EXPERT REPORT AND VEGETATION ROOT STUDY, HERO LANDS COMPANY, L.L.C. PROPERTY PLAQUEMINES PARISH, LOUISIANA

IN THE MATTER:

HERO LANDS COMPANY, L.L.C.

VERSUS

CHEVRON U.S.A. INC. ET AL.

DOCKET NO. 64-320, DIV. "A"

25TH JUDICIAL DISTRICT COURT

PARISH OF PLAQUEMINES

STATE OF LOUISIANA

PREPARED BY:

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MAY 8, 2020

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1.0 Introduction, Description and Land Use of the Property

1.1 Introduction

For the litigation, recorded as *Hero Lands Company, L.L.C. v. Chevron U.S.A., Inc. et al*., Docket No. 64-320, 25TH Judicial District Court, Parish of Plaquemines, State of Louisiana, Holloway Environmental Services, Inc. has been retained by Chevron U.S.A., Inc. Dr. Luther F. Holloway visited the Hero Lands Company, L.L.C. Property (Hero Lands) three times. He conducted a site review with attorneys and defendant experts on January 21, 2020, conducted site reviews and a root study on March 30-31 and April 1-3, 2020 and returned April 27, 2020 to perform site reviews and make additional observations.

The defendants in this case have been sued by the plaintiffs for various allegations of damages to their property including soil and groundwater contamination. Experts for the plaintiffs (Miller and Sills, 2019) have proposed two potential options for remediation of alleged soil contamination areas. The first option would be remediation of soil to 29B Regulatory Standards for uplands and for wetlands by digging out soil for disposal and replacement using clean soil stockpiled onsite or soil excavated from an offsite location. Another option would be using a liquid gypsum amendment for onsite remediation, all to depths of 2 to 10 feet depending on location. The total cost of soil remediation would be $34,288,601.00 dollars. Much of the plaintiff's proposed remediation would occur in areas within active well sites and other ongoing E&P activities. They also recommended remediation for a tract between the east Hero Lands tracts between Highway 23 and the Mississippi River levee that is not part of the lawsuit.

This report considers the characteristics of vegetative communities for root penetration in order to determine depths of trees and vegetative communities growing on the Hero Lands property. Also considered are characteristics of the vegetation communities for root penetration in order to determine depths of the effective root zones (ERZs) of plant species growing on the property area. This consideration is very important to determine the appropriate depth of remediation for propagation of the trees and other vegetative communities growing on the Hero Lands property. These data represent a site specific study which relates directly to the property under investigation and at issue in this litigation. Additional reviews of the subject properties were made to determine general conditions of the vegetation growing at various sites and under varying conditions over the tracts.

1.2 Location and Site Description of the Hero Lands Tracts

Figure A-1 shows the general location of all of the four Hero Lands tracts that are involved in the lawsuit while the general property boundaries are shown in a USGS map in Figure A-2. Figure A-3 is a high resolution imagery basemap for the Hero Lands tracts. The property is located on the west natural levee of the Mississippi River on the south side of the town of Belle Chasse, Louisiana. Part of the property lies on the batture side of the Main Line Mississippi River Levee. This area was in flood during the conduct of this study and could not be accessed for vegetative root investigations. The remainder of the Hero Lands property is located west of the levee and is bisected by Louisiana Highway 23 and the New Orleans and Gulf Coast Railway Company line that runs north to south between the east and west property parcels. For purposes of this report the four Hero Lands tracts are designated as northeast (NE), southeast (SE), northwest (NW) and southwest (SW). All four tracts total approximately 164 acres.

1.3 Previous, Present and Future Land Use

Early historical photographs in the 1930s of the Hero Lands property in the area reviewed for this report show that the tracts were mostly used for pasture. Since lateral ditches can be seen on early historical aerial photos of the tracts west of LA Highway 23, it is very likely that much of these western tracts were farmed to crops. At later times the property has been used for oil field exploration and production activities (E&P) with some parcels used for pasture. Present-day use is for oil field E&P activities. There is a home and two trailers located on the northwest side of the property. The southwest tract has an impoundment that is operated by the Chevron Oronite Company that is located across the highway/tracks to the east. Future use of the property will likely continue to be for oil field E&P activities and the impoundment facility.

2.0 Geology, Physiography, Soils, Vegetation

2.1 Geology and Physiography

As shown in Figure A-4, the Louisiana Geological Survey has mapped the subject tracts as Qnl, Quarternary Natural Levee, derived from Mississippi River overbank and backswamp floodplain deposits.

2.2 Elevation and Relief

Figure A-5 is a LIDAR (Light Detecting and Ranging) ground surface elevation model that shows the elevations within the Hero Lands property tracts to range from 8 to 12 feet

NGVD on the batture land on the unprotected side of the Mainline Mississippi River Levee. Most of the tracts west of the levee range from 2 to 6 feet NGVD.

2.3 Soils

The Soil Survey of Plaquemines Parish posted on the USDA Web Soil Survey site (Soil Survey Staff, 2019) shows six types of soil map units on the properties (Figure A-6). The following descriptions generally follow that of the Web Soil Survey, Soil Survey of Plaquemines Parish (Soil Survey Staff, 2000) and USDA Official Soil Series Descriptions.

