ATTACHMENT A

GCCS Design Plan (2017)

Landfill Gas Collection and Control System Design Report

Rowan County Solid Waste Landfill

Woodleaf, North Carolina

Prepared for:

Rowan County
Department of Environmental Management
2727 Old Concord Road, Suite D
Salisbury, NC 28146

Issued June 3, 2016
Revised September 22, 2017
Revised November 27, 2017

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1 Certification

This New Source Performance Standards (NSPS) Landfill Gas Collection and Control System (GCCS) Design Report was prepared for the Rowan County Landfill as authorized by the Rowan County Department of Environmental Management.

I certify that the GCCS as described in this plan meets the design requirements specified in 40 CFR 60.759, and any alternatives pursuant to 40 CFR 60.752(b)(2). I further certify that this report was prepared by me or under my direct supervision, and that I am a duly registered Professional Engineer under the laws of the State of North Carolina.

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11/27/17
MICHAEL D. PLUMMER

Michael D. Plummer, P.E.
Certifying Engineer

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2 Introduction

2.1 Purpose

This report was prepared by HDR Engineering Inc. (HDR) on behalf of the Rowan County Department of Environmental Management (Rowan County) to fulfill the requirements of the New Source Performance Standards (NSPS), 40 CFR Part 60, Subpart WWW, for a Landfill Gas Collection and Control System (GCCS) Design Plan for the Rowan County Landfill (Landfill). The Landfill is located in the Town of Woodleaf and is owned and operated by Rowan County. The recently published revisions to the NSPS regulations will lower the threshold for which landfills become regulated by the NSPS. The revised threshold will be triggered when a landfill's design capacity exceeds 2.5 million megagrams (Mg) and when its non-methane organic compounds (NMOC) emissions rate exceeds 34 megagrams (Mg) per year as opposed to 50Mg/yr. As such, the Landfill will be subject to NSPS regulations that will require the installation of a GCCS to manage landfill gas (LFG). The collected LFG will be directed to a flare that will reduce the NMOC emissions. This design plan was prepared in accordance with 40 CFR 60.752(b)(2) and fulfills the requirements of 40 CFR 60.752 and 60.759.

2.2 Site Background Information

The Landfill is located at 789 Campbell Road (SR 1947) in Woodleaf, North Carolina and is permitted under NCDENR Permit No. 80-03. The landfill property consists of approximately 375 acres. A closed land clearing and inert debris (LCID) landfill and a closed construction and demolition (C&D) landfill are located on the eastern portion of the property. In 1989, Rowan County constructed Phase I of the lined Subtitle D landfill. The complete Subtitle D landfill area will consist of Phases I – IX with a total design capacity of approximately 15.071 million cubic yards. Currently, the landfill's permitted capacity for Phases I, II, III, IIIA (vertical expansion) and IV totals 5,437,000 cubic yards. Permitting a full build out of Phases I – IV would increase the landfill capacity to 7,160,000 cubic yards. Waste is currently being deposited in Phases I, II, III and IV. As of November 22, 2017, no landfill areas are capped.

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3 Proposed Landfill Gas Collection and Control System

This section identifies the components of the proposed GCCS and describes how LFG will be managed. A phased GCCS was designed and constructed in order to provide NSPS compliance by April 2017 and continue compliance for the entire landfill lifespan. The proposed GCCS design consists of sixty (60) vertical extraction wells. Twenty-seven (27) of which will be installed within the Phase I and Phase II area by April 2017 and the remaining thirty-three (33) will be installed in Phases III and IV after final grades are reached. Due to the limited waste depth in the permitted Phase IV contours (I.e. 20 to 35 feet vertically) well heads will be connected to the leachate collection system in order to control and extract landfill gas. Future GCCS expansions beyond the 15year system life will be designed, permitted and installed as each future landfill lateral expansions into Phases V – IX) reaches completion. LFG collected from the landfill will be routed to a blower/flare station where the LFG will be combusted using a candlestick flare. The candlestick flare will be designed to provide a minimum 98 percent NMOC destruction efficiency required by §60.752(b)(2)(iii). If alternative utilization or control devices are used in the future, they will be designed to comply with the applicable NSPS requirements. The proposed GCCS design was designed so that future expansion of the system can be accommodated.

Permit level drawings depicting the proposed GCCS system (Phase I, II, III and IV) are included in Appendix A.

3.1 Landfill Gas Generation

Per NSPS requirements the GCCS is required to be sized to handle the maximum expected gas flow rate over the intended use period of the system. For design purposes the baseline years of 2017 through 2032 were used as the intended use period.

The United States Environmental Protection Agency (USEPA) LandGEM (Version 3.02) gas generation model was used to determine the total LFG generation rate over the 15 year collection system design life. The inputs to the model are consistent with AP-42 and EPA guidance. Waste tonnages used in the model were obtained from landfill records and assumed to remain constant from 2016. The waste design capacity was calculated using the full build out design capacity of 7.160 million cubic yards for Phases I through IV and the current average in-place density of 0.6575 tons per cubic yard (reported in the Rowan County Landfill Airspace Calculations Report dated July 24, 2017). The Phases I – IV capacity is anticipated to last through the intended use period. The LandGEM model results are presented in Appendix B.

The maximum expected LFG generation rate during this design period is estimated to be 1,162 cfm.

3.2 Landfill Gas Collection

LFG extraction will be achieved using a well field of vertical extraction wells. The well field is connected to the blowers which provide a negative vacuum across the landfill area via a system of lateral pipes and header pipes. While Rowan County intends to install vertical extraction wells to the extent practical, particularly in areas at or near final (or long-term interim) grades, initial gas collection may come through well head connections to the leachate collection system when installation of vertical wells is not feasible due to the site geometry, waste depth or filling sequence. In addition, although not shown in this design, horizontal collector wells may be employed as necessary to enhance collection.

3.2.1 Vertical Collectors

In lined landfills, the vertical wells are typically drilled to 75 percent of the landfill depth but no closer than 15-feet above the liner. This standard practice is used to avoid accidental damage to the liner system. Vertical wells will be constructed of Schedule 80 PVC pipe installed in 36-inch diameter boreholes. Typically, the lower two-thirds of the well pipe is perforated. However, perforated pipe is typically not used closer than 10 feet from the landfill surface. Perforations are typically 3/4-inch diameter holes spaced 4-inches apart vertically and 90 degrees apart horizontally. However, alternative slot or perforation designs which provide comparable performance may be considered. The spacing between vertical gas extraction wells depends on the landfill characteristics (e.g., waste density, age, LFG generation rate, etc.) and the amount of applied vacuum.

3.2.2 Well Placement and Radius of Influence

The locations of gas extraction wells were selected to meet the NSPS requirements for sufficient density throughout all gas producing areas. When a well is placed under the influence of vacuum, the recoverable LFG in the immediate vicinity will begin to move towards the well. This area of gas movement is referred to as the well’s radius of influence (ROI).

Some factors that influence a well’s ROI include the depth of the well, the length of perforated pipe for gas collection, the refuse temperature, the in-situ LFG generation rate, the amount of vacuum applied to the well, and waste density. For design purposes, a theoretical ROI for a vertical gas extraction well was estimated. The estimation was calculated for a maximum expected LFG generation rate of 1,162 cfm and an average well depth of 58 feet with perforated pipe length of 42 feet. The estimated ROI was determined to be 121 feet. Actual ROI varies and cannot be measured until a well is installed. ROI calculations are included in Appendix B.

Specific locations for the vertical gas collection wells were initially selected based on a 200-foot grid pattern across the landfill area. Well locations were then adjusted to locations where the depth of waste was sufficient to accommodate 15 feet of clearance from the baseliner, 10 feet of solid pipe below the landfill surface grade, and a minimum 5 feet of perforated pipe length. Then well locations were adjusted to establish a vacuum across as much of the landfill as practical given the estimated ROI. Some overlap of the

ROI is provided to provide for better collection efficiency. Finally, well locations were adjusted based on the topography and ability of a drill rig to access the area. For example, given that it is preferred to drill wells on a flat surface rather than a steep sideslope, well locations that fall on steep sideslopes based on the 200-foot grid pattern are relocated to nearby benches or plateau areas. In addition, the final location of gas extraction wells may be adjusted in the field based on the actual field conditions during installation.

The layout of the collection system is shown on Sheet 00C-02. Sixty (60) wells are positioned throughout the Phases I through IV. The vertical gas extraction well schedule is shown in the tables on Sheet 00C-03.

3.2.3 Wellhead Assemblies

Each LFG collection well will have a wellhead as shown on the design drawings. The wellhead will include a valve to regulate gas extraction rates and quick connect instrument ports compatible with a Landtec GEM-2000 landfill gas monitoring instrument (or similar monitoring device) to measure gas flow, temperature, pressure and major LFG constituents (methane, carbon dioxide, oxygen, nitrogen). Wellheads will be connected to the lateral pipes by means of flexible piping to accommodate for waste settlement.

3.3 Header and Lateral Collection Piping

3.3.1 Collection Piping Layout

The collection system pipes are installed to apply a vacuum across the well field and convey the gas collected to the blower/flare station. The collection piping for the landfill consists of header pipes and lateral pipes. Lateral pipes connect the vertical gas extraction wells to the header pipes. The header pipe system will incorporate a series of loops to allow for flexibility and redundancy. The collection system layout is illustrated in design drawing Sheets 00C-02 and 00C-04.

The header and lateral pipes will be constructed of fusion-welded HDPE pipe. Header and lateral pipes may be installed either below or above grade. In locations where above grade header and laterals are used, the piping will be appropriately anchored. The header pipe system was designed to drain condensate to low points via gravity. Whenever possible, the header pipe has a minimum slope of 5 percent to facilitate condensate management after expected settlement. Condensate drip legs will be installed at each low point to capture condensate. The proposed drip legs are located near existing leachate cleanout risers and will drain via gravity to the nearest leachate collection system cleanout. The header system was designed so that it can be expanded as the Landfill is developed. As new phases are developed, interim headers will be installed between the phases to create new individual loops.

Additional features include isolation valves and header pipe access points. The header pipe isolation valves, located throughout the system, are used to isolate particular sections of header pipe for maintenance or vacuum control purposes. Header pipe access points, consisting of a blind flanged assembly that sweep into the header pipe will provide pipe pigging capacity and spare connection points for lateral tie-ins in case existing laterals become compromised and/or additional wells are installed. Blind flanges will be installed at locations where tie-ins to future phases are planned. All GCCS construction materials will be constructed of corrosion resistant materials such as PVC, HDPE, and all metal parts potentially exposed to LFG will be stainless steel or coated to increase corrosion resistance. The seats, seals, and valve body material will be appropriate for use in a LFG environment.

