

**Sulphur Brine Field**  
**Camera Feasibility Study**

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## APPENDIX

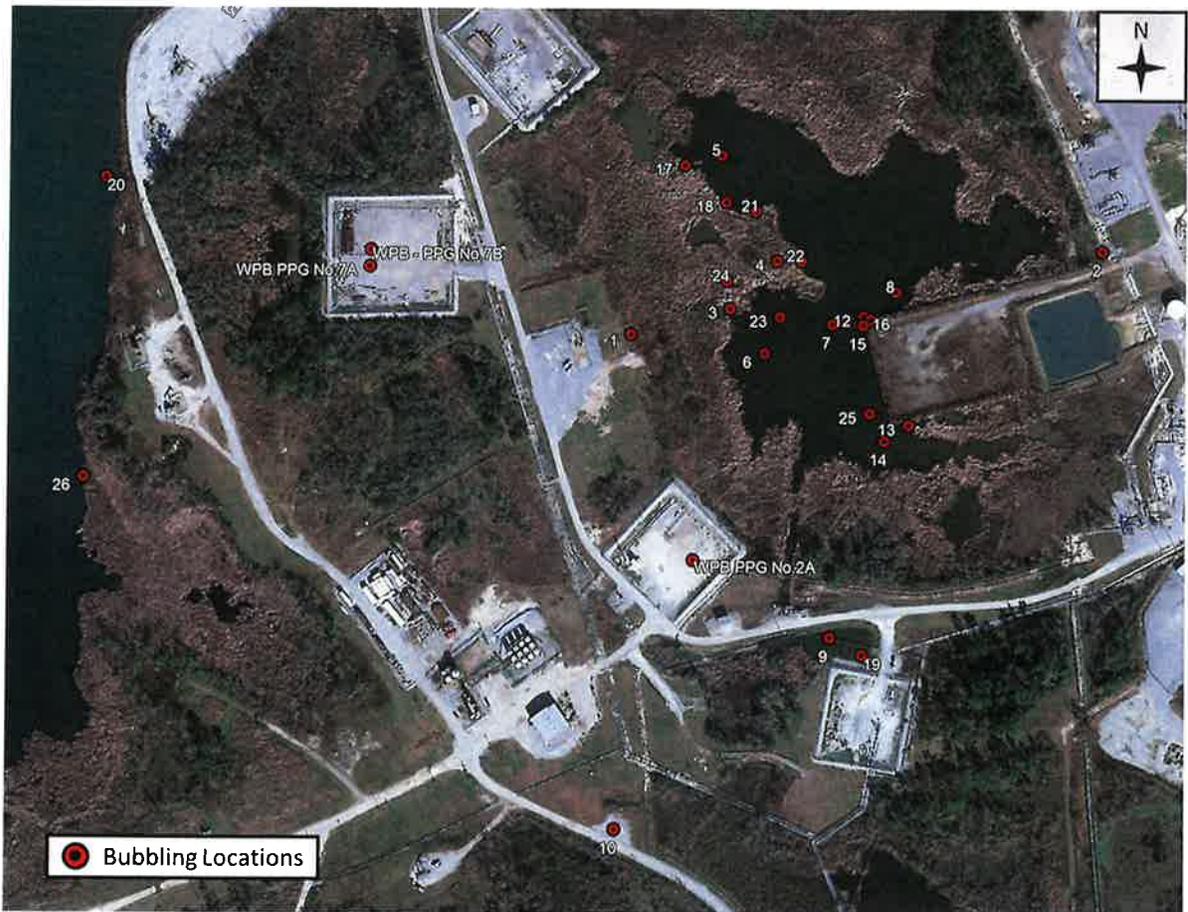
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## 1.0 BACKGROUND

Order 3.h. of the Third Supplement to Compliance Order No. IMD 2022-027 issued by the State of Louisiana Department of Natural Resources Office of Conservation requires Westlake US 2, LLC (Westlake) to submit feasibility study for the incorporation of thermography camera camera (forward-looking infrared cameras or other comparable devices) into daily observational scope.

