



840 West Sam Houston Pkwy N
Suite 600
Houston, Texas
77024-4613

Telephone: +1 281 600 1000
Fax: +1 281 520 4625
www.erm.com

Via Email

20 February 2023

Mr. Stephen H. Lee, PG, Esq.
Director, Injection and Mining Division
Office of Conservation
Louisiana Department of Natural Resources
617 North Third Street, LaSalle Building
Baton Rouge, Louisiana 70802



Reference: 0677804

Subject: Groundwater and Surface Water Investigation Work Plan
First Supplement to Compliance Order No. IMD 2022-027
Westlake US 2, LLC
Sulphur Dome
Calcasieu Parish, Louisiana

Dear Mr. Lee:

Environmental Resources Management (ERM), on behalf of Westlake US 2, LLC (Westlake), is pleased to provide this Work Plan in response to the January 19, 2023 Louisiana Department of Natural Resources (LDNR) Office of Conservation's First Supplement to Compliance Order No. IMD 2022-027. This Work Plan addresses the plans to investigate any potential impacts to the Underground Source of Drinking water (USDW) in the vicinity of the Sulphur salt dome, as well as any potential impacts to surrounding surface waters.

1. SITE SETTING

The Sulphur salt dome is located approximately 2 miles northwest of the city of Sulphur Louisiana (Figure 1). Economic production of minerals (sulfur, oil and gas, and brine) from within and surrounding the salt dome has been occurring since the early 1900s and continues to the present. The salt dome cap rock is encountered between approximately 600 to 1,000 feet below ground surface (bgs) (Figure 2), with the salt encountered at approximately 1,500 feet bgs (Figure 3). Current brine production is occurring within salt caverns at depths generally greater than 2,000 feet bgs (Figure 4).

The Chicot Aquifer underlies the site and surrounding area and is used for industrial, irrigation, domestic, and municipal purposes. Numerous water wells are present in the vicinity of the salt dome (Figure 5). Water supply for brine production is from the 500-foot sand of the Chicot Aquifer. The deepest active water well within a 2-mile radius of the salt dome is well ID 019-582, operated by Westlake for brine production, which is installed to a depth of 609 feet. The city of Sulphur utilizes as many as seven water wells for public supply, all of which are screened in the 500-foot sand of the Chicot Aquifer and located approximately 2.5 miles to the southeast of the Sulphur salt dome.

The majority of the salt dome lies within LDEQ surface water drainage basin subsegment 031001, Bayou Choupique from headwater to Intercoastal Waterway (Figure 6). The eastern portion of the dome lies with subsegment 030901, Bayou d'Inde from headwater to Calcasieu River. Due to the estuarine environment of these subsegments, there are no surface water numerical criteria for chloride, sulfate, or total dissolved solids (TDS) within these subsegments.

2. WORK PLAN

This plan addresses Requirement 1.a.of the Supplement to the Order, which requires Westlake to submit “a plan to investigate any impacts to the Underground Source of Drinking Water (“USDW”) and surrounding surface waters”.

2.1 USDW Evaluation

A preliminary evaluation of the USDW was conducted using data publicly available on the LDNR's SONRIS database. Based on this preliminary evaluation, the USDW is shallower directly over the salt dome and deepens with distance from the dome. Understanding the depth to the top of the USDW and the groundwater uses in the vicinity of the dome is critical to identifying and evaluating potential groundwater impacts. ERM has developed a plan to evaluate and better define the depth to the top of the USDW directly over the dome and outside the footprint of the dome and to assess if hypothetical events at the dome could affect groundwater quality within the aquifer.

2.2 Water Well Sampling

ERM proposes to utilize active water wells within the vicinity of the salt dome to monitor groundwater quality (Figure 7). Westlake currently utilizes four water wells southwest of the salt dome, with a fifth well installed but not currently operational. Photographs of the Westlake water wells are provided in Attachment 1. There are also four deep observation wells, installed and owned by Boardwalk Pipelines (Boardwalk), on the southeastern flank of the dome. The active water wells and observation wells are well-positioned to monitor the groundwater between the salt dome and other wells/groundwater users to the southwest and southeast. Samples were collected from the four Westlake water wells on January 26, 2023; data from that sampling event are summarized on Table 1. The results from this initial sampling event will serve as a baseline dataset for subsequent monitoring. For reference, the results of a brine sample collected from Brine Well 6X on January 25, 2023, are also included on Table 1. Final laboratory reports received to date are provided in Attachment 2.