3.3.2 Collection Pipe Sizing

The LFG flow characteristics through the refuse cannot be precisely predicted because of the non-homogeneous nature of refuse. For purposes of sizing the LFG transmission piping, estimates of the pipe frictional loss due to the LFG flow were calculated and were used to optimize the LFG pipe and blower sizes.

An analysis was performed on the proposed pipe network to model its ability to adequately handle the maximum LFG that may be generated from the Phases I through IV during the design period. This evaluation was performed using the KYGAS model. KYGAS was developed by Dr. Don J. Wood and Dr. James E. Funk at the University of Kentucky. The program was based on the KYPIPE modeling program which models water distribution systems. KYGAS is used to calculate the head losses, system pressures, and velocities in piping systems controlled under vacuum. KYGAS operates under the assumptions that all flow in the piping network is steady, one-dimensional, isothermal flow. The program uses the Darcy-Weisbach equation for head losses related to incompressible flow and the Ideal Gas Law for pressure-temperature-density relationships.

The following parameters are required for operation of KYGAS.

- Pipe inside diameter
- Pipe length
- Minor loss coefficient
- Roughness within the pipe
- LFG flow rate into the system at each well or node
- LFG operating temperature
- Specific gravity of the LFG
- Ratio of specific heats
- Absolute viscosity of LFG

The modeling started by first laying out the piping network including junctions, drip legs, blowers and flare by using engineering judgment. This information was imported from an AutoCAD drawing. After entering the system layout, an initial run of the conceptual layout was performed to determine if the design criteria was met. The design criteria for the header system were:

• Maximum flow velocity:	40 feet per second (fps)
• Maximum pressure drop:	0.36 psig per 1,000 feet
• Minimum vacuum at the blower:	40 inch w.c.

- LFG flow: 1,162 cfm (consistent with the design period flow from 2017 through 2032)

Using an iterative process, the LFG piping system was modified until all the design criteria were met.

The proposed GCCS configuration results in a calculated total system pressure drop of approximately 8-inch w.c.; the maximum flow velocity is 34.46 fps; and the maximum pressure drop is 0.17 psig/1000 ft. All values are within the design operational ranges. The results of the KYGAS analysis are included in Appendix B.

The header loop sizing around the Phases I and II is 10” diameter SDR 17 HDPE pipe. The lateral collection piping sizing is either 4” or 6”diameter SDR 11 HDPE pipe. The final design diameter of each segment of header pipe may vary in size, depending on the volume of LFG it will be expected to convey. The LFG collection system layout with header and lateral pipe size is illustrated in design drawing Sheet 00C-02.

3.3.3 Condensate Management

As LFG extracted from the warm waste mass cools in the collection network, condensate forms. If the gas condensate is not removed from the collection system, liquid buildup will occur and adversely affect gas flow rates or create a blockage. The condensate generation rate depends upon the LFG flow rate and the temperature differential between the LFG in the waste mass and temperature in the lateral and header piping.

The estimated daily condensate generation rate based on the maximum expected LFG generation rate of 1,162 cfm and an ambient temperature of 50 °F was approximately 551 gallons per day (gpd). Condensate generation was also estimated during summer months using an ambient temperature of 80 °F and the condensate generation was estimated to be 305 gpd. These values represent average anticipated daily condensate generation rates and are dependent upon seasonal weather. The condensate generation estimates are included in Appendix B.

The GCCS was designed to drain gas condensate by gravity to condensate drip legs located at low points throughout the header system. The drip legs will be connected to the existing leachate cleanout risers and will drain condensate back into the existing leachate collection system. In addition, a condensate sump will be installed at the header entering the blower/flare station and a condensate knockout pot at the blower/flare station to remove additional moisture from the LFG.

3.4 Gas Blower/Flare Station

The GCCS design utilizes a blower to exert vacuum across the well field and extract LFG from the Landfill. The collected LFG will be conveyed to the flare station for combustion. The blower/flare station was sized to handle maximum expected gas flow rate during 2017 through 2032. The maximum expected gas flow rate for this period is 1,162 cfm. The GCCS design will utilize a candlestick-type flare (also called an open or utility flare) as control equipment which combusts LFG outside the stack. The proposed location of a blower/flare station was selected based on safety considerations, access to 3-phased electricity, and general accessibility by major equipment, proper drainage, future connection points, operational considerations, and other factors such as noise, odor, and visual impact to the surrounding area. The location of the blower/flare station is shown on the design drawings. This location also provides space for potential future landfill gas to energy (LFGTE) projects.

3.4.1 Blowers

Blowers for the GCCS were sized and configured for incremental capacity to match the LFG generation and collection curves over the design life. The design allows for spare blower units and future blower upgrades. Over the design lifespan, the Landfill will generate between 776 cfm to 1,162 cfm of LFG. The initial phase of the gas collection system is designed to combust 1,500 cfm of landfill gas to control the maximum expected LFG generation. A dual blower system will be used to cover the maximum LFG generation rate. Each blower will be capable of applying a minimum of 40 inches of water column vacuum that can operate between flow rates of 0 to 1,000 cfm. A minimum of 40 inches water column vacuum will be applied to the header at the blower/flare station and the discharge pressure will be at least 10 inch water column. A condensate knock-out pot will be installed to remove additional condensate prior to proposed flare station. A fail-close actuator valve to shut off flow to the blowers will be installed.

3.4.2 Flare

A candlestick flare will be sized to combust the LFG and destroy NMOCs by a minimum 98 percent to comply with 40 CFR 60.18. The flare will have a maximum flow capacity of 1,500 cfm with a 5:1 turndown ratio capacity to allow for fluctuations in gas generation and collection over the design life of the equipment (2032). The flare will be skid mounted and fastened to a poured concrete pad along with the blowers.

3.4.3 Blower/Flare Station Controls

The controls at the blower/flare station will include the following:

- Programmable logic controller (PLC);
- LFG flow meter;
- Blower and flare controls interface for automatic motor starting following pilot ignition;
- Alarm indicators for high temperature, low temperature, flame failure, pilot failure, and blower failure; and,
- Chart recorder or digital data recorder for flare temperature and LFG flow rate.

4 Future Site Development

4.1 Landfill Development Plan

The Landfill will continue to be filled with MSW in accordance with the solid waste permit. Installation of GCCS components is anticipated to be coordinated with fill operations and the requirements of the NSPS regulations. Due to potential operational changes, the GCCS design presented in Appendix A may require minor modifications to maintain compliance with the provisions of the NSPS and to accommodate actual field conditions at the time of construction. Any major changes will be brought to the NCDEQ prior to initiation. Minor modifications will be reflected in the construction certification documents.

4.2 GCCS Expansion Capabilities

Typically, it is assumed that the GCCS components will have a maximum lifespan of 15 years. After that period it often becomes necessary to perform significant maintenance or to replace some of the components. Over time, as the Landfill expands and as site conditions dictate, various features of the GCCS may be relocated or replaced in order to accommodate future landfill operations.

It is intended that future GCCS designs will incorporate similar engineering judgment and methods as explained in this Design Report. The specific layout of future phases will be addressed as the expansions are developed and permitted. The GCCS design can accommodate the planned expansion of the Landfill Phases V through IX. Design considerations include appropriate header and condensate trap/sump sizing, additional blower and flare capacity, and tie-in locations for connection to the expansion areas. Header and condensate traps/sumps are sized based on the projected LFG recovery rates from the current landfill areas based on historical and projected future waste disposal rates.

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5 Compliance Review and Evaluation

The purpose of this Section is to document and certify compliance of the proposed GCCS with the applicable sections of 40 CFR 60.759 - Specifications for Active Collection Systems, including:

- §60.759(a) - Compliance with §60.752(b)(2)(i).
- §60.759(b) - Construction equipment or procedures.
- §60.759(c) - Conveyance of LFG in compliance with §60.759(b)(2)(iii).

Additionally, portions of §60.755 - Compliance Provisions relevant to GCCS specifications are addressed, including:

- §60.755(a)(1) - Calculations for maximum expected gas generation flow rate.
- §60.755(a)(2) - Sufficient density of gas collectors.
- §60.755(a)(3) - Collection system flow rate sufficiency.
- §60.755(a)(5) - Identification of excess air infiltration.

5.1 Compliance with §60.759(a)(1)

> §60.759(a)(1) states, *"The collection devices within the interior and along the perimeter areas shall be certified to achieve comprehensive control of surface gas emissions by a professional engineer. The following issues shall be addressed in the design: depths of refuse, refuse gas generation rates and flow characteristics, cover properties, gas system expandability, leachate and condensate management, accessibility, compatibility with filling operations, integration with closure end use, air intrusion control, corrosion resistance, fill settlement, and resistance to the refuse decomposition heat."*

This GCCS was designed to be consistent with NSPS requirements to achieve comprehensive control of both lateral migration and surface emissions of LFG. Issues related to compliance with §60.759(a)(1) are discussed in the following sections. Applicable information used in the design of the GCCS is included in Appendix A (GCCS Design Plans), Appendix B (Landfill Gas Generation Rate Modeling, Radius of Influence and Well Spacing Calculations, Condensate Generation Estimates and Head Loss Analysis) and Appendix C (Surface Emissions Monitoring Plan).

5.1.1 Control of Surface Emissions

The GCCS was designed to minimize both subsurface lateral migration and surface emissions of LFG. The proposed surface emissions monitoring route maps for Phases I, II, III and IV were prepared in accordance with §60.755(c)(1) and are included in Appendix C. Surface emissions monitoring will be conducted in accordance with §60.755(c) using the proposed route maps. The actual surface emissions monitoring routes may change depending on the site conditions.

5.1.2 Depths of Refuse

Depths of refuse were calculated based upon existing topography, permit plans and record documentation of landfill base liner grades. Surveyed baseliner grades were not available for Phase I. The baseliner grades for Phase I were estimated by adding 10-feet of elevation onto historical groundwater elevations ensuring a conservative vertical separation distance between the base grades and the ground water level. The surveyed record baseliner grades for Phases II, III and IV were utilized to calculate the depths of refuse within these three phases. The depths of refuse for the proposed vertical LFG extraction wells were estimated based on the differences between the final grades and the record/created baseliner grades. The estimated depths of refuse vary between 52 feet to 123 feet for Phases I and II and 38 to 127 feet for Phases III and IV.

5.1.3 Refuse Gas Generation Rates and Flow Characteristics

A maximum LFG generation rate of 1,162 cfm during the design period (2017 through 2032) was estimated as detailed in Section 3.1.

