significant human health and environmental impacts. The plaintiff's experts have not considered these impacts nor have they considered the massive cost of implementing their remedy, which is completely inconsistent with typical EPA and state cleanup guidance.

25. ICON has yet to implement a massive groundwater cleanup on a legacy oilfield site in Louisiana like the one they have proposed for the Hero Lands property. We are not aware of any oilfield site in the state of Louisiana where a massive ICON remedy has been implemented or has been required by the LDNR. In fact, the LDNR has rejected similar massive, unreasonable, excessive and not feasible groundwater remediation plans put forth by ICON and others as documented below:
    A. "Based on the information available on the record it appears that the Tensas Poppadoc's Plan (ICON's approximate $100 million dollar plan) is not the most reasonable plan and would require overly intrusive and expensive actions to be undertaken." The LDNR considered ICON's Tensas Poppadoc Plan, Concordia Parish, presented in the first Louisiana Act 312 Public Hearing to be "unreasonable" (See April 17, 2009 LDNR Evaluation/Remediation Plan for the Tensas Poppadoc property). (Tensas Poppadoc, Inc. vs. Chevron USA, Inc., et al., Docket No. 40769, Division B, 7th Judicial District Court, Concordia Parish, Louisiana)
    B. LDNR has also rejected a similar massive groundwater remediation plan ($865 million 56 year plan) in the Agri-South, L.L.C. et al., vs. Exxon Mobil Corporation, et al. case, Docket No. 24.132, 7th Judicial District Court, Catahoula Parish. The LDNR considered the groundwater plan "excessive, and not feasible." (October 3, 2013 LDNR Office of Conservation's Written Reasons in Support of Most Feasible Plan as Required by LA RS 30:29).

FIGURES

TABLES

APPENDIX A QUALIFICATIONS AND EXPERIENCE

APPENDIX B SUMMARY OF WORK PERFORMED AND MATERIALS RELIED UPON

Summary of Work Performed and Materials Relied Upon

The following tasks have been completed during the investigation of the plaintiffs' property.

1. ICON Environmental (ICON) conducted investigations of the plaintiffs' property between November 2017 and June 2019 that included the following:

   - Electromagnetic conductivity (GEM-2) survey conducted in November 2017. ERM was not notified of this survey and was not able to observe. The presence of numerous steel pipelines will result in interferences to the survey that are difficult if not impossible to remove from the results. MP&A does not believe the GEM screening surveys provide a reliable indicator of subsurface impacts based upon our review of GEM data from numerous sites. The GEM instrument only provides screening level data that cannot be used to compare to RECAP cleanup standards or be relied upon for remediation cost estimates.
   - Collection and analysis of 12 soil samples from 7 locations from depths up to 4 feet below ground surface (bgs) utilizing a hand auger in November 2017. The soil samples were analyzed for Statewide Order 29-B salt parameters [Electrical conductivity (EC), sodium adsorption ratio (SAR), & exchangeable sodium percentage (ESP)], metals, oil and grease (O&G), and total petroleum hydrocarbons (TPH) Diesel and Oil range mixtures. ERM was not notified of this sampling event and was not able to observe or split samples.
   - Collection and analysis of 158 soil samples from 41 locations from depths up to 76 feet bgs utilizing a hand auger and hydraulic, direct-push drilling rig from August 2018 to June 2019. The soil samples were analyzed for Statewide Order 29-B salt parameters, metals, O&G, and TPH Diesel and Oil range mixtures. ERM conducted oversight of ICON's soil sampling activities and collected and analyzed split samples.
   - Installed and sampled forty-three groundwater monitoring wells both on and off property between August 2018 and February 2019. Forty-two ground water samples (not counting duplicates) were collected and analyzed for metals, bromide, sulfate, alkalinity, chloride, total dissolved solids (TDS), TPH-D, TPH-O, benzene, toluene, ethylbenzene, and xylenes (BTEX), and radium-226/-228. ERM conducted oversight of ICON's well installation and groundwater sampling activities and collected and analyzed split samples.
   - Slug tests were performed by ICON on eight wells in May 2019. ICON performed three rising head slug tests on each of the following monitoring wells: BC-1, BC-9, BC-14, BC-3B, BC-7B, BC-8B, BC-22B, and BC-28B. The recovery of water levels was electronically monitored in each well during the tests with pressure transducers.

1. ERM conducted oversight of ICON's investigations from August 2018 through June 2019. ERM (formerly MP&A) personnel observed, documented, and split samples (soil and groundwater) during assessment activities performed by ICON. ICON collected soil samples, downhole electrical conductivity probes, completed and sampled monitor wells, and conducted slug tests on monitor wells. Upon notification, ERM observed these activities, recorded photos, field notes, and GPS coordinates, and split samples. ERM documented their observations through the recording of field notes and photographs.