Carville, Cancienne and Schriever soils, frequently flooded (Cv) consists of mineral soils that are level and somewhat poorly drained and poorly drained. Slopes are generally less than 1 percent. These soils are located on the unprotected banks (batture lands) between the Mississippi River and the protection levees. The Carville soil makes up about 40 percent of the map unit, the Cancienne about 30 percent and the Schriever soil about 20 percent. These soils are subject to frequent flooding as the river seasonally rises and falls. The soil pattern is irregular with some areas containing all Carville, some all Cancienne, some all Shriever and other areas containing all of the soils. These soils are frequently flooded by the Mississippi River. Unless it is drained and protected from flooding, the soil is not suited for cropland, pasture, woodland or urban uses due to extensive flooding. This soil provides habitat for some game animals and associated species. Hunting and fishing are popular in some areas.

Cancienne silt loam (Cm), 0 to 1% slopes, consists of somewhat poorly drained silty alluvium that formed on natural levees. The Cancienne series consists of very deep, level to undulating, somewhat poorly drained mineral soils that are moderately slowly permeable. These soils formed in loamy and clayey alluvium. They are on high and intermediate positions on natural levees and deltaic fans of the Mississippi River and its distributaries. A saturated zone is perched above the clayey lenses or layers and is at 1.5 to 4 feet below the surface during December through April. Most areas are protected from flooding by levees. Unprotected areas are subject to occasional to frequent flooding for brief to long durations. Typical profile consists of silt loam in the first 23 inches and silty clay loam from 23-80 inches. Areas are used mainly for cropland; sugarcane, soybeans, corn and wheat are the principle crops.

Schriever silty clay loam (Sh), 0 to 1 percent slopes, consists of very deep, poorly drained very slowly permeable soils that formed in clay alluvium. The soils occur on the lower parts of natural levees of the lower Mississippi River alluvial plain and its tributaries. Schriever silty clay loam has high fertility. Typical soil profiles are composed of silty clay loam from the surface to 5 inches and clay from 5 to 60 inches in depth. Water moves

through this soil very slowly. Water moves off the surface slowly and stands in low places for long periods after heavy rains. This soil has a seasonal high water table with a depth to the water table of about 0 inches for parts of the year. This soil is moderately well-suited to cultivated crops. Wetness and very slow permeability are the main limitations. The growth of crops is limited by the very high clay content but increase in the content of organic matter in the soil helps prevent crusting and improves tilth. Suitable crops are soybeans and sugarcane with proper drainage. This soil is well-suited for pasture. Wetness and very slow permeability are the main limitations. Species such as Bermuda grass, Dallas grass, rye grass and white clover are suitable pasture plants. This soil is well-suited to southern hardwoods and has good production potential. This Schriever soil is also suitable for urban use, however, it is not suitable to home site development because of flooding, seasonal high water table and high shrink swell.

Schriever clay (Sk), 0 to 1 percent slopes consists of soils very similar to the Schriever silty clay loam, however, these soils are located at lower positions on the edges of the Mississippi River natural levees and backswamp areas. This silty clay loam soil has high fertility. Water and air moves through this soil very slowly and water runs off the surface slowly and stands in low places for long periods after heavy rains. Seasonable high water table fluctuates between a depth of about 2 feet and the soil surface from December to April. Typical soil profiles of Schriever clay are composed entirely of clay from the surface to 80 inches in depth. This soil is often susceptible to increased flooding conditions due to its location at lower elevations. This soil is somewhat poorly suited to most cultivated crops and pasture. Wetness and poor tilth are limitations for farming these soils. The main limitations are wetness and very slow permeability. Bermuda grass is the main suitable pasture plant. This soil is well-suited to southern hardwoods, however, wetness often limits timber harvest practices. This soil is poorly suited to most urban areas and it is not suitable for building sites due to wetness, very slow permeability and high shrink swell potential.

Vacherie silt loam (Va), 0 to 1 percent slopes, occurs as a small area at the very north portion of the northeast tract between the Mississippi River levee and Highway 23. The Vacherie series consists of deep, somewhat poorly drained, very slowly permeable soils that formed in silty and clayey alluvium. These soils are nearly level to very gently sloping floodplains of the Mississippi River. Natural fertility of Vacherie silt loam is high and permeability is very slow. A typical soil profile of Vacherie silt loam ranges from silt loam at 0 to 24 inches, silty clay at 24 to 33 inches and clay from 33 to 60 inches. The water table ranges from about 12 to 36 inches with no flooding or ponding. Vacherie soils are typically used for crops and pasture with some areas used for woodland and wildlife. Typical crops are sugarcane and soybeans. Pasture plants include Bermuda

grass, Dallas grass, rye grass and white clover.

Urban land (Ub). A small portion of the southwest corner of the southeast tract is designated as Urban land.