5.1.4 Landfill Cover Properties

Areas currently at interim grade are covered with daily cover and 12-inches of cover soil. These conditions are factored into the design of the LFG collectors and wells in order to minimize the potential for pulling ambient air into the landfill. The final cover system was designed in accordance with the NCDEQ solid waste permit closure details and the applicable rules at the time of closure. According to the application for permit to construct Phase IV, the proposed components of the final cap system for Phases I through IV from the top surface to the bottom will consist of:

- 6 inches of vegetative cover
- 18 inches of compacted soil cover
- Geonet drainage media
- 40 mil LLDPE geomembrane
- Geosynthetic clay liner
- 12 inches intermediate cover layer

5.1.5 Gas System Expandability

The GCCS was designed to account for future expansion by providing sufficient capacity for 1,162 cfm during the proposed design period, which is the expected typical design life of these components. The LFG blowers, flare and the LFG collection headers are sized to adequately collect and control LFG by creating optimum vacuum condition within the collection system and controlling fugitive LFG emissions to the required levels. Inclusion of tees and wyes with bling flanges along the LFG transmission piping provide planned access for future expansion. Please note Appendix A, Drawing 00D-04 for typical expansion (i.e. blind flange) locations. If actual LFG flow rates do exceed the capacity of the system, additional GCCS components can be designed and installed in accordance with the NSPS requirements.

5.1.6 Leachate and Condensate Management

Leachate management is accomplished through the use of an engineered leachate collection and management system (LCS). The LCS is designed according to Subtitle D standards (40 CFR§257 and §258). Leachate is collected through perforated pipes overlaying the bottom liner system to sump areas and from there leachate is pumped through forcemain to the existing 1.35 million gallon lined leachate storage basin at the site. LFG headers will be sloped to gain the maximum slope practicable (the goal is 5-percent slope) to promote condensate to flow by gravity to engineered low points. Condensate collected in these low points is drained back into the lined landfill area where it is collected by the LCS. Condensate drip legs are shown on Drawing 00D-02 in Appendix A.

5.1.7 Accessibility

The majority of the GCCS piping will be installed below grade and accessibility to these components will be achieved through wellheads, valves and access points located throughout the system. Accessibility to the blower/flare station equipment is readily available as this equipment is installed at grade and outside the limits of waste.

5.1.8 Compatibility with Waste Operations

Initially, the GCCS will be installed in areas that are near final grade within Phases I and II. The gas collection system was designed for integration into the permitted final-grade configuration of the Landfill. As filling operations proceed and portions of the site reach final (or near-final) grades, the GCCS will be expanded to incorporate these areas. Some vertical wells may be installed in areas that will receive additional waste and these wells are extended as filling progresses. Wells can be raised 20 to 30 feet in active areas and still maintain adequate LFG collection rates. This method of installation allows GCCS components to be constructed in accordance with §60.752(b)(2)(ii)(A)(2)(i) and (ii) while minimizing interference of the GCCS with ongoing filling operations.

5.1.9 Integration with Closure End Use

According to the Closure and Post-closure End Use Plan (CPC Plan) the Landfill will be developed as a grassed area and maintained as pasture land or possibly as a recreational/wildlife area following closure. Any modifications to the CPC Plan will be reviewed by the County to evaluate their compatibility with the GCCS. Well heads and other GCCS appurtenances can be modified as needed to not interfere with the proposed CPC Plan. The design, construction or modification of any component of the GCCS will be performed or restored in accordance with the applicable rules and the approved permit to install.

5.1.10 Air Intrusion Control

Air intrusion will be controlled by the landfill's cover system, by utilizing at least 10-feet of solid pipe near the ground surface for vertical LFG extraction wells, and by installing hydrated bentonite plugs around the vertical well casings where they penetrate the landfill cover. To accommodate the penetration of the future final cap geomembrane, the geomembrane will be fitted to the pipe penetrations utilizing a “pipe boot”. Furthermore, air intrusion will be controlled through periodic monitoring and adjustment of the GCCS vacuum in accordance with NSPS requirements and appropriate maintenance of the landfill cover system.

5.1.11 Corrosion Resistance

Corrosion resistance of the GCCS is achieved through the use of corrosion resistant materials or materials that have a corrosion resistant coating, in accordance with 40 CFR §60.759(b)(1). The primary component used in the construction of the GCCS is HDPE and PVC piping and associate appurtenances. All HDPE and PVC piping will have a minimum rating of SDR 17 and Schedule 80, respectively. Components will be inspected during routine GCCS monitoring for abrasion, chipping, or other potential deterioration of the components. If damage to the materials is observed that may be detrimental to the performance of the GCCS, the components will be replaced or repaired.

5.1.12 Fill Settlement

Settlement will occur due to decomposition of the refuse. To accommodate refuse settlement, the GCCS components were designed with several features to account for this settlement that includes:

- LFG transmission piping will be sloped at sufficient grades (a goal of 5 percent slope within waste limits and a minimum of 0.5-percent slope outside the waste limits) so that reasonable amounts of differential and total settlement may occur without causing pipe breakage, or disrupting the overall flow gradient of the LFG transmission piping.
- Fusion welded HDPE piping will be used for the construction of the header and lateral piping and transmission system. HDPE piping is flexible and absorbs differential settlement without breaking or cracking.
- Periodic header access riser will be installed that will allow landfill personnel to identify the location of the below grade header to aid in troubleshooting and repairs as settlement occurs.
- LFG extraction well heads will connect to the LFG transmission piping via a flexible pipe or hose connection. This allows the LFG piping to accommodate changes in the orientation of the LFG transmission piping or LFG extraction well.
- Well casings will be placed in 36-inch diameter boreholes, which will provide additional separation between the waste and the well casings and reduce the potential for differential stresses being placed on the casings.

5.1.13 Resistance to Decomposition Heat

Resistance of the GCCS to the heat generated as a result of refuse decomposition will be achieved through the use of materials tested and proven to withstand temperatures well above those typically found in landfills. The maximum operating temperature for HDPE is in excess of 150°F under low vacuum application conditions such as LFG extraction. The softening temperature, the temperature at which the PVC and HDPE materials begins to exhibit plasticity, is in excess of 250°F which is far in excess of normal LFG system operating conditions of 90°F to 120°F. The GCCS will be inspected during routine LFG system monitoring for heat damage. If heat damage of the GCCS components is observed and is believed to be detrimental to the operation of the GCCS, the cause of the elevated landfill temperature will be investigated, and the GCCS will be adjusted or modified to mitigate the effects of the elevated temperatures.

5.2 Compliance with §60.759(a)(2)

> §60.759(a)(2) states, *"The sufficient density of gas collection devices determined in paragraph (a)(1) of this section shall address landfill gas migration issues and augmentation of the collection system through the use of active or passive systems at the landfill perimeter or exterior."*

As described in Section 3.2.2, the LFG extraction wells were designed to provide comprehensive coverage with appropriate zones of influence. Well spacing was estimated by calculating the well ROI using an equation from the 1991 NSPS Background Information Document. This GCCS design was developed using a conservative ROI to ensure sufficient density of wells and some overlap was provided for radius of influence of individual wells, allowing better collection efficiency.

To determine the performance of the GCCS with respect to migration control, quarterly monitoring for off-site migration of combustible gases will be performed at landfill gas probe locations around the perimeter of the facility. The Landfill will conduct surface monitoring in accordance with NSPS/Federal EG requirements. If the GCCS does not meet the requirements, the GCCS will be adjusted or modified to meet the requirements. Adjustments or modifications may include the installation of additional collection elements, cap repairs or other actions defined by field conditions at the time of monitoring. Since installation of the LFG collection system, the current results indicate that the GCCS is effective in controlling gas migration beyond the landfill footprint.

5.3 Compliance with §60.759(a)(3)

> §60.759(a)(3) states, *"The placement of gas collection devices determined in paragraph (a)(1) of this section shall control all gas producing areas, except as provided by paragraphs (a)(3)(i) and (a)(3)(ii) of this section."*

Collection devices will be installed in all landfill areas based on the site conditions and where waste is at or near its final grade. Vertical well spacing was based on a conservative estimated ROI value of 121 feet to ensure adequate control of LFG in gas producing areas.

5.3.1 Asbestos and Nondegradable Materials

> §40 CFR 60.759(a)(3)(i) states, *"Any segregated area of asbestos or nondegradable material may be excluded from collection if documented as provided under*

> *§60.758(d). The documentation shall provide the nature, date of deposition, location and amount of asbestos or nondegradable material deposited in the area, and shall be provided to the Administrator upon request."*

There is no known area where asbestos and other non-degradable items have been deposited.

5.3.2 Nonproductive Areas

> §40 CFR 60.759(a)(3)(ii) states, *"Any nonproductive area of the landfill may be excluded from control, provided that the total of all excluded areas can be shown to contribute less than 1 percent of the total amount of Non-Methane Organic Compound (NMOC) emissions from the landfill. The amount, location, and age of the material shall be documented and provided to the Administrator upon request. A separate NMOC emissions estimate shall be made for each section proposed for exclusion, and the sum of all such sections shall be compared to the NMOC emissions estimate for the entire landfill."*

At the time of the design of the GCCS, no areas within Phases I through IV were determined to be non-productive. Therefore, no areas of the landfill were excluded from the coverage of the GCCS.

5.4 Compliance with §60.759(b)(1), (2) and (3)

5.4.1 Landfill Gas Extraction Component Construction

> §40 CFR 60.759(b)(1)states, *"The landfill gas extraction components shall be constructed of polyvinyl chloride (PVC), high density polyethylene (HDPE) pipe, fiberglass, stainless steel, or other nonporous corrosion resistant material of suitable dimensions to: convey projected amounts of gases; withstand installation, static, and settlement forces; and withstand planned overburden or traffic loads. The collection system shall extend as necessary to comply with emission and migration standards. Collection devices such as wells and horizontal collectors shall be perforated to allow gas entry without head loss sufficient to impair performance across the intended extent of control. Perforations shall be situated with regard to the need to prevent excessive air infiltration."*

5.4.1.1 Materials

The GCCS components will be constructed of PVC, HDPE, stainless steel, and other nonporous corrosion resistant materials.

5.4.1.2 Component Sizing

The GCCS components were sized for the maximum LFG generation rate expected from the site (1,162 cfm) during the design period as described in Section 3.3 of this design report. If future GCCS components are required, they will be sized in accordance with NSPS requirements.

5.4.1.3 Component Loading

The GCCS components were designed to withstand the estimated installation, static, settlement, overburden, and traffic loads. The designed GCCS components within the landfill are consistent with those at other landfills that have operated for extended periods of time.

