Explosive Gas Monitoring Probe Work Plan and Explosive Gas Monitoring Plan

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA) LEGACY CLASS 1 LANDFILL

SOLID WASTE PERMIT 0254-S1-R3
TITLE V AIR PERMIT 2087-AOP-R0
AFIN: 16-00199

TERRACON PROJECT 35097125
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1.0 INTRODUCTION

The Craighead County Solid Waste Disposal Authority (CCSWDA) submitted a permit modification application to the ADEQ dated January 9, 2009. The permit modification included a vertical expansion of the CCSWDA Legacy Class 1 Landfill. The ADEQ Solid Waste Management Division issued a Notice of Deficiency (NOD) letter dated December 22, 2009 (Document Number: 55964). This Work Plan and Monitoring Plan document is submitted in partial fulfillment of the requested response to the NODs. Item 6 of the NOD list indicates that the design plans and site maps do not indicate permanent gas probes around the perimeter of the landfill. This Work Plan presents the number and location of proposed gas probes and discusses the rationale behind their proposed locations and construction details. As a result of changing the landfill gas monitoring program, an amended Explosive Gas Monitoring Plan is presented too. This Explosive Gas Monitoring Plan for the landfill presents information including a preliminary action plan outlining immediate steps that will be taken to protect human health and safety should methane gas levels exceed the limits outlined in *Reg.22.415* of *Arkansas Regulation 22*. The Explosive Gas Monitoring Plan (GMP) will address the requirements of *Reg.22.41 (a)* through *(f)* of *Arkansas Regulation 22*.

1.1 BACKGROUND

The CCSWDA owns, operates and maintains a Class 1 Municipal Solid Waste Landfill (MSWL) under Solid Waste Permit Number 0163-S1-R3 (Permit) issued by the Arkansas Department of Environmental Quality (ADEQ) on October 17, 1994. The Landfill is located approximately five miles south of Jonesboro, Arkansas near the intersection of Highway 1 and Half Acre Road. A site location map depicting the location of the Landfill is presented as **FIGURE 1**.

The Landfill performs quarterly gas monitoring as required in *Reg.22.415 (b)* of *Arkansas Regulation 22.* Gas monitoring at the landfill has historically consisted of gas monitoring in the existing groundwater monitoring wells, other designated sampling points, and in the on-site buildings.

The facility proposes to install 18 new explosive gas monitoring probes near the property boundaries as described in Section 3.1 below. The 18 new explosive gas monitoring probes (Probes) will be monitoring points for explosive gas at the boundaries of the Landfill. **FIGURE 2** depicts the approximate locations of the proposed Probes.

1.2 REGULATORY REQUIREMENTS

The decomposition of solid waste (in particular household waste) produces methane, a potential landfill gas. The accumulation of methane gas in municipal solid waste landfill (MSWL) structures can result in fire and explosions that can injure or kill employees, disposal site customers, and occupants of nearby structures. EPA 40 CFR 258.23 and *Arkansas Regulation 22* outline specific requirements for landfill gas monitoring corresponding to municipal solid waste landfills. The EPA handbook *Solid Waste Disposal Facility Criteria: Technical Manual*

(EPA, 1993) includes additional information which provides assistance to landfill operators in achieving compliance with EPA 40 CFR 258.

1.2.1 APPLICABILITY

According to EPA 40 CFR 258.23 and *Reg.22.415* of *Arkansas Regulation 22*, owners and/or operators of all MSWL units must insure that:

1. *The concentration of methane gas generated by the facility does not exceed 25 percent of the lower explosive limit (LEL) for methane in facility structures (excluding gas control or recovery system components); and*

2. *The concentration of methane gas does not exceed the lower explosive limit for methane at the facility property boundary.*

1.2.2 MONITORING PROGRAM REQUIREMENTS

In addition, owners or operators of all MSWL units must implement a routine methane monitoring program to insure that the standards given above are met. The type and frequency of monitoring must be determined based on the following factors:

1. *Soil conditions;*

2. *The hydrogeologic conditions surrounding the facility;*

3. *The hydraulic conditions surrounding the facility; and*

4. *The location of facility structures and property boundaries.*

The minimum frequency for facility landfill gas monitoring shall be quarterly according to the regulations.

1.2.3 GAS MONITORING PLAN

This GMP has been developed for ADEQ review and approval. This GMP includes a preliminary action plan outlining immediate steps that will be taken to protect human health and safety should methane gas levels exceed 25 percent of the LEL. The Plan includes, but is not limited to the following information:

1. Site specific factors affecting landfill gas migration;

2. Site conditions, landfill history, site design, and construction practices;

3. Proximity and construction of on-site and off-site structures within 1/4 mile of the limits of refuse;

4. Monitoring system design rationale and methodology that includes detailed location and design plans for in-soil gas probes; narrative description of rationale for location and depths of the gas probes; narrative, schedules and specifications for the construction of the probes and implementation of an approved monitoring routine;

5. A description of the monitoring points in structures, and equipment locations;

6. Monitoring procedures including permanent probe monitoring, barhole probe description, monitor calibration, recordkeeping, etc; and

7. Contingency plans in case of monitoring results exceeding the limits, notification procedures, remedial actions, etc.

1.2.4 DEFINITION

For purposes of this section, “lower explosive limit” means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25°C and atmospheric pressure.