2.4 Vegetation

Vegetation on the Hero Lands tract consists of bottomland hardwood stands on the northwest and southwest tracts west of Highway 28 and on the northern portion of the northeast tract between Highway 23 and the Main Line Mississippi River Levee. The hardwood stands in these areas consist of mostly young stands with a spotty distribution of older trees. Overstorys in these areas consist of water oak (*Quercus nigra),* sugarberry (*Celtis laevigata*), sweetgum (*Liquidambar styraciflua*), box elder (*Acer neguno)*, common persimmon (*Diostyros virginiana*), green ash (*Fraxinus pennsylvanica*), occasional sweet pecan (*Carya illinoensis),* white mulberry (*Morus alba*), red mulberry (*Morus rubra*), American elm (*Ulmus Americana*), Chinese tallow tree (*Triadica sebifera*) and black willow (*Salix nigra*) in some of the wetter locations. Only one Nuttall oak (*Quercus* texana) and one chinaberry tree (*Melia* azedarach) were noted at the study sites. Understory species generally consist of reproduction of the overstory along with species such as Chinese privet (*Ligustrum sinense*), roughleaf dogwood (*Cornus drummondii*), deciduous holly (*Ilex decidua*) and an occasional dwarf palmetto (*Sabal minor*). Ground cover in most of the wooded areas on the tract is very sparse consisting mostly of vines such as poison ivy (*Toxicodendron radicans*), peppervine (*Nekemias arborea*), Virginia creeper (*Parthenocissus quinquefolia*), ladies' eardrops (*Brunnichia ovata*) and trumpet creeper (*Campsis raticans*). Other herbaceous plants noted on the property included blackberry (*Rubus argutus)* and southern dewberry (*Rubus trivialis*). In one location on the southwest side of the northwest tract, citrus trees had been planted. These included lemon (*Citrus x limon*) and grapefruit (*Citrus x paredisi).*

At open areas around production sites and other areas of E&P operations woody species in the surrounding areas and edges consist of typical bottomland hardwood species and shrubs such as silverlings (*Baccharis halimifolia*) that have invaded the sites. Herbaceous stands in these areas include species such as Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halepense*), Dallas grass (*Paspalum dilatum*), Vasey's grass (*Paspalum urvillei*), St. Augustine grass (*Stenataphrum secundatum*), frog fruit (*Phyla lanceolata*), powderpuff (*Mimosa strigillosa),* basketgrass (*Oplismenus hirtellus*),torpedo grass (*Panicum repens),* curly dock (*Rumex crispus*) and foxtail (*Setaria pumila*). Other species in the areas surrounding the production sites included species such as goldenrod (*Solidaga altissima*), marsh goldenrod (*Solidaga sempervirens*), Brazilian vervain (*Verbena Brasiliensis)*, Spiny thistle (*Cirsium horridulum*), giant ragweed

(*Ambrosia trifida*), common ragweed (*Ambrosia artemisiifolia*) and annual marsh elder (*Iva annua)*. Wetter areas around production sites also included numerous nutsedges and plant sedges (*Cyperus* spp.).

Areas on the south side of the northeast tract and the southeast tract of the Hero Lands property contain scrub-shrub communities consisting of woody species such as young green ash and water oak, Drummond red maple, box elder, silverling and Jesuit's bark (*Iva frutescens*). Herbaceous plant species consist of marsh goldenrod, bigpod sesbania (*Sesbania herbacea*), annual marsh elder, seashore dropseed (*Sporobolus virginicus*), Malabar sprangletop (*Leptochloa fusca*) and numerous sedges and rushes.

3.0 Plant Root Study

3.1 General Aspects

Since scant literature exists in the area of the effects of oil field E&P activities on plant roots, the author, and occasionally with others, has undertaken numerous site specific investigations to determine root depths and effective root zones (ERZs) of plants growing in and around areas of alleged oil field impacts. During the course of these investigations, he has found that root densities and penetrations in various soil types have varied greatly from site to site. This is particularly important with the changes in soil types, disturbance factors, area hydrology and the intended future use for various properties. As such, it is imperative to tailor an investigation that is specific to the plants and soils of the areas of alleged impact and surrounding areas in order to determine the particular depths at which plant roots grow and for the potential formulation of depths where remediation measures may be required.

Another important consideration that I have found in many studies is that depths or depth intervals of soil samples for salt parameters such as electrical conductivity (EC), exchangeable sodium percentage (ESP) and sodium adsorption ratio (SAR) generally overestimate (at many times grossly so) these parameters. For example, soil samples extracted from the 0 to 2 foot and 0 to 4 foot depths below ground surface, which is mixed for analysis, can show levels that are much higher than those within the ERZs that only extend to 6 to 12 inches in depth. To be accurate for salt parameters in root zones, zones, soil samples should reflect specific depths of the ERZs and/or root zones, not deeper depths where roots do not occur or occur in only negligible quantities.

3.2 Methods

During the three site visits E&P production sites, forested communities, herbaceous

stands and other areas of importance were visually examined. In order to determine past and present impact of oil field E&P activities on the four subject tracts, plant communities were viewed for general health of the vegetation, signs of oil field E&P impacts on the plants and plant successional stages.

To determine the root depths and distributions of the woody vegetation, seven trees were selected for study (T-01 to T-07). The locations of these plants are shown in Figure A-7. The general distribution of the typical plants that grow in the area were chosen for study and represent a general mix of the most abundant species that occur on the subject tracts. Trees selected for the study were measured at diameter at breast height (dbh). The dominant roots extending from the trees were measured for depth to top of root at various distances along their lengths. They were also measured from the bole (trunk) of the tree to the deepest depth in most cases. These data were entered on a root form along with species name and coordinates showing the location of the plant. Extensive reviews were conducted of the dominant roots on the trees by probing with steel rods to determine the general depths of all of the major roots around the tree. Along with the major roots, views of the roots and the growth of feeder roots were also taken of the trees. Photographs of individual trees, root distributions and surrounding plant communities are shown in Appendix B while root depths and other important information for the trees are shown on the tree root forms in Appendix C.