5.4.1.4 System Expansion

The GCCS will be expanded as necessary to conform to emission standards set forth in the NSPS. Future expansion of the GCCS will be performed in accordance with scheduling requirements set forth in the NSPS or an approved alternative schedule. Additionally, if surface emissions and migration monitoring indicate a need for additional GCCS components, the system shall be expanded as necessary to comply with NSPS requirements. Expansions of the GCCS will be certified by a professional engineer and the measures of performance of the LFG system verified as set forth in the NSPS.

5.4.1.5 Component Perforation

The collection pipes for extraction wells will be perforated to allow LFG entry without inducing head losses sufficient to impair performance across the intended extent of control.

5.4.1.6 Air Infiltration

The LFG extraction wells were designed to prevent excessive air infiltration through the use of solid pipe near the ground surface and with the installation of hydrated bentonite plugs around the vertical well casing where they penetrate the landfill cover. The effective depth of perforations will typically be at least 10 feet below existing grade, which will be sufficient to control excessive air infiltration.

5.4.2 Landfill Gas Extraction Component Installation

> §40 CFR 60.759(b)(2) states, *"Vertical wells shall be placed so as not to endanger underlying liners and shall address the occurrence of water within the landfill. Holes and trenches constructed for piped wells and horizontal collectors shall be of sufficient cross-section so as to allow for their proper construction and completion including, for example, centering of pipes and placement of gravel backfill. Collection devices shall be designed so as not to allow indirect short circuiting of air into the cover or refuse into the collection system or gas into the air. Any gravel used around pipe perforations should be of a dimension so as not to penetrate or block perforations."*

5.4.2.1 Component Placement

Where possible, survey data for the base liner will be used for vertical well design depths. Vertical extraction wells will be installed with the bottom of the borehole at least 15 feet above the liner system.

Leachate within the landfill will be managed by the leachate and condensate management system as described in Section 3.3. If free liquids are encountered during well drilling, the drilling contractor will drill through the perched zone of liquids allowing drainage into the underlying waste mass and the leachate collection system. If perched liquids are observed within the extraction well affecting efficient LFG extraction, leachate levels will be reduced by pumping the well. Liquids removed from the well casings will be discharged to the leachate collection system.

5.4.2.2 Holes and Trenches

Vertical wells will be installed within 36-inch diameter boreholes that are sufficient for installation of well casings and backfill materials. All holes and trenches for piped wells and horizontal collectors will be of sufficient cross-sectional area so as to allow for their proper construction and completion including the centering of pipes and placement of gravel backfill.

5.4.2.3 Component Short Circuiting

LFG collection elements were designed to prevent air infiltration through the cover, refuse contamination of the collection elements, and direct venting of LFG to the atmosphere. Air intrusion control will be verified through monitoring of operational standards for the LFG collection elements and maintaining of the landfill cover in accordance with NSPS requirements. Contamination of the collection elements by the refuse will be prevented by placing gravel backfill in the extraction well bore holes to provide a filter pack between the refuse and the LFG collection elements. Direct venting of the LFG to the atmosphere will be prevented by operating the GCCS under vacuum.

5.4.2.4 Gravel Backfill

Gravel used for backfill of extraction wells will be of sufficient size to not penetrate or block perforations (> ¾" diameter).

5.4.3 Connection of Landfill Gas Collection Device to Collection Header Pipes

> §40 CFR 60.759(b)(3) states, *"Collection devices may be connected to the collection header pipes below or above the landfill surface. The connector assembly shall include a positive closing throttle valve, any necessary seals and couplings, access couplings and at least one sampling port. The collection devices shall be constructed of PVC, HDPE, fiberglass, stainless steel, or other nonporous material of suitable thickness."*

The collection devices will be connected to the collection header pipes using lateral piping. The lateral piping will be connected to the header piping either above or below the landfill surface, as required by field conditions at the time of installation. The connector assemblies (vertical extraction wellheads) will be located above grade. These assemblies will include a positive closing throttle valve, necessary seals and couplings, access ports and couplings, and a minimum of two sampling ports. The collection devices will be constructed of PVC, HDPE, fiberglass, corrosion-resistant steel, and other non-porous materials of suitable thickness.

5.5 Compliance with §60.759(c)(1) and (2)

> *§40 CFR 60.759(c) states, "Each owner or operator seeking to comply with §60.752(b)(2)(i)(A) shall convey the landfill gas to a control system in compliance with §60.752(b)(2)(iii) through the collection header pipe(s). The gas mover equipment shall be sized to handle the maximum gas generation flow rate expected over the intended use period of the gas moving equipment using the following procedures…"*

The blowers were sized to handle the maximum expected LFG flow expected during the useful life of the equipment. Modifications to the system may be required to accommodate collection of LFG from any future landfill expansions.

5.5.1 Existing Landfill Gas Flow Rate Data

> §40 CFR 60.759(c)(1) states, *"For existing collection systems, the flow data shall be used to project the maximum flow rate. If no flow data exists, the procedures in paragraph (c)(2) of this section shall be used."*

The initial installation of the GCCS has occurred and it is in the wellfield tuning period. As such, no reliable flow data is available for comparison at this time.

5.5.2 Future Landfill Gas Flow Rate Estimates

> §60.759(c)(2) states, *"For new collection systems, the maximum flow rate shall be in accordance with §60.755(a)(1)."*

The maximum flow for the design was derived from LFG recovery modeling using U.S. EPA default values and the U.S. EPA LandGEM Program, Version 3.02. As indicated in Section 3.1, the maximum projected LFG generation rate during the design period of 2017 through 2032 was estimated to be 1,162 cfm.

Landfill gas generation projections are provided in Appendix B.

5.6 Alternatives and Compliance with §60.759(b)(2)

Recently published revisions to §40 CFR 60.752(b)(2) lower the calculated NMOC emission rate from equal to or greater than 50 megagrams per year, to equal to or greater than 34 megagrams per year, which will trigger the installation of a GCCS.

5.6.1 Submit a Design Plan

> §60.752(b)(2)(i) states, *"Submit a collection and control system design plan prepared by a professional engineer to the Administrator within 1 year…"*

On behalf of Rowan County, HDR has prepared this GCCS design plan for the Landfill. Rowan County is submitting this design plan to the NCDEQ DAQ for approval consistent with NSPS requirements.

5.6.2 Alternatives to the NSPS

§60.752(b)(2)(i)(B) states, *"The collection and control system design plan shall include any alternatives to the operational standards, test methods, procedures, compliance measures, monitoring, record keeping or reporting provisions of §60.753 through §60.758 proposed by the owner or operator."*

Several alternatives to the operational standards, test methods, procedures, compliance measures, monitoring, recordkeeping or reporting requirements of §60.753 through §60.758 of the NSPS are proposed at this time. These alternatives are requested for three reasons 1) for the safety of employees and consultants; 2) to allow for flexibility in operations to reduce the potential for landfill fires and exothermic reactions; and 3) to allow for some flexibility in operations to bring the system back into compliance after times when the system may become temporarily out of compliance.

5.6.2.1 Surface Emissions Monitoring

Per 60.753(d), the operational standard for surface emissions monitoring (SEM) allows the facility to exclude areas with steep slopes or other dangerous areas from monitoring. Therefore, Rowan County will avoid potentially dangerous areas, such as, access roads, active areas or working face, slopes steeper than 3H:1V, areas where cover material is disturbed to replace or repair components of the GCCS, leachate, or LFG condensate collection systems when conducting surface emissions monitoring.

5.6.2.2 Wellhead Monitoring and Operation

The NSPS requires that at each wellhead, oxygen concentration must be less than five percent [§60.753(c)], and each well must be under vacuum [§60.753(b)]. The only time a well is allowed to operate under non-negative pressure is if there is a landfill fire or an increased well temperature, or when a well is decommissioned. In the special case where a well is inadvertently "over pulled," either as a result of aggressive LFG system operation or declining LFG production in a portion of the Landfill, oxygen may be present in concentrations greater than five percent. This condition occurs when LFG is extracted at a rate that is faster than it is being generated by the decomposing refuse. To remediate this situation, the most immediate course of action is to decrease the vacuum that is applied to the well or to shut the well off.

If wellhead valve adjustments are not effective in decreasing the oxygen concentration, even at vacuum readings on the order of 0.1 inches in the water column, it may be necessary to temporarily shut the wellhead valve and allow the methane concentration to increase and oxygen to decrease. Otherwise, to continue to exert vacuum on the well, even at low levels, could contribute to conditions conducive for subsurface combustion.

If temporarily closing a wellhead valve is necessary to remediate over pulling of a well, the County will continue to monitor the well on a monthly basis for oxygen concentration and pressure. However, non-negative vacuum readings or oxygen concentrations greater than or equal to five percent by volume recorded during this period will not be considered to exceed the NSPS wellhead operating criteria.

During this temporary period, the well will be maintained such that positive pressure does not occur. If positive pressure occurs, the wellhead valve will be opened to relieve the pressure. If the oxygen concentration has decreased to less than five percent by volume, the well will remain online. However, if the oxygen concentration remains above five percent, the wellhead valve will be shut off again after the pressure is relieved. Once oxygen concentration returns to less than five percent, the wellhead valve will be opened and the well returned to service.

5.6.2.3 Exclusion of Unsafe Areas from Wellhead Monitoring

In order to provide for the safety of field personnel, Rowan County realizes that in some instances it may be excessively dangerous to monitor certain LFG extraction wells during the monthly wellfield monitoring event. Two examples of unsafe conditions include monitoring of wells within or near the active face of the Landfill and wells raised for additional waste disposal in the vicinity of the well. Heavy equipment and waste disposal vehicles operating within or near the active face pose danger to the field personnel attempting to conduct well monitoring. Wells can be raised by about 10 to 20 feet as waste is placed around the wells and this may be an ongoing process for periods exceeding one month at a time, and affected wells may not be accessible for all or a portion of this time. Therefore, Rowan County is proposing that if unsafe conditions exist, monthly monitoring of the affected wells pursuant to §60.756(a) may not be possible. Therefore, all wells within the GCCS may not be monitored every month based on the field conditions. Monitoring of these wells will be resumed as soon as access to them is deemed safe for the field personnel.

5.6.2.4 Correction of Exceedance without Expansion of GCCS

Per §60.755(a)(3) and (5), if wellhead conditions that exceed operating criteria for pressure, temperature, or oxygen criteria are not remediated within 15 days, the GCCS must be expanded within 120 days unless an alternative timeline is approved. However, expansion of the GCCS is not always required in order to remediate pressure, temperature, or oxygen exceedances. Therefore, Rowan County is requesting approval to utilize alternative actions when wellhead conditions exceed operating criteria instead of expanding the GCCS.