## 2.0 INTRODUCTION

This study investigates how feasible it would be for Westlake to incorporate the use of thermographic cameras in their daily observational scope to monitor the locations of interest (provided by Westlake) shown in **Figure 1**.



**Figure 1 – Bubbling Locations**

## **3.0 TECHNOLOGY**

An Optical Gas Imaging (OGI) camera was considered in this study for its ability to detect gas using infrared technology. This type of camera looks for absorption of signature wavelengths of light, indicating the presence of gas.

### **3.1 PORTABLE VS. STATIONARY**

Portable and stationary options for the camera have their pros and cons:

A portable option would allow for greater flexibility in case procedures need to change over time, but they would require an employee to manually scan for gas on a regular basis. It would also require more maintenance, as the batteries of the device need to be recharged, and data would need to be transferred manually to a computer.

A stationary option would not have these maintenance setbacks, as it has continuous power and data transfer. However, the sensitivity of the stationary OGI camera is less than that of the portable version, and they would need to be mounted in many locations. If new gas leaks are detected, there is no guarantee that the installed cameras would be able to see them.

Overall, a portable OGI camera is the more viable option due to its ease of maintenance and the ability to monitor new leak points should they be discovered.

### **3.2 PORTABLE OGI CAMERA VERSIONS**

One of the leading manufacturers of OGI cameras is FLIR. Of their catalog of products, two cameras were recommended: the Gx320 and the Gx620. These are their top-of-the-line products for detecting gas leaks. The Gx320 has a smaller screen, but it is more sensitive to gas detection. The Gx620 has a larger screen for better clarity but uses the same sensor array as the Gx320, effectively reducing the sensitivity of the device.

Either option is acceptable. See **Appendix** for camera specifications.

### **3.3 OGI CAMERA EFFECTIVE RANGE**

The effective range of an OGI camera depends on many factors, several of which the user of the device has no control over. The ability to detect a gas depends on:

- Distance from the camera to the gas
- Temperature differential between the gas and the background radiation
- Composition and concentration of the gas
- Size of the camera lens
- Size of the camera's sensor array
- Size of the camera's viewfinder screen
- Skill and perceptivity of the user

Without being able to test the camera under the specific conditions of this project's scope, it is impossible to truly know the effective range. However, a test was performed by the National Physical Laboratory (NPL) on the FLIR GF320 camera (see Reference **FLIR OGI Operative Envelope Report**), a comparable model to the Gx320, to determine what distances the camera can reliably detect gases, accounting for changes in wind speed and temperature differential between the gas and the background. According to the results from this test, the effective range under normal wind conditions for Sulphur, LA (see Reference **Sulphur Wind Speed**) would be approximately 50 feet.