1.2.5 RECORD KEEPING

Records shall be maintained in accordance with *Reg.22.421* of *Arkansas Regulation 22* to document compliance with this section.

2.0 APPLICABLE REGULATIONS

This section identifies the most likely locations for landfill gas accumulation and potential paths of gas migration associated with the Facility. These locations are identified based on the relative position of the area being considered in relation to the solid waste disposal area, soil conditions, hydraulic conditions and hydrogeologic conditions.

2.1 TECHNICAL CONSIDERATIONS

A solid waste landfill can be conceptualized as a biochemical reactor, with solid waste and water as the major inputs, and landfill gas and leachate as the principal outputs. Gases found in MSWL units include ammonia, carbon dioxide, carbon monoxide, hydrogen, hydrogen sulfide, methane, nitrogen, and oxygen. **TABLE 1** indicates the relative proportions of various landfill gases found in typical MSWL units.

TABLE 1
TYPICAL CONSTITUENTS FOUND IN MSW LANDFILL GAS

COMPONENT	PERCENT (dry volume basis)
Methane	45-60%
Carbon Dioxide	40-60%
Nitrogen	2-5%
Oxygen	0.1-1%
Sulfides	0-1%
Ammonia	0.1-1%
Hydrogen	0-0.2%
Carbon Monoxide	0-0.2%
Trace Constituents	0.01-0.6%

Reference: Integrated Solid Waste Management Engineering Principles and Management Issues (1993)

Methane and carbon dioxide are the principle gases produced from the anaerobic decomposition of the biodegradable organic waste components in municipal solid waste (MSW). As shown in **TABLE 2**, landfill gases are the result of microbial decomposition of solid waste. Methane gas, the principal component of natural gas, is generally the primary concern in evaluating landfills because it is odorless and highly combustible.

TABLE 2
STAGES OF LANDFILL GAS DEVELOPMENT

Phase I - Initial Adjustment	Organic biodegradable components in MSW undergo microbial decomposition as they are placed in the landfill and soon after decomposition occurs under aerobic conditions because a certain amount of air is trapped in the landfill.
Phase II - Transition Phase	Oxygen is depleted and anaerobic conditions begin to develop. As the landfill becomes anaerobic, nitrate and sulfate are often reduced to nitrogen gas and hydrogen sulfide.
Phase III - Acid Phase	Microbial activity initiated in Phase II accelerates with the production of significant amounts of organic acids and lesser amounts of hydrogen gas.
Phase IV - Methane Fermentation Phase	A second group of microorganisms, which convert the acetic acid and hydrogen gas formed by the acid in the acid phase to methane and carbon dioxide, become more predominant. Both methane and acid form simultaneously.
Phase V - Maturation Phase	Occurs after the readily available biodegradable organic material has been converted to methane and carbon dioxide in Phase IV. The rate of landfill gas generation significantly diminishes.

Reference: Integrated Solid Waste Management Engineering Principles and Management Issues (1993)

Methane gas is lighter than air and carbon dioxide is heavier than air. The gases will remain mixed and will migrate according to the density gradients between the landfill gas and the surrounding gases. This is also significantly affected by other gradients such as temperature and partial pressure. Generally, landfill gas will migrate along the path of least resistance. In a MSWL, the internal gas pressure is usually greater than atmospheric pressure and will cause landfill gas to be released by convective flow and diffusion (RE: Sharma and Lewis).

2.2 LANDFILL CONFIGURATION

The landfill configuration for the CCSWDA facility was originally designed by The Mehlburger Firm of Little Rock, Arkansas. The Class 1 Landfill currently consists of Cells 1, 2, 3 & 4 and future Cells 7 through 21. The permitted site ownership contains approximately 420 acres, with approximately 310 acres permitted for current and future landfill construction. The Cells 1 through 4 area consists of approximately 61 acres with a proposed permitted capacity of about 5.98 million cubic yards (MCY). Annual tonnage is approximately 85,000 tons of Class 1 waste. Cells 1 - 4 are constructed and Cell 4 and a portion of Cell 3 are currently receiving waste. Approximately 3.5 MCY of airspace remains in the Landfill utilizing the proposed final landfill configuration.

Cells 1, 2 and 3 are Pre-Subtitle D areas with some areas having received baled waste. Part of Cell 3 (piggy-back portion) and Cell 4 have a Subtitle D Liner system. Cells 3 and 4 have a composite liner system consisting of 24" clay and 60 mil HDPE geomembrane.

Stormwater at the site gravity drains to the west and collects in the Stormwater Ponds located in portions of future Cells 7 through 11. Additional stormwater features are proposed to be constructed and operated under a pending no-discharge stormwater handling permit.

2.3 GEOLOGIC CONSIDERATIONS

A geotechnical and hydrogeologic investigation of the Legacy Landfill site was performed by Grubbs, Garner Hoskyn, Inc. (GG&H) in 1989. According to the GG&H report, the western portion of the site consists of alluvial terrace deposits of Quaternary Age with sand and gravel in the lower portion and silt and clay in the upper portion. The thickness of the clay was noted to be on the order of 17 to 20 feet or to an approximate elevation of 222 to 226 feet. Below the clay, the Quaternary sands with varying silt content were encountered to an elevation near 120 feet. These sands and some gravel zones comprise the Quaternary Alluvial Aquifer.