Examples of potential remedial actions include:

- Installation of dewatering pumps to reduce the liquid level in a well in order to remediate elevated oxygen levels.
- Repair of extraction well piping or wellheads that may be causing air infiltration.
- Header or blower station piping, valves modifications or repairs to remediate positive pressure and/or elevated oxygen levels.
- Repair of condensate management features to remediate positive pressure and/or elevated oxygen levels.
- Additional wellfield tuning to remediate positive pressure, elevated temperature, and oxygen levels.

- Repair of the landfill cap to reduce ambient air infiltration into a well and remediate elevated oxygen levels.

Other corrective actions may be considered in order to remediate an exceedance within the 120-day timeline.

5.6.2.5 Establishment of Higher Operating Temperature Value

Per 40 CFR 60.753(c), the landfill owner/operator may establish a higher operating value at the well for temperature. Rowan County will seek to establish a higher operating temperature (equal to or higher than 131 degrees F) at an extraction well subsequent to failed attempts to correct the elevated temperature levels. The demonstration will provide data showing the elevated temperature will not cause subsurface combustion and will not inhibit anaerobic decomposition by killing methanogens. Rowan County will make this determination on a well-by-well basis and submit notification to the NCDEQ within 120 days of an initial elevated temperature level, unless an alternate timeline is deemed more appropriate. A minimum of three months of operational data will be provided to support the establishment of a higher operating temperature range for any particular landfill gas collection device. The request will include information regarding the constituents of the LFG, carbon monoxide content, well logs from initial well installation, and visual survey information regarding subsurface combustion.

5.6.2.6 Well Abandonment

Rowan County may abandon a vertical extraction well or horizontal collector in the GCCS upon provision of a statement that the Landfill will maintain sufficient well field density in compliance with NSPS coverage requirements. This statement will be supported by data and information submitted to the NCDEQ and shall be certified by a professional engineer registered in the state of North Carolina.

A

Appendix A - GCCS Design Plan Drawings

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APRIL 12, 1753

HDR Engineering, Inc. of the Carolinas
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Suite 1000
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. F-0116

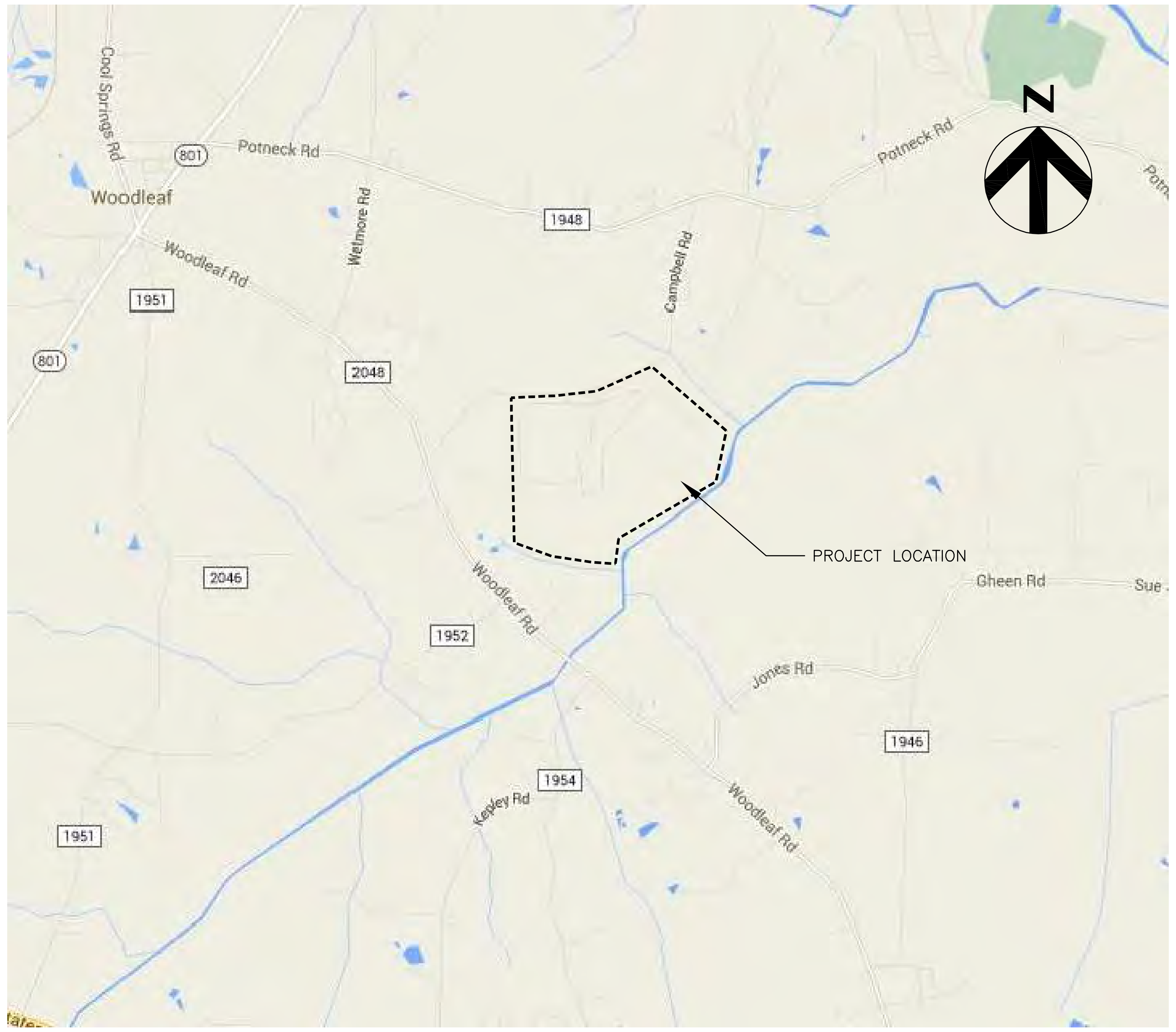
Rowan County

Phase I-IV Landfill Gas Collection and Control System Design Plan

Project No.
000000000276175

789 Campbell Road
Woodleaf, NC 27054

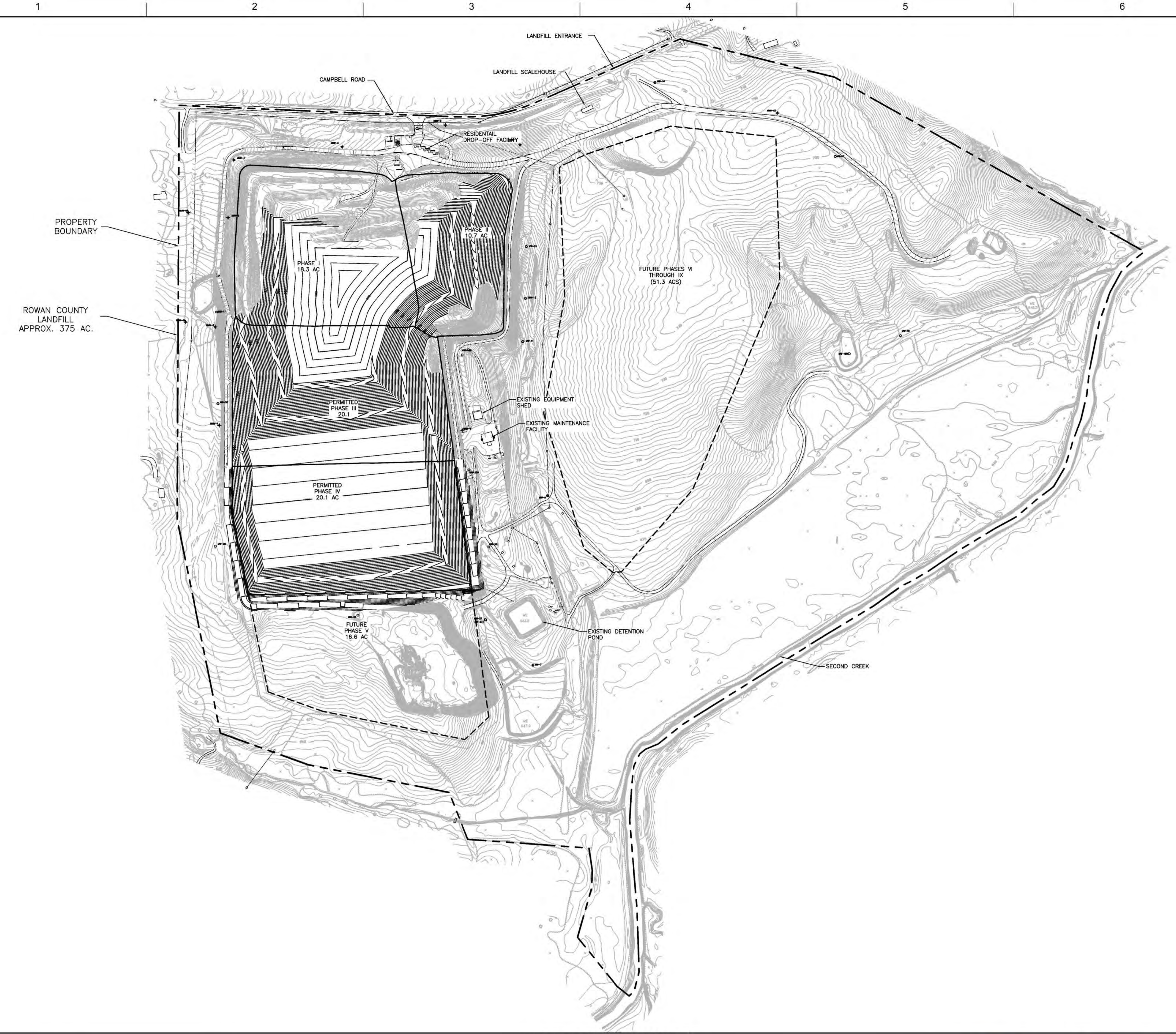
Issued for Review
June 2016
Revised October 2017
Revised November 2017



VICINITY MAP: ROWAN COUNTY, WOODLEAF, NC
NOT TO SCALE

INDEX OF DRAWINGS

FOR PERMITTING PURPOSES ONLY
NOT FOR CONSTRUCTION



N

LEGEND

— — —	PROPERTY BOUNDARY
- - - -	FUTURE PHASE BOUNDARY
———	PERMITTED PHASE BOUNDARY
———	EXISTING MAJOR CONTOUR
———	EXISTING MINOR CONTOUR
———	PERMITTED MAJOR CONTOUR
———	PERMITTED MINOR CONTOUR
◐ EW-27	GAS EXTRACTION WELL
☐	PROPOSED VALVE BOX
(DL)	PROPOSED DRIP LINE
(AP)	PROPOSED ACCESS POINT
●	CONDENSATE SUMP

NOTES:

1. TOPOGRAPHY FOR EXISTING PHASES I, II, III, IV AND FUTURE PHASE V PROVIDED BY GDA PHOTOGRAMMETRIC MAPPING, SURVEYING, GPS & GIS SERVICES DATED MAY 27, 2016.
2. PROPERTY LINE BY JAMES T. HILL PLS L-2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
3. LIMITS OF WASTE BASED ON ANCHOR TRENCH FROM PHASE III AS-BUILT AND EXISTING SITE CONDITIONS DRAWINGS PROVIDED BY S&ME.