Requests have been made to Boardwalk for access to the four deep observation wells. Once access has been granted, ERM will inspect/evaluate each well to determine the viability of using these wells for monitoring and/or sampling. The condition of these wells is unknown; however, discussions with personnel involved in the installation of these wells indicates they were not installed or constructed using materials and procedures typically used in the installation of environmental monitoring wells. The wells were constructed of oilfield well casing and were not completed with typical slotted well screens. Instead, wells were perforated at variable target intervals. We have not been able to determine in the wells were developed; therefore, drilling residuals could still be present. Once access to the wells is granted, ERM will perform modified slug tests to determine that the wells exhibit a good hydraulic connection with the portion of the Chicot Aquifer in which they were perforated. If the slug test results demonstrate a good hydraulic connection with the Chicot Aquifer, an attempt will be made to develop the wells by purging. Water

level elevation data from these wells may provide valuable information regarding the capture zone from pumping of the Westlake water wells. Samples may be collected from the Boardwalk observation wells with the understanding that they were not installed or intended to be used as environmental sampling points.

Quarterly sampling of the five Westlake wells is proposed for 2023, followed by semi-annual sampling for two additional years. The Boardwalk wells may be sampled, if access can be obtained and it is determined that samples representative of the Chicot Aquifer can be collected. Samples will be analyzed by a Louisiana accredited environmental laboratory for analysis of the following parameters:

- Metals (As, Ba, Cd, Ca, Cr, Fe, Pb, Mg, Mn, Hg, K, Se, Ag, Na, Sr, Zn),
- Chloride, Bromide,
- Bicarbonate, Carbonate
- Sulfate, Sulfide, Hydrogen Sulfide,
- Total Dissolved Solids (TDS),
- Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), and
- Total Petroleum Hydrocarbon (TPH) fractions

Samples will also be collected for dissolved gases and submitted to Isotech, a Stratum Reservoir company, for isotopic evaluation.

2.3 Water Well Survey

ERM proposes to conduct a water well survey within a one-mile radius of the salt dome. It is important to identify users of groundwater nearest to the dome. The water well survey will consist of a letter survey mailed to property owners, followed by a visual inspection and face-to-face follow-up visit, as necessary. Owners of any unregistered water wells identified will be asked to register the wells with LDNR.

2.4 Capture Zone Analysis

The four active Westlake water wells are pumping a total of approximately 2,000 gallons per minute (gpm) from the 500-foot sand of the Chicot Aquifer (i.e., approximately 2.9 million gallons per day) for brine production. This large-scale pumping is likely inducing a hydraulic gradient causing groundwater to flow toward the wells. However, the extent of the influence of pumping in the vicinity of the salt dome and the influence of pumping occurring by other operators is unknown. ERM proposes to evaluate the capture zone of the wells in the vicinity of the salt dome to better understand the potential migration pathways in the event that site-related constituents were to be detected within the usable portions of the Chicot Aquifer. The capture zone will be evaluated using MODFLOW, MODPATH, and MT3DMS, which are industry standard software packages for evaluating groundwater flow and transport.

2.5 Surface Water Sampling

The surface water in the vicinity of the salt dome is generally isolated with little or no connection to other surface waters within the drainage basin (Figure 8). “Bubble sites” have been observed in and around the well pads, and within a pond centrally located above the salt dome (“the central pond”). The waters where bubbles have been observed are isolated and do not have any connection to surrounding water bodies. The majority of the surface water bodies are shallow. The central pond was measured at <1 inch at the Central Pond sample location and approximately 6 feet deep, following a heavy rainstorm, at CP BS 3. Photographs of the surface water sampling areas are provided in Attachment 1. Final laboratory reports received to date are provided in Attachment 2.

Samples from seven bubble sites have been collected, and the data (if final laboratory reports have been received) are summarized on Table 2. One location adjacent to the PPG 22 Brine Well exhibited visible sheen and oil accumulation at the bubble site. A berm has been built around that location to isolate it from the central pond and from the other surface water bodies. Samples from two other bubble site locations (Brine Well 7A BS, and 110159 BS) were collected from standing water within a well pad as a result of recent rain events.