Investigation of the eastern portion of the site (western margin of Crowley's Ridge) encountered deposits of the Upper Claiborne Group at or near the surface. The Upper Claiborne Group consists of massive clay with varying amounts of sand seams to depths of about 16 to 29 feet. Occasional gravel layers were encountered within this upper zone. Underlying the upper zone, clay and sandy clay was encountered to a depth of about 56 feet. The Memphis Sand aquifer underlies the Upper Claiborne Group deposits and consists of fine to medium sand with some interbedded clay. According to published geologic mapping for the state of Arkansas, deposits associated with Claiborne Group outcrop along the flanks of Crowley's Ridge in the vicinity of the landfill.

The potentiometric surface of the Quaternary Aquifer at the site was found by GG&H to be near elevation 170 feet msl. Due to extensive groundwater withdrawal for crop irrigation in this highly agricultural region, only the lower portion of the aquifer is saturated, primarily within the cleaner sands and gravels. Groundwater flows to the southwest at the facility, typically fluctuating down in water table elevation due to periodic irrigation withdrawal. This regional groundwater table is not expected to influence landfill gas migration in the vicinity of the landfill.

2.4 GAS MIGRATION POTENTIAL

Landfill gas migration will be along the path of least resistance from the point of generation within the landfill. Gas generated in areas with composite liner systems is expected to primarily migrate through the various layers of waste and daily cover to the landfill surface. Some portions of the existing permitted Class 1 landfill were constructed prior to *Arkansas Regulation 22* and Subtitle D. There is therefore a greater potential for lateral landfill gas migration from

the landfill from these areas.

Clayey deposits in the vicinity of the site are not conducive to liquid or gas migration. Along the western portion of the site, therefore, gas migration is expected to take place above the surface layer of fine-grained deposits, or if a conduit is established, through the underlying sands in the vadose zone of the Quaternary Aquifer, typically encountered at around 20 feet. Landfill gas can potentially migrate easterly away from the landfill through sandy layers encountered in the Upper strata of the Claiborne Group and Memphis Sand.

In general, the probability for gas migration through the base liner system will increase during the "post closure" period, as the entire landfill will have received "final cover", thus restricting gas migration through the surface of the landfill. Anaerobic gas activity and associated pressure build up will increase initially during the post closure period and taper off as the waste material decomposes and the landfill stabilizes. A gas collection and control system may be installed at the site to manage landfill gas accumulations and reduce the potential for subsurface migration of landfill gas from the waste disposal areas.

3.0 PROCESS DESCRIPTION

The accumulation of methane in MSWL structures can potentially result in fire and explosions that can endanger employees, users of the disposal site, and occupants of nearby structures, or cause damage to landfill containment structures. In accordance with 40 CFR 258.23 and *Arkansas Regulation 22*, the following information outlines the procedures that will be implemented at the facility to help insure that hazardous/dangerous levels of methane are not exceeded at the facility property boundary and/or in any structures on site.

In general, the GMP for the Landfill includes the following:

- Quarterly monitoring for landfill related landfill gas in probes and landfill structures (methane);

- Immediate steps are to be taken to protect human health in the event of methane gas levels exceeding 25% of the LEL in the facility structures and/or the concentration of methane gas exceeds the LEL of methane at the facility property boundary (*Reg.22.415 (d)*);

The surrounding area corresponding to the monitoring point that indicates an explosive hazard will be evacuated and flagged with warning tape with the writing "Explosive Danger" clearly visible in order to protect human health and safety. The outer extremities of the "exclusion zone" will be defined by taking surface readings with the portable gas monitor. If there are no concentrations above 25% LEL at the surface in the vicinity of the monitoring location, then the exclusion zone tape will be flagged in a 10 foot radius around the location in question. No one will be allowed in the "Explosive Danger" area without prior approval from the landfill supervisor until corrective measures have been taken and the area is considered "safe".

Any monitoring points with readings in excess of the established criteria (25% LEL in buildings and 100% LEL at the property boundary) will be monitored again on an hourly basis. This process will continue until either (A) Three consecutive readings below the criteria are recorded, or (B) Three consecutive readings above the criteria are recorded. If scenario "(A)" takes place, the monitoring point will be checked again the following day, and an explanation of the possible reason for the initial excessive reading will be placed in the facility permanent operating record (i.e., equipment failure, etc.). If scenario "(B)" occurs, the facility will proceed to corrective action as described below and the ADEQ will be notified of the potential hazard within 7 days.

If it is determined that an "explosive hazard" exists at any of the locations described above, a corrective action plan will be submitted to the ADEQ within 60 days which will include steps that will be implemented to reduce or eliminate excessive gas buildup within the landfill unit and related potential migration to areas that could pose danger to human health and the environment. In addition, a copy of the corrective action plan will be placed in the facility

permanent operating record.