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HDR

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N.C.B.E.L.S. License Number: F-0116

ISSUE	DATE	DESCRIPTION
C	11/2017	REVISED PER NCDEQ-DAQ COMMENTS
B	10/2017	REVISED PER NCDEQ-DAQ COMMENTS
A	06/2016	ISSUED FOR REVIEW

PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	C. KOEHLER, P.E.
DRAWN BY	J. GAUL
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill

Landfill Gas Collection
and Control System

789 Campbell Road
Woodleaf, NC 27054

NORTH CAROLINA

SITE PLAN
CURRENTLY PERMITTED GRADES

0 1" 2"

FILENAME 00C-01.DWG

SCALE 1"=300'

SHEET 00C-01

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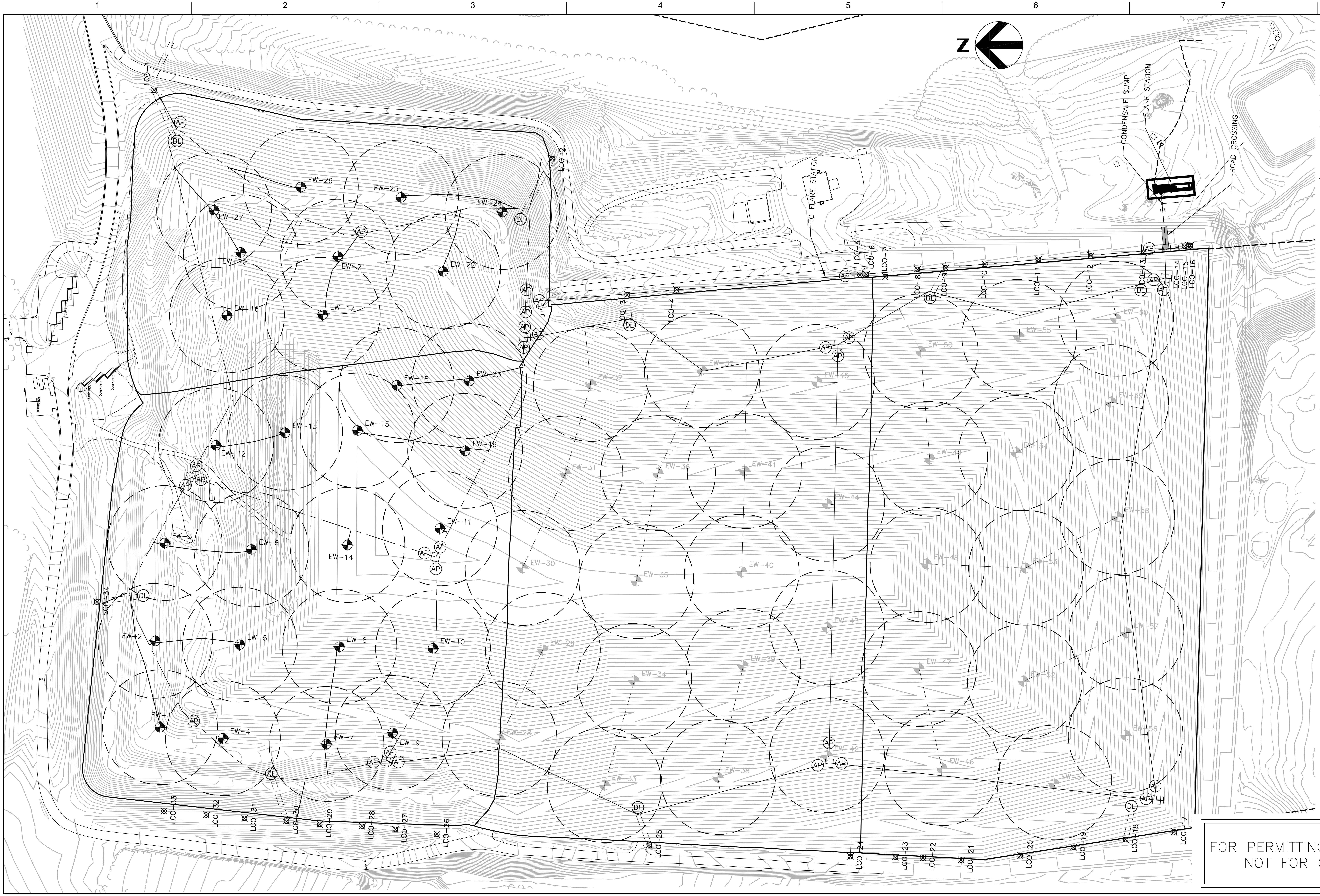

FOR PERMITTING PURPOSES ONLY
NOT FOR CONSTRUCTION

LEGEND

———	PERMITTED PHASE BOUNDARY
– – – – –	LEACHATE PIPING
—— —— ——	121' WELL OFFSET
———	MAJOR CONTOUR
———	MINOR CONTOUR
——— – ———	10" HEADER PIPE
———	4" LATERAL PIPE
———	PROPOSED 10" HEADER
—— —— ——	PROPOSED 4" LATERAL
EW-27	GAS EXTRACTION WELL
EW-42	PROPOSED GAS EXTRACTION WELLS FOR FUTURE CONSTRUCTION
☐	PROPOSED VALVE BOX
(DL)	PROPOSED DRIP LEG
(AP)	PROPOSED ACCESS POINT
☒ LCO	EXISTING LEACHATE CLEANOUT RISER (APPROXIMATE LOCATION)

NOTES:

1. EXISTING TOPOGRAPHY PROVIDED BY SANBORN AERIAL PHOTOGRAPHY DATED MARCH 10, 2002.
2. PROPERTY LINE BY JAMES T. HILL PLS L-2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
3. LIMITS OF WASTE BASED ON ANCHOR TRENCH FROM PHASE III AS-BUILT AND EXISTING SITE CONDITIONS DRAWINGS PROVIDED BY S&ME.
4. WELLS 28-60 ARE FUTURE WELLS TO BE INSTALLED WHEN PHASES III AND IV REACH FINAL GRADE.
5. THE LEACHATE CLEANOUTS WILL BE USED TO PULL GAS FROM THE LEACHATE PIPING NETWORK. THE LEACHATE PIPING LOCATIONS ARE APPROXIMATE.
6. SHALLOW WASTE AREAS IN PHASES I-IV WILL HAVE GAS EXTRACTION VIA THE LEACHATE COLLECTION SYSTEM INITIALLY. ONCE WASTE GRADES REACH THE DESIGN ELEVATIONS WELLS WILL BE INSTALLED.
7. THIS GAS SYSTEM LAYOUT IS CONCEPTUAL AND SUBJECT TO CHANGE BASED ON VARYING FIELD CONDITIONS.

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ISSUE	DATE	DESCRIPTION
E	11/2017	REVISED PER NCDEQ-DAQ COMMENTS
D	10/2017	ISSUED PER NCDEQ-DAQ COMMENTS
C	06/2017	ACTUAL WELL LOCATIONS FOR PHASE 1 AND PHASE 2
B	06/2016	ISSUED FOR REVIEW
A	01/2016	ISSUED FOR BIDDING

PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	C. KOEHLER, P.E.
DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill

Landfill Gas Collection
and Control System

789 Campbell Road
Woodleaf, NC 27054

NORTH CAROLINA

GAS SYSTEM LAYOUT (WELLS)

0 1" 2"

FILENAME	00C-02.DWG
SCALE	1"=100'

SHEET
00C-02

NOTES:

1. WELLS 1–27 WILL BE INSTALLED AS THE INITIAL DEVELOPMENT PHASE FOR THE LANDFILL.
2. WELLS 28–60 ARE FUTURE WELLS TO BE INSTALLED WHEN PHASES III AND IV REACH FINAL GRADE.
3. PROPOSED WELL DEPTHS DO NOT INCLUDE 4' STICK UP ABOVE GRADE.
4. SHALLOW WASTE AREAS IN PHASES I–IV WILL HAVE GAS EXTRACTION VIA THE LEACHATE COLLECTION SYSTEM INITIALLY. ONCE WASTE GRADES REACH THE DESIGN ELEVATIONS WELLS WILL BE INSTALLED.

INITIAL INSTALLATION WELLS

LFG Extraction Well Number	Grid Coordinates		Existing Grade Elevation (ft)	Base Grade Elevation (ft)	Total Waste Thickness D_R(ft)	Proposed Well Depth D_B(ft)	Solid Pipe Length D_S(ft)	Proposed Perforated Length D_P(ft)
	Northing (ft)	Easting (ft)						
1	733681.21	1536889.43	769	721	48	33	15	17
2	733699.81	1537071.05	768	719	49	34	15	18
3	733690.41	1537277.83	770	720	50	35	15	19
4	733547.66	1536872.79	770	720	50	35	15	19
5	733521.72	1537071.71	785	716	69	54	15	38
6	733506.90	1537273.18	795	716	79	64	15	48
7	733328.95	1536871.37	763	717	46	31	15	15
8	733311.56	1537077.52	813	714	99	84	15	68
9	733190.81	1536901.73	768	715	53	38	15	22
10	733114.52	1537083.72	815	711	104	89	15	73
11	733112.30	1537336.77	834	711	123	108	15	92
12	733592.33	1537488.83	780	722	58	43	15	27
13	733447.94	1537522.12	812	720	92	77	15	61
14	733305.16	1537292.38	833	713	120	105	15	89
15	733295.68	1537534.46	833	717	116	101	15	85
16	733582.32	1537763.20	778	730	48	33	15	17
17	733380.69	1537774.63	802	735	67	52	15	36
18	733217.64	1537633.86	813	724	89	74	15	58
19	733067.03	1537502.48	812	715	97	82	15	66
20	733560.00	1537897.50	762	712	50	35	15	19
21	733354.45	1537898.46	764	709	55	40	15	24
22	733131.49	1537877.98	762	714	48	33	15	17
23	733065.40	1537650.02	770	720	50	35	15	19
24	733012.89	1538009.13	745	702	43	28	15	12
25	733227.98	1538029.44	747	705	42	27	15	11
26	733439.91	1538041.16	747	708	39	24	15	8
27	733620.21	1537983.40	751	711	40	25	15	9