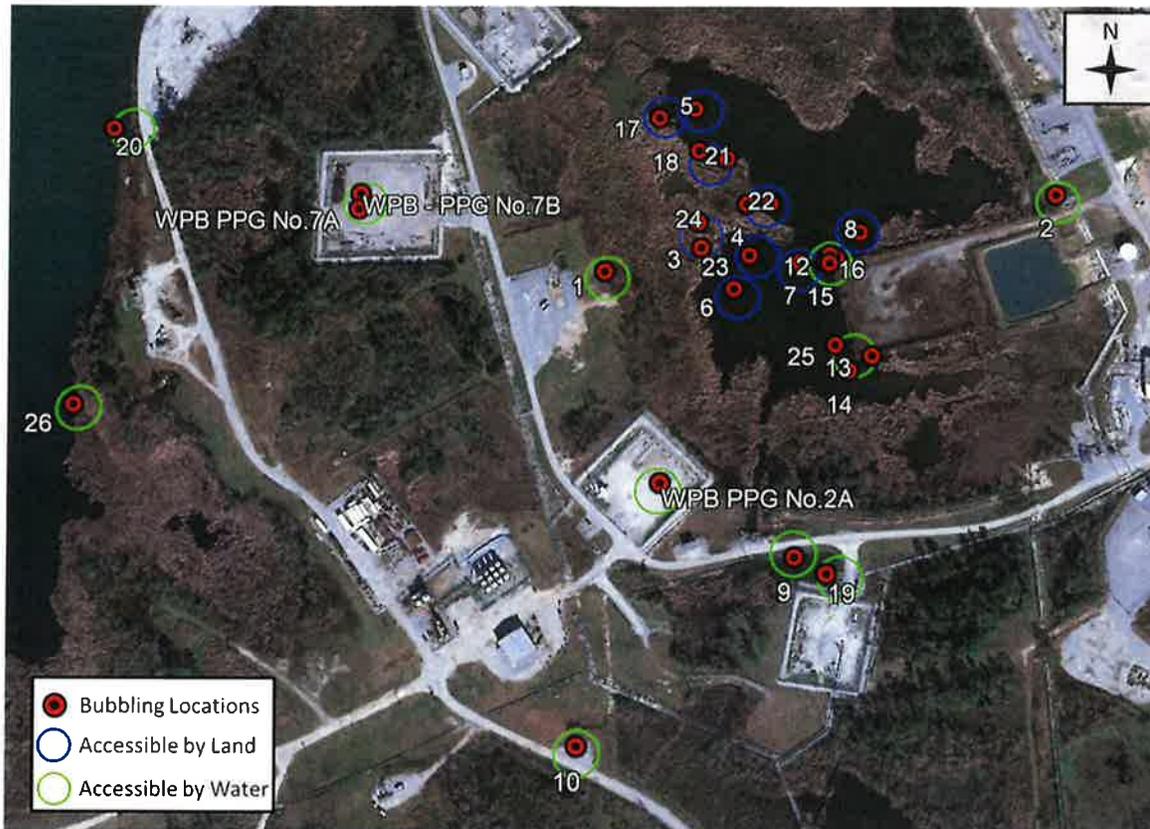
### **3.4 OGI CAMERA SOFTWARE**

**FLIR Thermal Studio Pro:** This subscription software is meant to assist in arranging photos and videos from the camera. Additionally, the **FLIR Route Creator** plugin can be purchased to enable the creation of inspection routes, where individual areas of interest are labeled with GPS coordinates. Pictures uploaded with GPS coordinates near these areas are automatically grouped with the associated area.

## **4.0 DAILY MONITORING PROCEDURE**

To monitor the gas leaks, a worker will need to perform a 360-degree scan within the effective detection range of the camera from each scan area shown in **Figure 2**. It is recommended that this is performed using the video feature of the camera. If gas is detected, pictures should be taken of the leak source using the camera, recording the time, date, and location.

The scan areas shown in **Figure 2** have been selected to cover multiple gas leaks where possible. Many locations will need to be reached by boat, represented by the blue circles. The locations accessible by land are represented by the green circles.



**Figure 2 – Scan Areas**

Photos and videos from the camera should be uploaded to a computer each day to document and backup the data. The camera should be set to recharge after each use. Considering the operation time per battery of the OGI camera, it is recommended that another battery is purchased, and that both batteries are charged daily.

Time to complete one day of monitoring is estimated to take up to four hours but will likely become faster as the designated worker becomes more familiar with the route. Additional time will be necessary to properly upload and catalog the data acquired. Overall, the full scope of scanning and maintaining the files will likely require an employee to work full time on this task.

## 5.0 REFERENCE

### Sulphur Wind Speed

<https://weatherspark.com/y/10160/Average-Weather-in-Sulphur-Louisiana-United-States-Year-Round>