- The Director may establish alternative schedules for demonstrating compliance with these regulations. For the purposes of this program, the lower explosive limit means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25 degrees Celsius and atmospheric pressure.

3.1 LANDFILL GAS MONITORING PROBE CONSTRUCTION

Eighteen (18) gas monitoring probes designated GP-1 through GP-18 are planned to be installed in early 2010 in order to adequately monitor explosive gas at or prior to the property boundary. The probes are to be installed to provide data for evaluating potential landfill gas migration beyond the landfill refuse and near the property boundary. The gas probes will be utilized to document whether landfill gas is currently migrating away from the landfill to surrounding properties and structures. The total depth of the monitoring probes will range approximately between 20 and 50 feet below ground surface. All probes will be constructed of half-inch diameter Schedule 80 PVC and installed above the saturated zone at each location. **FIGURE 2** illustrates the proposed probe construction. A specification for the probes is presented in **APPENDIX A**.

In order to determine gas probe monitoring locations and depths, the following was considered: Maximum spacing of probes, in areas where no adjacent, off-site structures exist, was to be 1000 feet. Probes along the east side of the landfill would be placed between the landfill and structures along the County road along Crowley's Ridge. As mentioned in Section 2.4, gas probes were to be installed within higher permeability (sandy) subsurface strata that correlate approximately with the bottoms of the landfill cells in the vicinity of the probes.

Generalized soil profiles published in the geotechnical and hydrogeologic investigation by Grubbs, Garner Hoskyn, Inc. (GG&H 1989) were used to determine probe depth and screened interval placement. Probes placed along the flank of Crowley's Ridge east of the landfill were generally designed to intercept any interbedded sandy strata and to correlate approximately with the bottoms of adjacent landfill cells.

3.2 LANDFILL GAS MONITORING PROCEDURES

To demonstrate compliance with the requirements of 40 CFR 258.23, and *Arkansas Regulation 22*, the facility will routinely monitor air quality inside the landfill office building, scale house, and any other facility structure where methane gas could potentially accumulate. The person conducting the monitoring will be trained in the proper use of the gas monitoring equipment, including calibration procedures. Prior to performing each quarterly landfill gas monitoring event, a qualified operator will calibrate the methane detector and record the applicable weather conditions.

Monitoring within facility structures will consist of recording the concentration of methane (in % LEL) in each room of the facility utilizing an explosive gas analyzer calibrated to methane. When possible, readings shall be taken in enclosed areas, near electrical outlets, or floor drains, which could potentially be sites for landfill gas migration into the structure. At each location, the operator will measure the time, methane (% LEL), and oxygen (%). Any detected readings will be recorded for each location in each room. If no methane is detected in the room, a "non-detect (ND)" will be entered for that room on the landfill gas record form. In the event a detection occurs, a no-smoking policy will be strictly enforced within the facility structure.

Routine sampling procedures will be exercised at the 18 gas monitoring probe locations, and will include at least the following procedures:

- Record the date, weather conditions, and monitoring equipment operator;
- calibrate explosive gas analyzer to methane and oxygen;
- Inspect and record the integrity of gas probe ;
- Unlock padlocks and take off the protective hood;
- Open the well or valve and allow the well sufficient time to equilibrate;
- Place explosive gas analyzer on the probe opening and record gas concentration in % LEL and % oxygen;
- Record gas and oxygen concentrations;
- Close well opening once all measurements have been completed;
- Detach explosive gas analyzer and put protective hood casing back over the gas probe and secure casing with padlocks.

3.3 LANDFILL GAS MONITORING EQUIPMENT

Landfill gas measurements will be collected at each probe with a gas monitoring instrument (Landtec GEM 2000 or equivalent). The instrument will be capable of recording the concentration of methane in "percent LEL". The instrument will be calibrated to methane prior to each monitoring event as outlined in the equipment manufacturer's literature. This information will include calibration procedures and maintenance information that will help ensure that the equipment is in proper working condition. In the event landfill gas is detected within a facility structure, a permanent gas monitor with an alarm will be installed within that structure.

3.4 RECORD-KEEPING REQUIREMENTS

This Plan and all correspondence shall be retained as part of the facility's permanent operating record. All quarterly gas monitoring reports will also be maintained in the facility's permanent operating record. All information and records associated with the Landfill Gas Monitoring Program will be available for review, and will be submitted to the ADEQ as requested. All monitoring results will be recorded and documented on a "Landfill Gas Monitoring Record Form" similar to the one provided in **APPENDIX B**.

APPENDIX A
Monitoring Probe Specification

APPENDIX A

SPECIFICATION

SECTION 15483

LANDFILL GAS MONITORING PROBES

PART 1 - GENERAL

1.1 SCOPE

A. This Section covers the minimum requirements for the supply and installation of the gas monitoring probes.

B. It is the intent of these Specifications that the gas monitoring probe be supplied as a prefabricated assembly by an ISO 9001 certified manufacture.

1.2 APPLICATION

A. Gas monitoring probes shall be installed near the landfill facility property boundary to monitor the migration of landfill gas. Approximate locations are illustrated on **FIGURE 2** of the Explosive Gas Monitoring Probe Work Plan.