*SEE NOTE 1

PHASED WELL INSTALLATION

LFG Extraction Well Number	Grid Coordinates		Existing Grade Elevation (ft)	Base Grade Elevation (ft)	Total Waste Thickness D_R(ft)	Proposed Well Depth D_B(ft)	Solid Pipe Length D_S(ft)	Proposed Perforated Length D_P(ft)
	Northing (ft)	Easting (ft)						
28	732965.13	1536899.17	776	737	39	24	15	8
29	732883.01	1537091.65	817	719	98	83	15	67
30	732934.27	1537261.85	834	731	103	88	15	72
31	732853.47	1537465.11	798	715	83	68	15	52
32	732809.56	1537656.06	760	708	52	37	15	21
33	732739.25	1536813.12	748	710	38	23	15	7
34	732687.21	1537035.75	795	705	90	75	15	59
35	732693.16	1537245.69	833	702	131	116	15	100
36	732658.54	1537475.34	790	697	93	78	15	62
37	732576.48	1537658.46	756	693	63	48	15	32
38	732501.71	1536841.57	752	707	45	30	16	13
39	732459.22	1537078.60	801	702	99	84	17	66
40	732472.32	1537276.52	832	699	133	118	15	102
41	732476.53	1537488.42	786	695	91	76	15	60
42	732274.06	1536898.29	756	699	57	42	15	26
43	732287.13	1537167.58	816	694	121	106	15	90
44	732299.15	1537427.81	802	690	112	97	15	81
44	732333.25	1537683.48	752	686	66	51	15	35
46	732030.43	1536883.43	752	691	61	46	15	30
47	732088.78	1537090.60	791	690	101	86	15	70
48	732084.09	1537311.59	813	685	127	112	15	96
49	732088.01	1537533.23	778	684	95	80	15	64
50	732117.95	1537758.64	734	678	56	41	15	25
51	731793.19	1536861.81	734	686	48	33	15	17
52	731867.81	1537074.76	770	686	84	69	15	53
53	731874.99	1537313.17	765	682	83	68	15	52
54	731906.81	1537555.42	766	679	88	73	15	57
55	731911.86	1537799.34	725	673	51	36	15	20
56	731647.24	1536971.38	726	683	43	28	15	12
57	731655.93	1537187.55	723	680	43	28	15	12
58	731687.08	1537430.19	725	678	47	32	15	16
59	731711.85	1537671.08	725	674	51	36	15	20
60	731709.75	1537847.12	714	670	44	29	15	13

*SEE NOTE 2

TOTALS	3457	903	2494

Note: Proposed well depths do not include 4' stick up above grade.

HDR Engineering, Inc. of the Carolinas

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N.C.B.E.L.S. License Number: F-0116

ISSUE	DATE	DESCRIPTION
B	11/2017	REVISED PER NCDEQ-DAQ COMMENTS
A	01/2016	ISSUED FOR BIDDING

PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	C. KOEHLER, P.E.
DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill
Landfill Gas Collection
and Control System
789 Campbell Road
Woodleaf, NC 27054

NORTH CAROLINA

LFG EXTRACTION
WELL SCHEDULE

0 1" 2"

FILENAME 00C-03.DWG
SCALE N/A

SHEET
00C-03

Z

LEGEND

———	PERMITTED PHASE BOUNDARY
– – – –	FUTURE PHASE BOUNDARY
———	EXISTING MAJOR CONTOUR
———	EXISTING MINOR CONTOUR
—▸——▸—	SOLID PIPE
– – – –	PERF. LATERAL PIPE
⊕ EW-27	GAS EXTRACTION WELL
☐	PROPOSED VALVE BOX
(DL)	PROPOSED DRIP LINE
(AP)	PROPOSED ACCESS POINT
●	CONDENSATE SUMP
⊠ LCO	EXISTING LEACHATE CLEANOUT RISER (APPROXIMATE LOCATION)
(⊠) LCO	LCO CONSTRUCTED WITH A WELL HEAD

NOTES:

1. TOPOGRAPHY FOR EXISTING PHASES I, II, III, IV AND FUTURE PHASE V PROVIDED BY GDA PHOTOGRAMMETRIC MAPPING, SURVEYING, GPS & GIS SERVICES DATED MAY 27, 2016.
2. PROPERTY LINE BY JAMES T. HILL PLS L-2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
3. LIMITS OF WASTE BASED ON ANCHOR TRENCH FROM PHASE III AS-BUILT AND EXISTING SITE CONDITIONS DRAWINGS PROVIDED BY S&ME.
4. LEACHATE CLEANOUT CONNECTIONS IN PHASE 4 WILL BE USED EXCLUSIVELY FOR GAS EXTRACTION UNTIL THE AREA REACHES ITS FINAL GRADES.
5. PHASE I COLLECTOR PIPE SIZES AND LOCATIONS ARE APPROXIMATED.

LEACHATE CLEANOUTS WITH WELLHEAD CONNECTIONS

LCO-1
LCO-2
LCO-3
LCO-4
LCO-5
LCO-6
LCO-7
LCO-8
LCO-9
LCO-10
LCO-11
LCO-12
LCO-13
LCO-17*
LCO-25*
LCO-30
LCO-34

* INDICATES CONNECTOR TO BE MADE DURING THE PHASING IN OF LFG WELLS AFTER THE INITIAL INSTALLATION.

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704.338.6700

N.C.B.E.L.S. License Number: F-0116

ISSUE	DATE	DESCRIPTION
B	11/2017	REVISED PER NCDEQ-DAQ COMMENTS
A	10/2017	ISSUED FOR REVIEW

PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	C. KOEHLER, P.E.
DRAWN BY	J. GAUL
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill
Landfill Gas Collection
and Control System
789 Campbell Road
Woodleaf, NC 27054
NORTH CAROLINA

GAS SYSTEM LAYOUT
(LCS CONNECTION)

0 1" 2"

FILENAME 00C-04.DWG
SCALE 1"=100'

SHEET
00C-04

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LEGEND

━━━━	PERMITTED PHASE BOUNDARY
━ ━ ━ ━	FUTURE PHASE
────	EXISTING MAJOR CONTOUR
────	EXISTING MINOR CONTOUR
────	HEADER PIPE
- - - -	LATERAL PIPE
── ── ──	133' WELL OFFSET
EW-27 ◐	GAS EXTRACTION WELL
☐	PROPOSED VALVE BOX
(DL)	PROPOSED DRIP LINE
(AP)	PROPOSED ACCESS POINT
●	CONDENSATE SUMP
LCO ⊠	EXISTING LEACHATE CLEANOUT RISER (APPROXIMATE LOCATION)
▯	LEACHATE ENCLOSURE

NOTES:

1. TOPOGRAPHY FOR EXISTING PHASES I, II, III, IV AND FUTURE PHASE V PROVIDED BY GDA PHOTOGRAMMETRIC MAPPING, SURVEYING, GPS & GIS SERVICES DATED MAY 27, 2016.
2. PROPERTY LINE BY JAMES T. HILL PLS L-2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
3. LIMITS OF WASTE BASED ON ANCHOR TRENCH FROM PHASE III AS-BUILT AND EXISTING SITE CONDITIONS DRAWINGS PROVIDED BY S&ME.

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DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

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NORTH CAROLINA

FLARE STATION LOCATION

0 1" 2"

FILENAME 00C-05.DWG
SCALE 1"=100'

SHEET
00C-05

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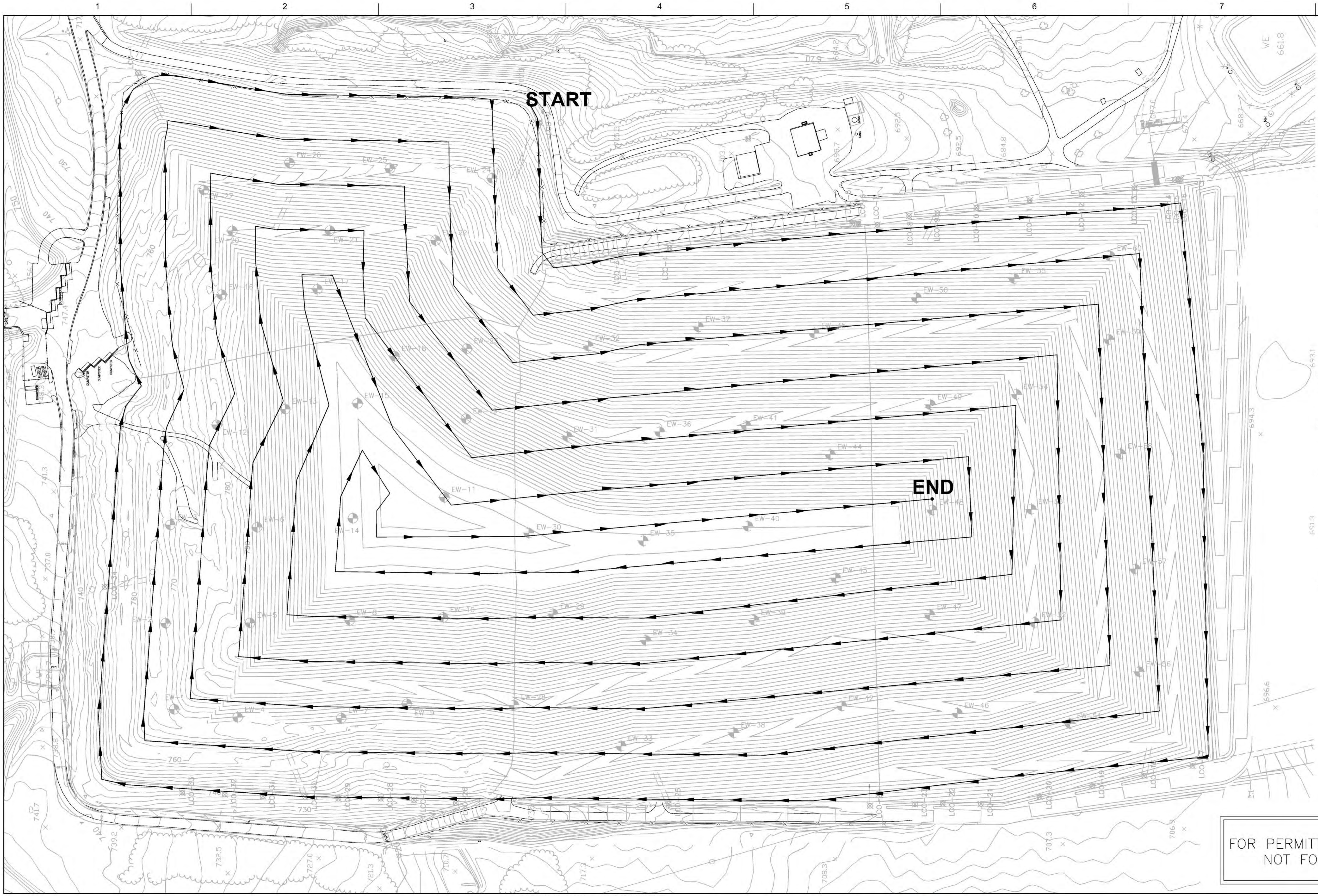