To determine the root depths and distributions of herbaceous species growing on the Hero Lands tract, two locations were selected for study (H-01 and H-02). The locations of these stands are shown in Figure A-8. At each observation site a pit was dug with a sharpshooter hand spade to a depth to where the overwhelming majority of roots were visible along the soil profile under the plant stand. Additionally, pits were dug to additional depths where no roots were visible. At each observational area, photographs were taken of the surrounding plant stands and the soil profile and are shown in Appendix B. At each site the prevalence of the roots was recorded and the data are shown in Appendix C. They consisted of a rating scheme of very abundant, abundant, common, sparse, very sparse and none for the root distributions along the soil profile. In the root investigations, at the same time that the roots were viewed or probed, a review was made of the existing plants around the sample point to determine the plant conditions and the notation of any impacts such as leaf scorch, leaf burning and dieback from any potential E&P impacts such as soil saline/sodicity conditions. Other factors watched for were epicormic branching, witches' brooms, dieback and other known features of salt or petroleum hydrocarbon impacts. Where applicable, this information is given in the results section below for various observation points. During the three site visits E&P production sites, forested communities and herbaceous stands around

production areas were visually examined. In order to determine past and present impact of oil field E&P activities on the four subject tracts, plant communities were viewed for general health of the vegetation, signs of oil field E&P impacts on the plants and plant successional stages.

In my studies, I use ERZ to mean the depth of the roots that are necessary for the plants to grow and complete their life cycles. The ERZ does not normally represent the deepest roots but comprises the depth where the majority of the roots that sustain the plants through growth and reproductive phases reside. While some may use ERZ to mean the area where eighty percent of the roots reside beneath the plants and from where the plants receive their nutrients, this definition generally underestimates the depth of the ERZs, therefore, the former method was used to evaluate roots on the subject tracts. These depths represent generous ERZ levels for the roots observed in this study.

3.3 Results

In order to determine root depths, 9 observation areas were set up across the subject tracts as described above. Locations of these areas are shown in Figures A-7 and A-8. These included typical and healthy woody trees and herbaceous stands. Appendix B shows the photographs of the plants that were observed along with plant stands in surrounding areas, where applicable. The data for each of the root systems observed at each location shown in the root forms is also located in Appendix C with data shown down to various depths. Each root observation area that was investigated is described in the following section.

3.3.1 Observation T-01 – Water Oak (*Quercus nigra);* DBH = 9.9"; ERZ = 6.5"

Tree T-01 is a water oak that is located on the southwest tract as shown in Figure A-7. Photo B-1 shows the crown of the tree at the time of the investigation. Photo B-2 shows the bole of the tree prior to the beginning of the root observations. The measurement at dbh is 9.9 inches. This tree is in excellent condition both in the top and along the bole showing no evidence of any kind of impacts or any kind of symptoms from oil field E&P activities such as salinity/sodicity factors or from petroleum hydrocarbons. Photo B-3 shows the vegetation facing to the east from the tree. Vegetation in the overstory consists of a mixed stand of mostly water oak, some sugarberry and sweetgum as the dominants and an occasional sweet pecan. Understory is mostly young sweetgum

along with some Chinese privet dotted around the area. Ground cover is extremely sparse in this area consisting mostly of poison ivy and some Virginia creeper. All of the vegetation to the east and other points around the tree show a very healthy stand with no E&P impacts. This is a healthy forest of mostly young trees with a dotted distribution of older specimens in the area. Photo B-4 shows the root distribution around Tree T-01 while Observation ID: T-01 shows the root distribution and the tree root lengths and depth to the top of the root around the tree. In observing the roots around this tree all of the roots were in excellent condition showing no signs of any impacts. Most of the roots around the tree ranged from 2 to 6.5 inches in depth with the deepest root measuring at 8.5 inches to the top as shown in Photo B-5. As shown in Observation ID: T-01, many of the roots were less than 4 inches beneath the level of the soil. Based on these considerations, an ERZ of 6.5 inches would be very generous for this tree.

3.3.2 Observation T-02 – Sweetgum (*Liquidambar styraciflua)*; DBH = 15.1"; ERZ =13.0"

Tree T-02 is a sweetgum that is located on the southwest side of the property. Photo B-6 shows the crown of the tree. Photo B-7 shows the bole of the tree and the conditions in the surrounding area. Both the crown and the bole of the tree show no impacts that would be indicative of any oil field E&P activities. This tree is in excellent condition and is a very representative specimen for the general area. Photo B-8 shows the vegetation facing to the east of Tree T-02. Vegetation in the overstory at this site consists of sweetgum with an occasional sugarberry. Other species include American elm and water oak. Understory is mostly reproduction of the overstory with sweetgum being the dominant. There is also some dogwood and wax myrtle dotted in the area. Ground cover consists mostly of poison ivy. All of the vegetation in this area is in excellent condition showing no impacts. Photo B-9 shows the flags that denote the root distribution around Tree T-02. Digging around the tree and observing the roots showed roots in excellent condition with no impacts from E&P activities or other indicia that would be indicative of oil field conditions. As shown in Observation ID: T-02 measurements of the roots that were shown in Photo B-9 showed a variation of depths ranging from 6.0 inches to 16.0 inches. The deepest root is shown on Photo B-10 for Tree T-02 with a depth of 16.0 inches to the top. Based on the root distribution and depths around this tree, an ERZ of 13.0 inches would be generous for this tree.