1.3 SUBMITTALS

A. The following documentation shall be submitted to the Engineer:

1. Manufacturer's Installation Instructions.
2. A drawing showing the components and dimensions of the gas monitoring probe.
3. Manufacturer's Warranty Information.

1.4 PRECEDENCE

A. The Specifications included in this Section are specific to this Section only. Unless called out otherwise, the Specifications shall have precedence over the Drawings. Additionally, if other specification sections are more stringent than those included in this Section, the most stringent shall apply. Should any conflicts between the Specifications arise, the Contractor shall immediately bring them to the attention of the Engineer.

PART 2 - PRODUCTS

2.1 PRODUCT DESCRIPTION

A. The gas monitoring probe shall be a LANDTEC LFG migration probe kit or approved equivalent and shall consist of threaded 5' extension tube segments, screen sections, end caps, labeled steel security cover, concrete pad, quick connect sample ports and probe name and depth I.D. tags.

B. Equipment supplied under this Section shall have a proven performance of not less than five (5) years in actual landfill service.

C. The probe assembly shall be capable of being used with the LANDTEC GEM 2000 Gas Analyzer, incorporating all GEM monitoring functions.

2.2 APPLICABLE DESIGN CODES

A. Pipe Material and Fittings

1. PVC pipe fittings used in the manufacture and installation of the probe will be Type I, schedule 80 pipe and shall conform to ASTM D-1785.

3. MATERIALS

A. PVC Pipe

All piping materials for the probes will be ½" inch diameter PVC with flush threaded (FPT) fittings. Pipe and fitting will be Type I, schedule 80 pipe and shall conform to ASTM D-1785. Pipe and fittings will be visually inspected in the interior of the pipe and will be free of all dirt and any other foreign objects upon completion of the installation. The exterior of the pipe will be free of any cracks or manufacturing defects.

B. Monitoring Port Valve

A ¼" NPT quick connect valve will be installed on each of the probe casings. The valves will have EPDM valve seats and are to be made of PVC construction.

C. Identification Tags

Each probe casing will have an identification tag attached. Tags will be made of 1/32" aluminum plate that will include the probe numbers and depth etched into the tag. Tags will be attached to the probe pipe below the quick connect valve.

D. Granular Fill

The granular fill will consist of 3/8" minus clean, washed, sound, durable, surrounded sands and gravels with no fines and containing no organic materials, anhydrite, gypsum, mica, calcareous material or other deleterious material.

The material will conform to the following gradation limits:

Standard Sieve Size	Percent Passing
3/8”	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

Prior to delivery to the site, the contractor will submit to the engineer a minimum of 25 pound sample for the granular fill material for testing and approval.

E. Filter Pack Material

The filter pack sand will be 20-40 CSSI clean sand. The filter pack sand shall be placed above the granular fill and below the bentonite seal. Filter pack will be at least 1-foot thick.

F. Bentonite Seal

Bentonite seals will be created using a premium grade bentonite clay or by using a Baroid Holeplug pellet as approved by the engineer.

Baroid Holeplug materials will have a diameter of less than ¼” and will be free of contaminants. The pellets will be placed in the borehole in such a manner as to prevent bridging and are to be saturated in place with a ratio of 2.5 gallons of water for every 25 pounds of pellets to achieve a 2-foot homogenous saturated seal.

G. Clean Backfill Soil

Backfill material will consist of soils free from debris, organic materials, and any non-mineral material. The maximum particle size of the materials shall not exceed 1 ½” in diameter and less than 25% of the materials shall pass the No. 200 screen. Materials not meeting these criteria may be used upon approval by the project engineer or geologist.

H. Probe Protective Steel Casing

A locking, steel security cover with identification tag will be neatly set over the probe assembly for protection as shown on the **FIGURE 2**.

2.4 EXPERIENCE

A. The equipment type must have at least five (5) years of proven landfill gas performance.

PART 3 - EXECUTION

3.1 DRILLING METHODS

Drilling will be conducted by a licensed drilling contractor, and by an experienced drilling crew. The Contractor will submit for review and approval by the project engineer or geologist his proposed plan for drilling the probes as shown on **FIGURE 2** and as specified herein. Probe bores will be drilled by an air-rotary hammer, dual-percussion hammer drill, or hollow-stem auger method. The Contractor is responsible for the drilling method selected.

The minimum diameter of the bore for the probe will be four inches as indicated on **FIGURE 2**. Probe bores will be drilled to the depths specified on **FIGURE 2** or to the elevation directed by the project engineer or geologist.

In the event during the drilled operation an impenetrable rock formation is reached such that the probe bore cannot be completed to the elevations indicated on the drawings, the engineer will determine whether the borehole is sufficiently deep for the Contractor to complete the monitoring probe or other methods of drilling must be used to complete the probe bore drilling to the specified elevations. Impenetrable rock is defined as practiced refusal of penetration of material with air rotary hammer or dual-percussion hammer drilling equipment and shall be verified by the project engineer or geologist.

If necessary, a temporary bore casing of either iron or steel, new or used, may be used to support the sides of the entire borehole during drilling and placement of the probe pipes, gravel pack, and bentonite seals. Any temporary casing will be approved by the project engineer or geologist and will have sufficient thickness to retain its shape and true section throughout its depth. The temporary casings will be removed from the borehole in such a manner as to not cause damage to the probes.