   Note: ICON performed investigation work prior to ERM's involvement in the project beginning in November 2017. The work conducted consisted of collecting shallow soil samples with the use of a hand auger and conducting terrain conductivity (GEM2) surveys. ERM was not notified of this initial work and was not able to observe and collect split samples.

2. ERM conducted investigations of the plaintiffs' property from December 2019 to July 2020, however, due to high water levels in the Mississippi River, the US Army Corps of Engineers required subsurface work be shut down from February to June 2020. ERM's investigations included the following:

   - Ground penetrating radar surveys (GPRS) of proposed soil boring and monitoring well locations to identify the locations of underground lines.
   - Collection and analysis of approximately 174 soil samples from 69 locations from depths up to 14 feet bgs. The soil samples were analyzed by Element Materials Technology (Lafayette, LA) and Pace Analytical laboratories (Baton Rouge, LA) for different parameters on a case-by-case basis, parameters included:
     - Statewide Order 29-B salt parameters (EC, SAR, ESP) and cation exchange capacity (CEC)
     - Statewide Order 29-B metals, including arsenic, barium, true total barium (TTBa), and lead. Selected samples were analyzed by synthetic precipitation leaching procedure (SPLP) for barium and lead
     - Hydrocarbons: Statewide Order O&G, TPH fractions, and Polycyclic Aromatic Hydrocarbons (PAH)
     - pH, Total Moisture
   - Eleven soil borings/groundwater monitoring wells were installed utilizing a Geoprobe® track-mounted, hydraulic direct push drill rig using a dual tube sampling system. The soil borings/wells were installed by Walker-Hill Environmental, Inc. (WHE), a Louisiana-licensed water well driller, from Foxworth, Mississippi. The monitoring wells were completed with the Geoprobe® rig utilizing a dual tube sampling system and 3 ¼" outer-diameter core barrels and one-inch diameter, Schedule 40 PVC well casing, and 5-10 foot long pre-pack well screens (0.01" slot). ERM prepared soil boring logs and well construction diagrams for the soil borings and monitoring wells and these are provided in Appendix I.
   - Continuous soil cores were collected from each soil boring to total depth and the soil cores were visually logged by an ERM professional and Louisiana-registered professional geoscientist. Soil samples were analyzed in the field for EC using a field EC pen.
   - Each monitoring well was developed and purged utilizing a peristaltic pump with dedicated polyethylene tubing. Field parameters, including pH, temperature, Specific Conductance (SC), TDS, Oxidation Reduction Potential (ORP), and dissolved oxygen (DO) were recorded with a Myron Ultra meter during well development. Turbidity was measured with a field turbidity meter. The newly installed wells were purged until a minimum of three (3) well volumes were removed, and the groundwater field parameters had stabilized. If wells went dry before three (3) well volumes were removed, they were allowed to recharge to a minimum of 80% and purged again.
   - Collection and analysis of groundwater samples from ERM monitoring wells. Groundwater samples were collected, using disposable polyethylene tubing and a peristaltic pump. If wells went dry prior to field parameter stabilization, they were allowed to recharge to a minimum of 80% before a sample was collected. The samples were analyzed for total and dissolved metals, BTEX, anions and cations, TPH fractions, and TDS by Pace Analytical laboratory, Baton Rouge Louisiana. Groundwater samples were

analyzed for Radium-226/-228 by Eberline Analytical laboratory in Oak Ridge, Tennessee.

- January 1, 2020 Inspection conducted by Michael Pisani, P.E. and David Angle, P.G., CGWP
- Laboratory reports are provided in Appendix J.
- Field notes recorded by ERM personnel during the field activities are provided in Appendix K. Ground level photographs taken by ERM personnel during the field activities, along with logs of the photos, are provided in Appendix L.
- Hydro Consultants, Inc., a Louisiana-licensed professional land surveyor based in Baton Rouge, Louisiana surveyed the location, top-of-casing (TOC) and ground surface elevations of the ERM wells and TOC on a subset of ICON monitoring wells. The survey report is included in Appendix N.
- Measurement of water levels in ERM and ICON monitoring wells on July 28, 2020.
- ERM conducted slug tests on five ERM installed monitoring wells (MW-1A, MW-1B, MW-5A, MW-6A and MW-8B) on March 4-5, 2020. Before conducting the slug tests, the static depth to water and total well depth were measured from the TOC using an electronic water level indicator graduated to the nearest 0.01-foot. An In-Situ Inc. Level Troll 700 pressure transducer equipped with a continuous data logger was lowered to the bottom of each well. The data logger was set to continuously record water level data and was connected to a laptop PC, to monitor each test in real-time. Falling head (slug-in) and rising head (slug-out) tests were performed utilizing a 4-foot long, 0.5-inch diameter solid slug. During the falling head tests, the slug was quickly lowered into the well. The water was allowed to equilibrate in the well with the slug in. Upon equilibration, the rising head tests were conducted by removing the slug and allowing the water level in the well to return to static conditions. This process was repeated as necessary. Rising head recovery tests were performed by rapidly removing the slug and letting the water level in the well return to steady state. After completion of each slug test, the pressure transducer was removed from the well and water level data were uploaded for analysis.
- ERM analyzed the electronic data from these slug tests by uploading the water level data into AQTESOLV Version 4.5, a commercially available and widely used software program. The water level displacement data collected during each test were plotted electronically on a logarithmic scale vs. elapsed time on a linear scale. As specified in RECAP Appendix F, the Hvorslev (1951) and Cooper, et al. (1967) curve-matching methods for confined aquifers were used to calculate hydraulic conductivities, where possible. Well yields were calculated based upon LDEQ's RECAP Appendix F equations.