### FLIR OGI Operative Envelope Report

<https://flir.netx.net/file/asset/12465/original/attachment>

# APPENDIX

## FLIR OGI Camera Specifications

### IMAGING & OPTICAL

<b>Adjustable Viewfinder</b>	Built-in, tiltable OLED, 800 × 480 pixels
<b>Camera f-number</b>	1.59
<b>Color LCD</b>	4", 640 × 480 pixel rotatable, touchscreen LCD
<b>Color Palettes</b>	Arctic, White hot, Black hot, Iron, Lava, Rainbow, Rainbow HC
<b>Detector Pitch</b>	<b>Gx320:</b> 30 μm <b>Gx620:</b> 15 μm
<b>Detector Type</b>	Focal plane array (FPA), cooled InSb
<b>Display Frame Rate</b>	60 Hz
<b>Field of View</b>	<b>14.5° Lens:</b> 14.5° × 10.8° <b>24° Lens:</b> 24° × 18°
<b>Focus</b>	<b>Gx320:</b> Manual <b>Gx620:</b> Auto & Manual
<b>Image Analysis</b>	10 spots, 5 boxes with max/min/average, 1 line (horizontal or vertical), measurement corrections
<b>Image Modes</b>	IR image, visual image, high sensitivity mode (HSM), noise reduction filter
<b>IR Resolution</b>	<b>Gx320:</b> 320 × 240 (76,800 pixels) <b>Gx620:</b> 640 × 480 (307,200 pixels)
<b>Laser Spot</b>	Yes
<b>MPEG Video Recording</b>	Yes
<b>Non-Radiometric IR Video</b>	<b>Gx320:</b> H.264 (AVC) over RTSP (Wi-Fi), MPEG4 over RTSP (Wi-Fi), MJPEG over UVC and RTSP (Wi-Fi) <b>Gx620:</b> Not listed
<b>On Camera Display</b>	Widescreen 800 × 480 pixel LCD, Tilttable 800 × 480 pixel OLED viewfinder
<b>Radiometric IR Video</b>	RTRR (.csq), Over UVC
<b>Radiometric JPG</b>	Yes
<b>Sensor Cooling</b>	Stirling Microcooler (FLIR MC-3)
<b>Spectral Range</b>	3.2 μm to 3.4 μm
<b>Video Recording &amp; Streaming</b>	H.264 to memory card
<b>Zoom</b>	1 – 8× continuous, digital zoom

### MEASUREMENT & ANALYSIS

<b>Accuracy</b>	±1°C (±1.8°F) for temperature range 0°C to 100°C (32°F to 212°F) or ±2% of reading for temperature range >100°C (>212°F)	
<b>Area Box</b>	5 (min./max./avg.)	
<b>Delta T</b>	Yes	
<b>Gas Quantification</b>	Quantification onboard camera	
<b>Gas Sensitivity</b>	<b>Gx320:</b>	<b>Gx620:</b>
	CH <sub>4</sub> : <9.6 ppm x m Hydrocarbons (multiple): <4 ppm x m (ΔT = 10°C, Distance = 1 m)	CH <sub>4</sub> : <29 ppm x m Hydrocarbons (multiple): <4 ppm x m (ΔT = 10°C, Distance = 1 m)
<b>Measurement Corrections</b>	Reflected temperature, distance, atmospheric transmission, humidity, external optics	
<b>Profile</b>	1 live line (horiz. or vert.)	
<b>Recording</b>	MultiREC Recording; Record multiple files automatically in customizable order	
<b>Spot Meter</b>	10	
<b>Temperature Range</b>	-20°C to 350°C (-4°F to 662°F)	
<b>Thermal Sensitivity</b>	<b>Gx320:</b>	<10 mK at 30°C (86°F)
	<b>Gx620:</b>	<20 mK at 30°C (86°F)

### COMMUNICATION & DATA STORAGE

<b>Communication Interfaces</b>	USB 2.0, Bluetooth via headset, Wi-Fi, HDMI
<b>Image File Format</b>	Standard JPEG, measurement data included. Infrared-only mode
<b>Radio</b>	Operating frequency:
	•Bluetooth + EDR: 2402–2480 MHz
	•WLAN 2.4 GHz: 2412–2462 MHz
	•WLAN 5 GHz: 5150-5250 MHz Note that frequency band 5150-5250 MHz is for indoor use only, see national regulations.
<b>Storage Media</b>	RF output (EIRP)
	• Bluetooth + EDR: <10 dBm
	•WLAN: <17 dBm
<b>Video Out</b>	Antenna
	•Integrated PIFA antenna (gain: maximum 2.6 dBi)
	Removable SD card
	HDMI, DVI