The project engineer or geologist will be notified immediately in the event groundwater is encountered during drilling. No gas probe shall be installed below groundwater table.

The drilling contractor will drill all borings as specified in the drawings and specifications provided. Drilling contractor will also be responsible for procurement, assembly, installation and placement of all pipe and fittings, backfill material, concrete apron, and steel protective casing as specified by the specifications and plans. Acceptance of all phases of the work must be approved by the engineer.

The Contractor will be compensated only for the portion of work completed and to elevations actually reached.

3.2 BOREHOLE LOGGING

The project engineer or geologist or his designated representative will log the borehole during drilling, and maintain records of the project activities. Boring will be logged on

standard forms developed for borehole logging and documenting probe construction details and daily drilling activities. Forms will include the landfill gas monitoring probe construction log, log of borehole, and daily field activity log.

3.3 ABANDONED BOREHOLES

If, for any reason, a probe bore must be abandoned, all abandonment procedures will be in accordance with local regulations. The purpose of properly abandoning a borehole is to prevent the hole from acting as a conduit for contamination of the groundwater or release of landfill gas.

3.4 PROBE CONSTRUCTION

A stable borehole will be constructed prior to attempting to install monitoring probes. If the borehole tends to cave, steps will be taken to stabilize the borehole prior to installing the probes. Boreholes that are not plumb or are partially obstructed will be corrected prior to probe installation.

The monitoring probes (perforated sections) and risers (blank sections) will be constructed to the depths shown on the drawings or as adjusted by the project engineer or geologist to place probes adjacent to soils that are most conductive to gas flow.

All monitoring probes will be installed above permanent low seasonal water table, above and below perched groundwater and above bedrock. In the event perched groundwater is encountered, the borehole section along the perched groundwater zone will be sealed with bentonite extending from 5 feet below to 5 feet above the perched water zone.

After the desired boring depth is attained, a one foot thickness of gravel will be added to the bottom of the boring through the drill pipe as a base for the monitoring probe. The perforated and riser sections of the probes shall then be connected and lowered through the drill pipe to the bottom of the boring.

Probes will be centered in the probe bore and held securely in place during placement of the gravel fill and bentonite seals. Precautions will be taken to assure that grease, oil, or other contaminates do not contact the pipe. Workers will wear a new pair of cotton or surgical gloves while handling pipe. To prevent kinking, no more than 20 feet of perforated or riser pipe shall be assembled above ground. The interval between joints will be 5 feet.

Gravel will then be carefully added while removing section of drill pipe until the gravel extends one foot above the screened or perforated interval. Next, a one-foot thickness of filter pack sand will be added prior to placement of the bentonite seal. A two-foot bentonite seal will be constructed above the filter pack sand.

The riser pipe will extend above grade and will be trimmed to the proper length after the top bentonite seal is placed. The top of the probes will be fitted with a monitoring port valve. Each probe will be temporarily marked immediately after it is installed with

masking tape clearly indicating the probe number. The tape will be removed as soon as the probe identification tags are installed.

The probe assembly will be completed with the installation of the probe protective casing.

In traffic areas, two traffic bollards per probe location will be constructed for protection and easier identification of the probes.

3.5 SAFETY

A. The Contractor shall provide a Health and Safety Plan appropriate for the Work that will be performed. In addition to general construction health and safety issues, the Health and Safety Plan shall address protecting workers from exposure to landfill gas and refuse during the execution of the Work.