3. Dr. Luther Holloway conducted a root study on the Property in Mary-April 2020. This study included inspections of the vegetation and evaluation of root depths and soil conditions of the plaintiffs' property.
4. Reviewed and evaluated plaintiff expert reports and other data, and documents generated and produced by Plaintiffs' and Defendants including the following:
   - March 7, 2018 Petition
   - October 31, 2018 First Restated Supplemental and Amended Petition for Damages
   - July 12, 2019 Expert Report and Remediation Plan for the Landowners, ICON

- August 12, 2019 Engineering and Operations Report On Stella Oil Field, Charles R. Norman
- August 12, 2019 An Expert Report, Paul H. Templet
- August 12, 2019 Ecological Impacts Associated with Oil and Gas Exploration and Production Activities on Hero Lands Company, L.L.C. Property Within Stella Oil and Gas Field, Plaquemines Parish, Louisiana, Walker B. Wilson.
- August 26, 2019 Toxicological Evaluation and Risk Assessment Associated with Oil and Gas Operations on Hero Lands Company, L.L.C. Property Within Stella Oil and Gas Field, Plaquemines Parish, Louisiana, William J. Rogers
- Plaintiff and Defendant produced documents.

5. Obtained and reviewed LDEQ Electronic Data Management System (EDMS) records for the following Agency Interest (AI) numbers located on or near the Property: 1002, 1708, 8268, 14114, 70956, 72424, 75431, and 167120.
6. Obtained and reviewed the United States Geological Survey (USGS) map for the New Orleans 30 x 60 Minute Geologic Quadrangle that covers the Property and surrounding area.
7. Obtained, mapped, and reviewed soil data from the United States Department of Agriculture (USDA) Natural Resources Conservation System database (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm).
8. Obtained, mapped, and reviewed underground pipelines utilizing the National Pipeline Mapping System (NPMS) database (https://www.npms.phmsa.dot.gov/).
9. Obtained, mapped, and reviewed water well information from the LDNR SONRIS GIS locator database and LDNR water well files (http://www.sonris.com/)
10. Obtained, mapped, and reviewed surface water data for Louisiana Department of Environmental Quality (LDEQ) Drainage Basin Subsegment LA020601 (Intracoastal Waterway – From Bayou Villars to Mississippi River (Estuarine)) and LA070301 (Mississippi River – From Monte Sano Bayou to Head of Passes) [http://www.deq.louisiana.gov].
11. Obtained, mapped, and reviewed water quality data from the USGS database: (http://nwis.waterdata.usgs.gov).
12. Obtained, geo-referenced, and reviewed numerous historical aerial photographs of the property area. Sources include Louisiana State University (LSU) Cartography Department (Atlas), USGS, Google Earth, and ArcGIS Online.
13. Obtained, mapped, and reviewed Light Detection and Ranging (LIDAR) ground surface elevation data from Louisiana State University (http://atlas.lsu.edu/lidar/).
14. Obtained and reviewed literature on soils and geology/hydrogeology from the United States Department of Agriculture (USDA), Louisiana Geological Survey (LGS), USGS, and other published references.
15. Reviewed and consulted the following:
    - LDEQ RECAP regulations and guidance;
    - LDNR Statewide Order 29-B regulations;
    - Louisiana Title 51 Public Health – Sanitary Code Part XII. Water Supplies;
    - EPA MCLs and SMCLs.

Data and information gathered and evaluated as part of the above tasks were relied upon for the development of this report. ERM may supplement the opinions presented herein based on the receipt and review of additional information.

APPENDIX C ZONING INFORMATION

APPENDIX D LDNR HISTORICAL WELL FILES

APPENDIX E LDNR INSPECTION RECORDS AND COMPLIANCE ORDERS

APPENDIX F STREAM COMMISSION CONTROL RECORDS

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[See attached CD]

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