3.3.3 Observation T-03 – Sugarberry (*Celtis laevigata*); DBH = 15.2"; ERZ = 10.0"

Tree T-03 is located in the northern area of the southwest tract on the Hero Lands property as shown in Figure A-7. Photo B-11 shows the crown of Tree T-03 while Photo

B-12 shows the bole of the tree. This tree is in excellent condition showing no evidence of any kind of impacts. There is no evidence of dieback, leaf damage or any other indicia that would be attributed to E&P activities. This tree has a good straight bole as shown in Photo B-12 and a dbh of 15.2 inches. Photo B-13 shows the vegetation around Tree T-03 facing to the south. The vegetation community in this area consists of an overstory of water oak, sugarberry and sweetgum as the dominants. Other trees dotted around the area include an occasional sweet pecan and American elm. Understory consists mostly of reproduction of the overstory with several young water oaks and sweetgums in the area surrounding the tree. Ground cover is very sparse in this area consisting mostly of poison ivy. All of this vegetation is in excellent condition showing no evidence of dieback or other symptoms related to E&P activities for this site. Photo B-14 shows the flags denoting the root distribution around Tree T-03. When observing the roots in this area, all were in excellent condition showing no evidence of impacts. Observation ID: T-03 shows the roots and the root distribution around the tree and the distance of the roots from the bole of the tree. Depth to the tops of the roots on this tree generally range from 2 to 10 inches as shown in Photo B-15 with the deepest root being Root No. 3B at a depth to the top of 15.5 inches. In viewing the range of the root depths on the tree and the distribution around the tree, an ERZ of 10.0 inches would be appropriate for this tree.

3.3.4 Observation T-04 – American Elm (*Ulmus Americana*); DBH = 13.5”; ERZ = 15.0”

Tree T-04 is an American elm that is growing on the north central area of the southwest tract on the Hero Lands property as shown in Figure A-7. This tree is located close to Tree T-03. Photo B-16 shows the crown of Tree T-04 while Photo B-17 shows the bole of the tree. This tree is in good condition with no evidence of any kind of impacts either to the crown or the bole of the tree. Photo B-18 shows the vegetation at the tree facing to the south. Vegetation in this area consists of reproduction of the overstory that is made up of water oak, American elm, sugarberry, persimmon and sweetgum. There is one old sweet pecan located in the area. Understory is basically reproduction of the overstory with much of it being American elm with other species such as water oak and occasional persimmon dotted in the stand. Dogwood is also dotted around the area. Other areas around the tree contain very similar stands that are all healthy in a growing forest. There is some Chinese privet in the understory. Ground cover is basically bare except for some poison ivy along with some peppervines and trumpet creeper. Photo B-19 shows the flags that denote the root distribution around Tree T-04 while Observation ID: T-04 shows the root distribution around the tree, lengths of the roots and depths to the tops of the roots. Photo B-20 shows the deepest root of Tree T-04. As shown in the

observation, depths range from 2.0 inches to 20.0 inches with the majority of the roots in the 16.0 inch range. Root No. 4 showed a depth to top of 20.0 inches. Based on these root distributions, an ERZ for this tree of 15.0 inches is generous for this tree.

3.5 Tree T-05 – Box Elder (*Acer negundo*); DBH = 10.7": ERZ = 7.0"

Tree T-05 is a box elder that is located on the southwest side of the property. Photo B-21 shows the crown while Photo B-22 shows the bole of Tree T-05. This tree and all of the vegetation in the surrounding area are in excellent condition. There is one dead tree here and it is an old box elder that is completely shaded out by poison ivy. All of the vegetation showed no indicia of any kind of oil field impacts such as salinity or sodicity factors in the soil or impacts from petroleum hydrocarbons. This is a healthy young stand of mostly box elder in this area. Photo B-23 shows the vegetation around Tree T-05 facing to the south. Vegetation in the surrounding area looking to the south is heavily dominated by box elder with an occasional American elm in the stand. Understory is some reproduction of the overstory along with some young American elm, Chinese privet and dogwood. Ground cover in the general area consists of dewberry, poison ivy and some blackberry. Photo B-24 shows the flags denoting the distribution of the roots around Tree T-05. All of the roots that were observed in this area were in excellent condition showing no evidence of any kind of impacts. Observation ID: T-05 shows the distribution of the roots around the tree along with the root numbers, total length and depth to the top of the roots at various distances from the bole of the tree. Depth to the top of the root ranged from 3.0 inches to 10.0 inches for Root No. 5 at a distance of 28.0 inches from the bole of the tree. Photo B-25 shows the deepest root that had a depth to the top of 10.0 inches. In viewing the data for the tree, most of the roots were shallow as is typical for box elder. An ERZ of 7.0 inches would be appropriate for this tree that generally has a very shallow root system.