END OF SECTION

APPENDIX B
Landfill Gas Monitoring Record Form

CCSWDA LEGACY LANDFILL
JONESBORO, ARKANSAS
LANDFILL GAS MONITORING RECORD FORM

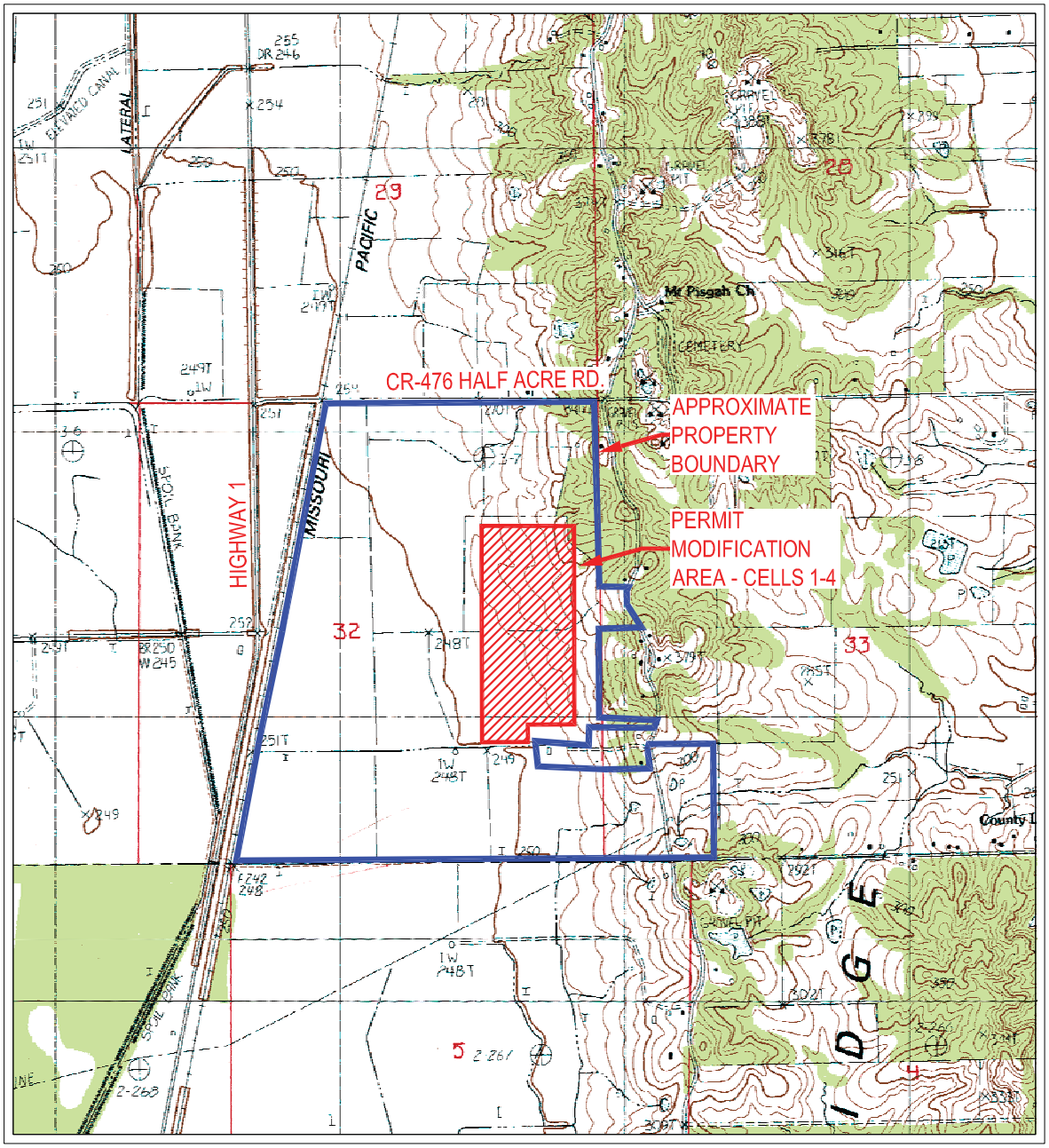
TECHNICIAN: _____ **DATE:** _____
AIR TEMPERATURE: _____ **WIND SPEED AND DIRECTION:** _____
ATMOSPHERE CONDITIONS: _____
EQUIPMENT UTILIZED: _____

MONITORING POINT	% LEL METHANE	% METHANE BY VOLUME OF AIR*	% OXYGEN	TIME	COMMENTS
GP-1					
GP-2					
GP-3					
GP-4					
GP-5					
GP-6					
GP-7					
GP-8					
GP-9					
GP-10					
GP-11					
GP-12					
GP-13					
GP-14					
GP-15					
GP-16					
GP-17					
GP-18					
Transfer Station					
Scale					
Break Room					
Shop					
Building A					
Building B					
Building C -proposed					
Water Building					
Wash Room					

5% METHANE BY VOLUME OF AIR IS EQUAL TO 100% LEL.

APPENDIX C
Figures

UNITED STATES – DEPARTMENT OF THE INTERIOR – GEOLOGICAL SURVEY

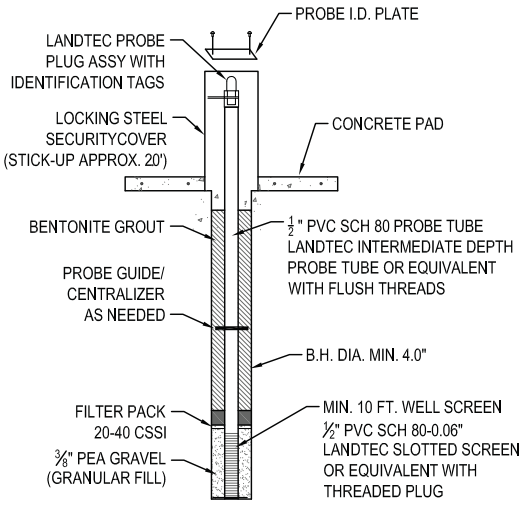


GREENFIELD
QUADRANGLE
1983
7.5 MINUTE SERIES (TOPOGRAPHIC)