ERM proposes to sample the bubble site locations quarterly for the first year or until the bubbles are no longer observed. Samples will also be collected as soon as possible if new bubble sites are identified. Three additional samples will be collected from the central pond (Figure 9) quarterly for the first year, then semi-annually for one additional year. Samples will be submitted to a Louisiana accredited environmental laboratory for analysis of the following parameters:

- Metals (As, Ba, Cd, Ca, Cr, Fe, Pb, Mg, Mn, Hg, K, Se, Ag, Na, Sr, Zn),
- Chloride, Bromide,
- Bicarbonate, Carbonate
- Sulfate, Sulfide, Hydrogen Sulfide,
- Total Dissolved Solids (TDS),
- Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), and
- Total Petroleum Hydrocarbon (TPH) fractions

At active bubbles sites, samples will also be collected for dissolved gases and sent to Isotech, a Stratum Reservoir company, for isotopic evaluation.

2.6 Surface Water Profile

ERM proposes to complete surface water profiling within the central pond. The profiling will consist of taking measurements of pH, Specific Conductivity (SC), Oxidation Reduction Potential (ORP), and temperature within the water column. Measurements will be made using a handheld meter while water is pumped at 1-foot depth intervals. The profiling will occur quarterly for the first year, and then semi-annually for one additional year.

3. REPONSES TO ADDITIONAL ORDER REQUIREMENTS

Westlake has also responded to additional requirements contained in the First Supplement to Compliance Order IMD 2022-027 not specifically included in this Work Plan.

Order 3 – Eagle is ordered as soon as possible but within seven (7) days to collect samples at all observed oil, gas, or brine expressions at the surface. Eagle must expeditiously perform constituent sample analyses on all collected samples.

Samples have been collected from all observed bubble sites and sheen within 7 days of the initial observation. Additional samples will be collected within 7 days if new surface expressions are identified. No brine surface expressions have been observed.

Order 4 – Eagle is ordered as soon as possible but within (7) days to request access from Yellow Rock to collect oil samples from the tubing and tubing annulus of Serial Number 110159, Fee SWD No. S-7. Eagle must perform an isotopic and constituent analysis on these samples to compare them to a similar analysis for the oil collected from PPG 007B.

ERM obtained a sample of tubing oil from well Serial Number 110159 on January 26, 2023. The sample was sent to NewFields in Rockland, Massachusetts for environmental forensic analysis. An attempt was made to collect any other liquids from the well, but no other liquids were produced. Oil samples were also collected from the Westlake oil storage stock tank and the 7B cavern (via transfer pump and Brine Well 20). These oil samples, along with the sheen collected at the Brine Well 22 bubble site, were submitted to NewFields for environmental forensic analysis.

4. SCHEDULE AND REPORTING

ERM has already implemented groundwater, surface water, brine and oil sampling with the assistance of Westlake personnel. The proposed schedule of sampling and reporting described herein is as follows:

4.1 Groundwater

- Sample Westlake production water wells – April, July, October 2023, January and July 2024 and 2025
- Sample deep observation wells – 7 days following approval from Boardwalk, then sampled quarterly with the water wells

Following each quarterly event, ERM will provide a brief summary report to LDNR including a discussion of observations, data trends, laboratory reports, and recommendations, as necessary.

Within 60-days of LDNR approval of this work plan, ERM will prepare a detailed evaluation of the USDW, water wells users in the vicinity of the dome, and capture zone analysis. A review of the sampling activities, data evaluations, findings, and recommendations will also be included.

4.2 Surface water

- Surface water sampling – April, July, October 2023, January and July 2024
- Surface water profiling – April, July, October 2023, January and July 2024

ERM

20 February 2023
Reference: 0677804

Page 6

The results of the sampling event will be provided within 30-day of receipt of the final analytical data reports.

Following each quarterly event, ERM will provide a brief summary report to LDNR including a discussion of observations, data trends, laboratory reports, and recommendations, as necessary.

Should you have any questions or wish to discuss our proposed plan, please contact us.

Sincerely,



Scott A. Himes, P.G.
Senior Consultant, Hydrogeology



David C. Upthegrove, P.G.
Partner