3.3.6 Tree T-06 – Green Ash (*Fraxinus Pennsylvanica*) DBH = 7.6"; ERZ =7.0"

Tree T-06 is a green ash that is located in the southwest corner of the property near Louisiana Highway 23. Photo B-26 shows the crown of this green ash while Photo B-27 shows the bole of this tree. This tree is in excellent condition with no evidence in the canopy or the bole of the tree showing any indicia such as bark sloughing, dieback or other symptoms that may have been indicative of salinity/sodicity factors in the soil at this area. Photo B-28 shows the vegetation around Tree T-06 facing to the east. The dominant species here is green ash along with an occasional box elder and American elm in the area. In several locations in this general area Chinese tallow has invaded the stand in several locations. There is also an occasional Drummond red maple in the area.

All of this vegetation is in good condition. Understory in this young stand is mostly a reproduction of the overstory of green ash with an occasional red maple and Chinese tallow. Ground cover is extremely sparse in the lower area here consisting of poison ivy, ladies' eardrops and peppervine. There are a few other woody-type species in the surrounding area. There was one chinaberry tree located in the area. Photo B-29 shows the distribution of roots around Tree T-06. All of these roots that were observed were in excellent condition with no evidence of dieback. Observation ID: T-06 shows the root distribution along with the root numbers, depth to the top and distance on the root from the bole where measurements were made. As shown in Observation T-06, this tree was generally shallow ranging from depths to the top of 3.5 inches to 9.5 inches at a distance of 25.0 inches from the bole of the tree. This root was 0.5 inches in diameter and this root is shown in Photo B-30. Based on the root distribution for this tree, an ERZ of 7.0 inches would be generous for this tree.

3.3.7 Tree T-07 – Water Oak (*Quercus nigra*); DBH = 16.5; ERZ = 6.0"

Tree T-07 is a water oak that has a dbh of 16.5 inches. This tree is located on the southwest side of the tract as is shown in Figure A-7. Photo B-31 shows the crown of this tree while Photo B-32 shows the bole of the tree and the area beneath the tree. This tree is in excellent condition showing no evidence of dieback or any kind of impacts at all. The bole is straight and if continued to be allowed to continue to grow would make a good log. Photo B-33 shows the vegetation surrounding Tree T-07 facing to the south. Most of this vegetation is a young stand that consists mostly of American elm, water oak and an occasional box elder. There is one Nuttall oak at the site. Other species in the surrounding area of the overstory consist of water oak, American elm, persimmon and occasional sugarberry. Understory is basically reproduction of the overstory along with some dogwood and Chinese privet. Ground cover is generally sparse consisting almost exclusively of poison ivy along with some peppervine and dewberry. Many of the trees in the surrounding area have poison ivy growing on the trunks of the trees. In viewing all of this vegetation in the surrounding area there are no indicia of any kind of impacts that could be attributed to E&P activities in this area. All of the overstory, understory and ground cover are all in excellent condition. Photo B-34 shows the flags denoting the distribution of the roots around Tree T-07. All of these roots that were viewed in this area are in excellent condition. Observation ID: T-07 in Appendix C shows the root lengths, depths to the tops of roots and distance on the root where measurements were taken from the bole of the tree. Page C-7A shows the root distributions around the tree. As shown on the observations for Tree T-07, root depths are generally very shallow with most occurring from the surface of the soil to 5.0 inches in depth to the tops of the roots. The deepest root for this tree is shown in Photo B-35.

The root depth to the top of this root is 9.0 inches. Based on the very shallow of roots around this tree, an ERZ of 6.0 inches would be generous for this tree.

3.3.8 Observation H-01 – St. Augustine Grass (*Stenotaphrum secundatum*); DBH = N/A; ERZ = 12.0"

H0-1 is a very lush stand of St. Augustine grass that is growing on the northeast side of the Hero Lands northwest tract. Photo B-36 shows the stand while Photos 37 and 38 show the vegetation growing to the west and north of the location at the site. Vegetation to the north of the site shows woody species that include a few willows at low sites, mulberries, box elder, Chinese tallow and an occasional silverling. Ground cover consists of species such as marsh goldenrod, peppervine, frog fruit and ladies' eardrops. All of this vegetation is in good condition. Areas to the west of H-01 are vegetated by a mixture of St. Augustine grass, frog fruit, buttercup, Dallas grass, powder puff and Bermuda grass. All of this vegetation is in good condition as is that growing to the southwest toward the pump jack. Some of the areas around the pump jack have been sprayed with herbicide. Photo B-40 shows the root profile and the root distribution at H-01. As shown in the photo and Observation ID: H-01, root distribution is very abundant from 0 to 2 inches and abundant to common from 3 to 8 inches. Photo B-41 shows the root distribution from 8 to 12 inches. In this area, the root distribution across the profile has begun to decrease in density with a common to sparse distribution. This root distribution at H-01 for the 12 to 17 depth that is shown in Photo 42-B shows the distribution decreasing to sparse in this area. Photo B-43 shows the root distribution to be very sparse in the 17 to 19 inch range and very sparse to none at 19 to 24 inches. Based on these profiles, the majority of the roots that are sustaining this stand of St. Augustine grass is in the top 12 inches of the soil. An ERZ of 12.0 inches is very appropriate for this stand of St. Augustine grass.