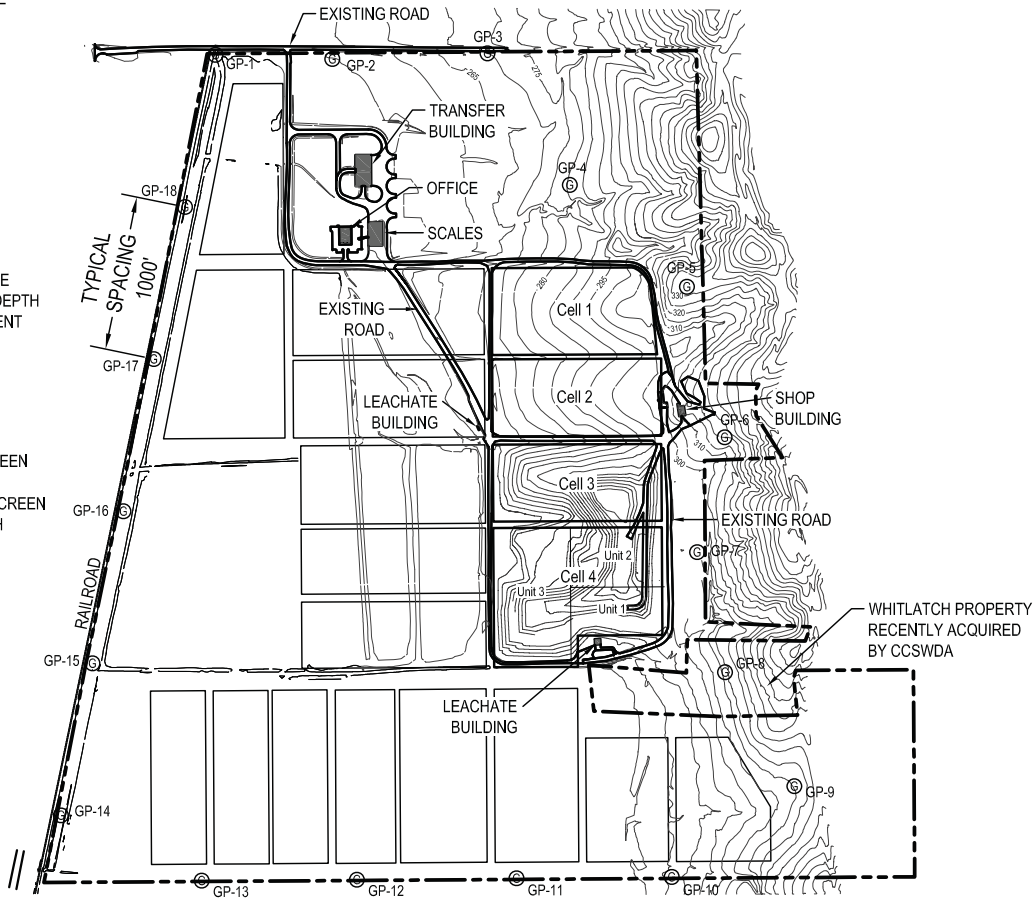
Project Mngr: FOC	Project No. 282-001-35097125	Terracon Consulting Engineers and Scientists	SITE LOCATION MAP	FIG. No.
Drawn By: PTG	Scale: AS SHOWN	25809 I-30 BRYANT, AR 72022	PERMIT MODIFICATION CELLS 1-4	1
Checked By: HAL	File No. 002	PH. (501) 847-9292 FAX. (501) 847-9210	CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY	
Approved By: FOC	Date: 2/17/2010		LEGACY LANDFILL	
			JONESBORO ARKANSAS	

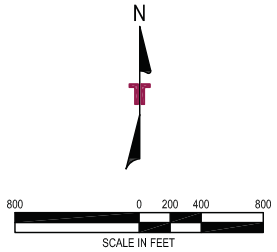
1 - REFER TO PROJECT BID SPECIFICATIONS. READ CAREFULLY BEFORE ATTEMPTING ASSEMBLY AND INSTALLATION OF PROBE KIT.

2 - SEE PROBE DEPTHS ON TABLE THIS DRAWING FOR PROBE DEPTHS AND SCREENED INTERVAL.



GAS MONITORING PROBE INSTALLATION DETAIL





Gas Probe Identification	Approximate Ground Elevation (ft)	Total Probe Depth (ft)	Perforated Pipe (ft)	Solid Pipe (ft)
GP-1	248	33	10	23
GP-2	255	25	10	15
GP-3	270	20	10	10
GP-4	280	20	10	10
GP-5	335	50	20	30
GP-6	320	50	20	30
GP-7	288	48	20	28
GP-8	287	47	20	27
GP-9	286	46	20	26
GP-10	263	38	10	28
GP-11	250	35	10	25
GP-12	250	35	10	25
GP-13	250	35	10	25
GP-14	249	34	10	24
GP-15	249	34	10	24
GP-16	248	33	10	23
GP-17	249	34	10	24
GP-18	250	35	10	25
Totals		652	230	422

LEGEND:

PROPERTY BOUNDARY

EXISTING INDEX CONTOUR

GP-1Ⓖ PROPOSED GAS MONITORING PROBE LOCATION

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

GAS PROBE LOCATION MAP

PERMIT MODIFICATION CELLS 1-4

CRAIGHEAD COUNTY SOLID WASTE DISPOSAL AUTHORITY (CCSWDA)

LEGACY LANDFILL

JONESBORO ARKANSAS

FIGURE 2

DESIGNED BY:	FOC
DRAWN BY:	PTG
APPVD. BY:	FOC
SCALE:	1" = 800'
DATE:	2/25/2010
JOB NO.	282-001-35097125
ACAD NO.	002A
SHEET NO.:	OF