## GENERAL

<b>Annotations</b>	Voice: 60 seconds with Bluetooth on still images and video Text: Text from predefined list or soft keyboard on touchscreen Image Sketch: Yes, on infrared only
<b>Cloud Services</b>	Via Wi-Fi; FLIR Ignite for direct, secure image uploading, organizing, storage, and sharing (required firmware available)
<b>FLIR Inspection Route</b>	Enabled in the camera
<b>GPS [removable]</b>	Location data automatically added to every still image and first frame in video from built-in GPS
<b>Laser Pointer</b>	Class 2
<b>Package Includes</b>	Infrared camera with lens, battery (2 pcs), battery charger, power supply including multi-plugs, hand strap, neck strap, lens cap, lens cap strap, memory card, HDMI-HDMI cable, USB cable, screwdriver TX20, knob screw (optional screw for the rear cover), printed documentation, hard transport case
<b>Packaging Size</b>	<b>Gx320:</b> 600 mm × 510 mm × 410 mm (23.6 in × 20.1 in × 16.1 in) <b>Gx620:</b> 400 × 190 × 510 mm (15.7 × 7.5 × 20.1 in.)
<b>Size [L x W x H] w Lens</b>	251.6 mm × 164.5 mm × 170.9 mm (9.9 in × 6.48 in × 6.73 in)
<b>Weight [incl lens &amp; batteries]</b>	3 kg (6.18 lb)

## USER INTERFACE

<b>Languages</b>	21
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## POWER

<b>Battery operating time</b>	>2.5 hours at 25°C (68°F) and typical use
<b>Battery Type</b>	Rechargeable Li-ion battery; 7.4 V, charged in camera or separate 2-bay charger
<b>Charging Time</b>	2.5 hours to 95% capacity, charging status indicated by LEDs
<b>Start Up Time</b>	Typically 7 min. at 25°C (77°F)

## ENVIRONMENTAL & CERTIFICATIONS

<b>Certifications</b>	RoHS: 2011/65/EU WEEE: 2012/19/EU RED: 2014/53/EU EMC: ETSI EN 301 489-1 (radio), ETSI EN 301 489-17, EN 55032 (emission), EN 55035 (immunity), EN 61000-4-8 Level 5 (magnetic field), EN 61000-6-2, Immunity Industrial Environment, FCC 47 CFR part 15 B, class B (emission), ICES-003
<b>Encapsulation</b>	IP54 (IEC 60529)
<b>Hazardous Location Compliance</b>	ATEX/IECEX, Ex ic nC op is IIC T4 Gc II 3 G ANSI/ISA-12.12.01-2013, Class I Division 2 CSA 22.2 No. 213, Class I Division 2
<b>Mounting</b>	UNC ¼"-20
<b>Operating Temperature Range</b>	-20°C to 50°C (-4°F to 122°F)
<b>Shock &amp; Vibration</b>	Shock: 25 g (IEC 60068-2-27); Vibration: 2 g (IEC 60068-2-6)
<b>Storage Temperature Range</b>	-30°C to 60°C (-22°F to 140°F)

### FLIR OGI Camera Example Images



Figure 3.a – Normal Video Recording of Gas Emission

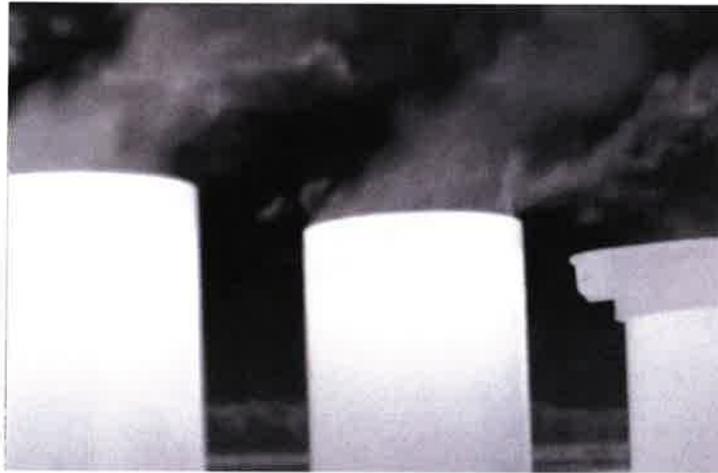


Figure 3.b – OGI Camera Recording of Gas Emission