3.3.9 Observation H-02 – Frog Fruit (*Phyla lanceolata*), Mixed Species; DBH = N/A; ERZ =15.0"

Observation H-02 is located to the southwest of H-01 as shown in Figure A-8. Photo B-44 shows a mixed stand that makes up the area where the pit was dug. The dominant species is frog fruit, however, numerous other species are within the area of the dig including a mixed stand of Dallas grass, powderpuff, buttercup and other species. Photo B-45 shows the vegetation growing in the surrounding area at this site that includes a mixed stand of grasses and weedy species. All of these plants are healthy showing no evidence of any kind of dieback symptoms or other indicia that would be indicative of salting of the soil or of presence of petroleum hydrocarbons. Photo B-46 shows the vegetation at H-02 facing to the southeast. Woody vegetation in this area consists of

Chinese tallow, green ash, mulberry and an occasional willow in some of the lower areas. Sub-canopy species consist of reproduction of the overstory plants with some silverling dotted along the edges. Ground cover consists of peppervine, blackberry, trumpet creeper and peppervine on some of the trees. All of this vegetation is in excellent condition showing no indication of any kind of impacts. Photo B-47 shows the vegetation at H-02 facing to the west. A pipeline runs north and south through the area just to the east of H-02 location. Woody vegetation includes green ash, silverling, Chinese tallow and some live oaks that are in the background. Herbaceous vegetation in the area includes annual marsh elder and goldenrods. As shown in Observation ID: H-02 and in Photo B-48, the root distribution from 0 to 2.5 inches shows an abundant distribution through this zone. Photo B-49 shows a common distribution from 2.5 inches to 9 inches. The distribution at 9 to 13 inches is shown in Photo B-50. As can be seen in this photo, the root distribution has become sparse through this zone. Photo B-51 shows the root distribution at H-02 to be very sparse from 13 to 17 inches to very sparse to none at 17 to 24 inches in Photo B-52. Based on these distributions through the profile at H-02, an ERZ of 15.0 inches is generous for this location.

Table 3.1. Effective Root Zone (ERZ) of Plant Species

Site ID	Common Name	*Scientific Name*	ERZ (in)
T-01	Water Oak	*Quercus nigra*	6.5
T-02	Sweetgum	*Liquidambar styraciflua*	13.0
T-03	Sugarberry	*Celtis leavigata*	10.0
T-04	American Elm	*Ulmus americana*	15.0
T-05	Box Elder	*Acer negundo*	7.0
T-06	Green Ash	*Fraxinus pennsylvanica*	7.0
T-07	Water Oak	*Quercus nigra*	6.0
H-01	St. Augustine Grass	*Stenotaphrum secundatum*	12.0
H-02	Frog Fruit (Mixed Species)	*Phyla lanceolata*	15.0

4.0 General Discussion

Site reviews that were conducted on the Hero Lands property and observations of the plant communities around root data investigation areas showed vegetative communities that are typical of the bottomland hardwoods that occur along the natural levees of the Mississippi River for the area of the investigation. Review of the tracts where the bottomland hardwoods were growing included the northwest tract, southwest tract and the north portion of the northeast tract. Detailed reviews were conducted of the vegetation to show the plant

community types and any kind of impacts that may have been occurring from past E&P activities. All of the areas viewed showed no evidence of typical indicia of plant growth effects, dieback, bark sloughing, epicormic branching and other symptoms that are exhibited by bottomland hardwoods when impacted by salting activities in the soil and/or petroleum hydrocarbons. Detailed reviews of woody plant communities around the production sites and old pits show stands similar to other woody plant communities over the tracts. In general, the plant communities in the forested areas showed a typical successional trend of forest community development that is typical of areas that have not experienced any oil field operations in the past. Overall, the plant succession is indicative of old field succession with some larger trees dotted around the areas on the tracts with younger vegetation in the understories. Areas where E&P activities had ceased showed good stands of trees succeeding back into these areas.

The tree root studies in the bottomland hardwood communities showed a very shallow distribution of roots that exhibited no impacts from past or present E&P activities. The seven trees that were chosen for investigation showed no evidence of any impacts due to oil and gas operations nor did the vegetation in the surrounding communities. The plant root studies showed a very shallow and very healthy distribution of roots. Tree canopies and boles showed no impacts. As shown in Table 3.1, effective ERZs for all of the trees ranged from 6 to 15 inches with the overwhelming majority of the roots occurring in the first 10 to 12 inches of all of the trees that were investigated. This represents typical shallow root depths that are generally found in soils along the Mississippi River and its tributaries. Water oaks, box elder and green ash showed ERZ depths ranging from 6 to 7 inches in depth. These represented the shallowest ERZs that were found with most of the roots of these trees in the very shallow range of 0 to 5 inches. Sugarberry, sweetgum and American elm tree roots showed ERZs from 13 to 15 inches with the deepest being American elm with one root at 20 inches in depth. Overall, these are shallow and healthy root systems showing no impacts that may have occurred from salting conditions or from impacts of petroleum hydrocarbons.

Herbaceous plant communities around production sites consisted of typical plant communities that can be found in similar areas that I have investigated over much of the state of Louisiana. All of the sites that were investigated showed healthy stands of herbaceous plants with little evidence of any kind of impacts that are typical of saline/sodic soils or petroleum hydrocarbons in the soil.

The two herbaceous areas investigated on the Hero Lands property included a dense stand of St. Augustine grass with minor species and frog fruit with a mixture of other species that were typical of the surrounding area. Data in the root data forms in Appendix C show very shallow root systems with the majority of the roots occurring within the top 8 to 10 inches of soil

beneath the plants. As shown in Table 3.1, ERZs of these two herbaceous plant observations ranged from 12 to 15 inches. These data indicate that root penetration into the deeper zones of the soil simply did not occur at these study sites. All of the roots are healthy with no signs or any indicators of impacts from saline/sodic levels in the soil or petroleum hydrocarbons. The only significant impact that occurred around any of the production facilities to the plants was from herbicide applications.

Due to wetness factors and trafficability problems and moving equipment as part of the remediation process, if required, a 24 inch depth of remediation would be more than appropriate for the wooded areas and herbaceous sites involved in this investigation. Any remediation to greater depths would provide no benefits to the forest or herbaceous plantings on the properties if remediation measures are required.

The south end of the northeast tract and the southeast tract showed successional changes that reflected the past impacts to these areas. The vegetative communities in these areas had succeeded to scrub-shrub communities that showed changes that occurred from the influence of increased salinity and sodicity levels in the soil. The remediation plan as proposed by Miller and Sills (2019) included these areas and the out parcel between them that was not part of the lawsuit. Any data generated for this area should be subtracted from any of the estimates for remediation that were made in their report. Soils in these areas are essentially level with little relief and would lend themselves to remediation, if required. Based on the root studies on these typical soils in surrounding areas, a remediation depth of 24 inches would be very appropriate for these areas and any depths greater than this depth would not benefit any plants that could conceivably be grown on these sites after remediation. Studies presented herein are appropriate for all plant communities that are growing on the Hero Lands tracts. Remediation to greater depths proposed by the plaintiffs would be overkill and would provide no additional benefits to future uses for plant growth and health over the remediation depths proposed in this investigation.

5.0. Opinions and Conclusions

a. The views on the Hero Lands tracts where bottomland hardwoods were growing and in the specific areas of the tree root investigations showed that the hardwood communities are typical of those found in the general region and showed no impacts from E&P activities. If required, remediation of these communities would provide little or no benefits because the vegetation is healthy and exhibiting excellent growth over these sites.

b. Data from the root studies showed that a broad range of the tree species growing on

the property have shallow rooting depths. Effective root zones of all the observed trees were very shallow with no ERZ extending past 15 inches with most of the roots much shallower and near the surface of the soil.

c. The evidence presented in the studies reported herein showed that the trees have shallow root systems with ERZs ranging from 6 to 15 inches with most of the roots shallow and very near the surface of the soil. If any remediation is required for any of the wooded areas on the Hero tracts, a remediation depth of 24 inches would be sufficient to allow for root development that may occur for plants if these areas are reforested after remediation.

d. Studies of the herbaceous communities on unforested areas on the tract showed healthy communities that had developed in these areas with little discernible impacts to the vegetation. Only some sites showed evidence of herbicide kill.

e. The two root zone studies that were conducted for typical plant communities for the herbaceous stands showed ERZs of 12 to 15 inches in depth with the majority of the roots occurring within 8 to 10 inches of the surface.

f. All of the roots on the herbaceous plants were healthy showing no evidence of impacts. If required, any remediation of these sites should not extend past 24 inches in depth. This depth would more than allow for any root penetrations through the profile if only a small portion of the roots occur past 12 to 15 inches.

g. Based on the root studies on these typical soils in surrounding areas, a remediation depth of 24 inches would be very appropriate for the scrub-shrub areas on the north and southeast tracts. Any depths greater than this depth would not benefit any plants that could conceivably be grown on these sites after remediation.

h. Plaintiff's remediation recommendations to greater depths directly contradict the findings that are presented in this report. Since the roots that were investigated showed shallow root systems that do not come near many of the depths proposed by the plaintiff's experts, remediation past the 24 inch levels that are proposed herein would be greatly in excess of the rooting needs for vegetative stands that could conceivably be grown on the Hero Lands tracts in the future.

6.0 Basis for Opinions and Conclusions

The defendants in this case have been sued by the plaintiffs for various allegations of damages to their property, including soil and groundwater contamination. This report

considers the characteristics of the vegetation at the property. A root study was conducted for root penetration in order to determine depths of the particular plant populations growing at each area. This consideration is very important to determine the appropriate depth of remediation, if required, for the propagation of the types of vegetation that grow in the area. These data represent a site specific study which relates directly to the Hero Lands tracts that are under investigation.

Holloway Environmental Services, Inc. does hereby certify that the information reported in this document is, to the best of our knowledge, accurate and complete. I, Luther F. Holloway, reserve the right to supplement and/or amend this report should additional information become available.

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7.0 References/Literature Reviewed

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