LEGEND

——►	MONITORING PATH
——	EXISTING MAJOR CONTOUR
——	EXISTING MINOR CONTOUR
——	PROPOSED HEADER AND LATERAL PIPE
EW-27	PROPOSED GAS EXTRACTION WELL
☐	PROPOSED VALVE BOX
(DL)	PROPOSED DRIP LINE
(AP)	PROPOSED ACCESS POINT

NOTES:

1. EXISTING TOPOGRAPHY PROVIDED BY SANBORN AERIAL PHOTOGRAPHY DATED MARCH 10, 2002.
2. PROPERTY LINE BY JAMES T. HILL PLS L–2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
3. SURFACE EMISSIONS MONITORING PATHWAY REPRESENTS FINAL GRADE CONDITIONS. INTERIM PATHWAYS WILL BE MONITORED BASED UPON THE SEQUENCE AND EXTENT OF WASTE PLACEMENT AND GCCS DEVELOPMENT IN ACCORDANCE WITH NSPS REGULATIONS.
4. TYPICAL SPACING FOR THE MONITORING PATH IS APPROXIMATELY 30 METERS (98 FEET). SOME LOCAL VARIATION MAY OCCUR TO ACCOMODATE FIELD CONDITION AT THE TIME OF MONITORING.
5. MONITORING TO BE PERFORMED IN ACCORDANCE WITH 40 CFR 60.755 (C).

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PROJECT ENGINEER	C. KOEHLER, P.E.
DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill

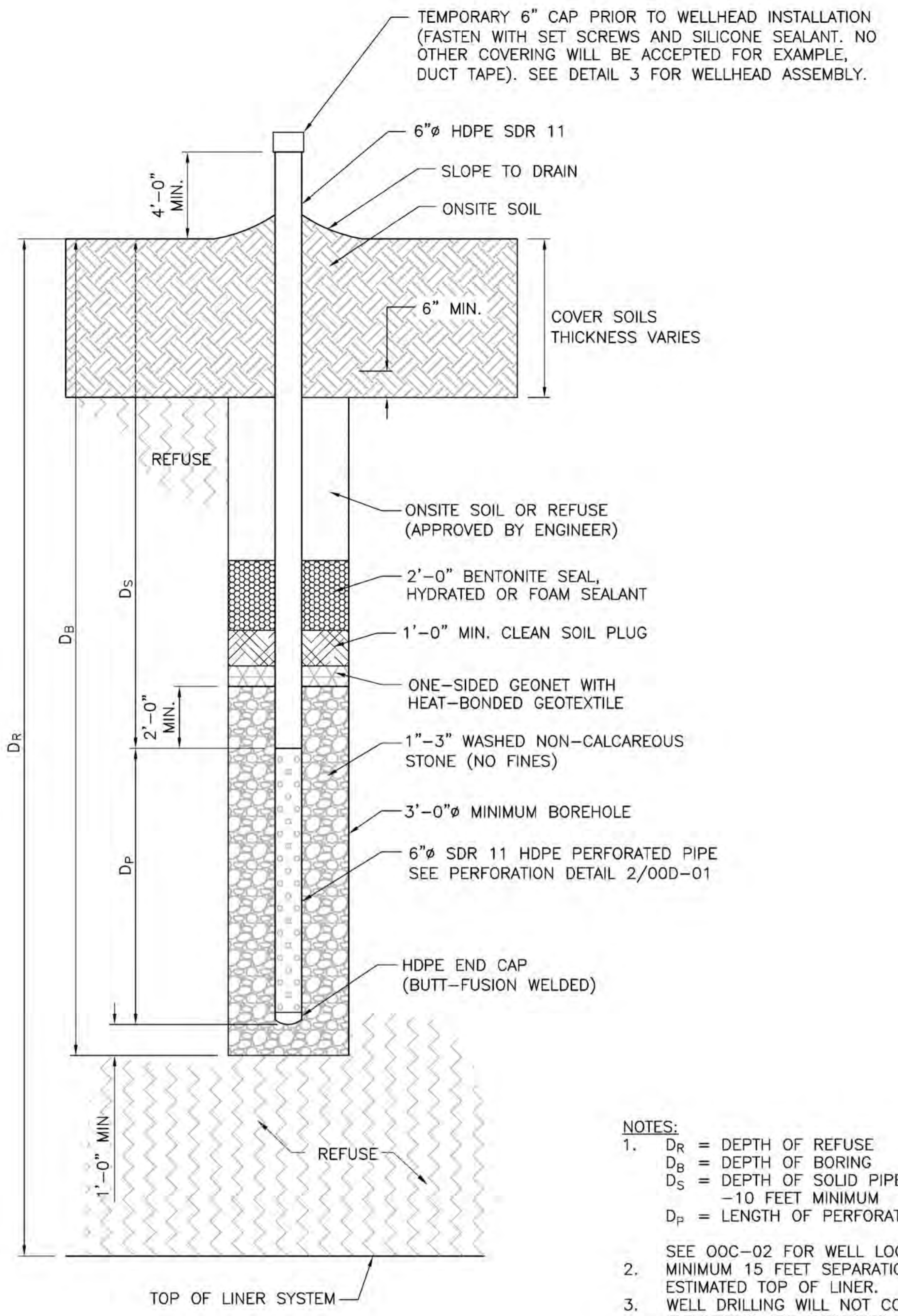
Landfill Gas Collection
and Control System
789 Campbell Road
Woodleaf, NC 27054
NORTH CAROLINA

SURFACE EMISSIONS MONITORING PLAN

0 1" 2"

FILENAME SEM.DWG
SCALE 1"=100'

SHEET
SEM



NOTES:

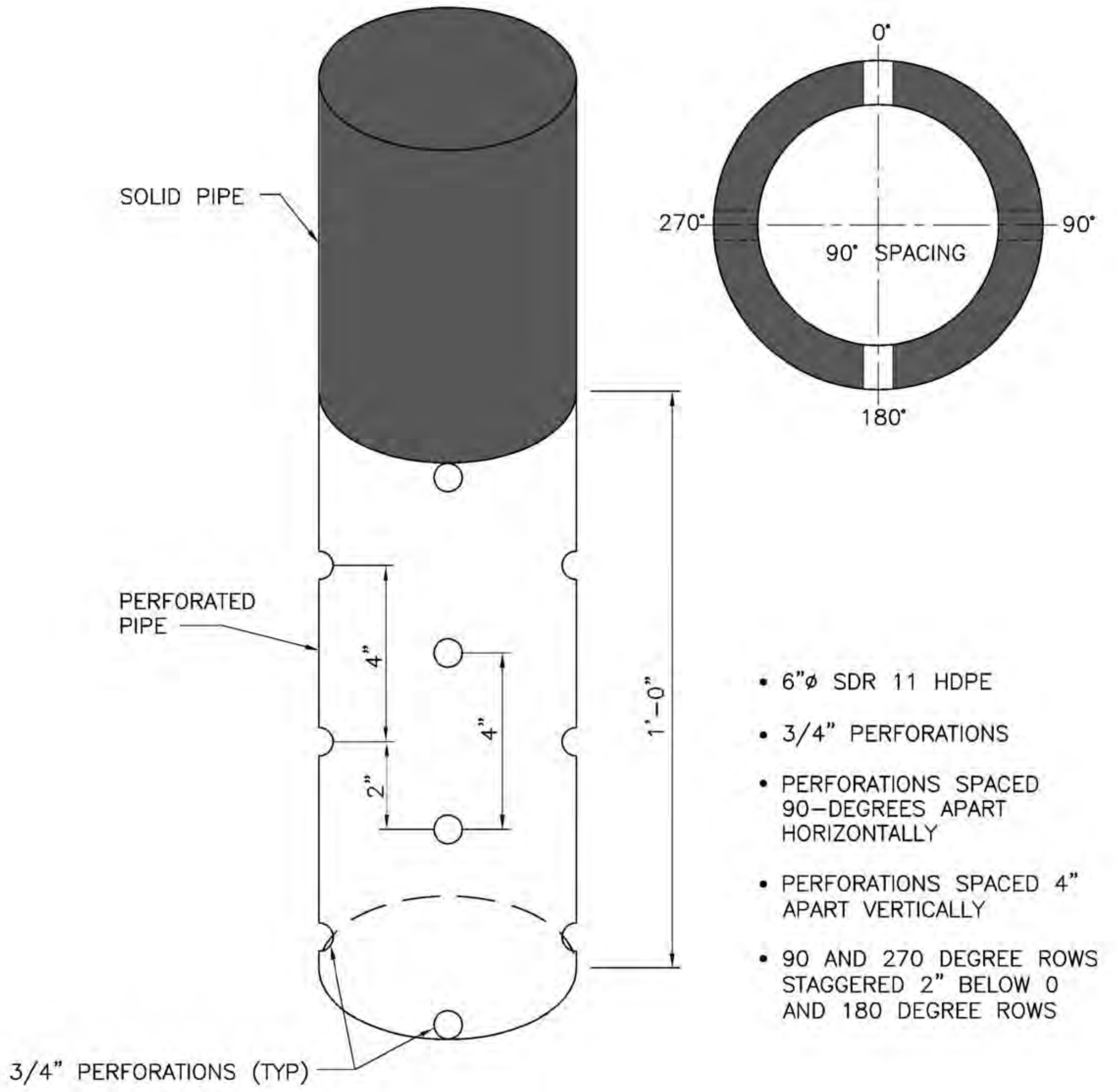
1. D_R = DEPTH OF REFUSE
   D_B = DEPTH OF BORING
   D_S = DEPTH OF SOLID PIPE (BELOW GRADE) −10 FEET MINIMUM
   D_P = LENGTH OF PERFORATED PIPE

   SEE 00C-02 FOR WELL LOG.
2. MINIMUM 15 FEET SEPARATION BETWEEN BASE OF BORING AND ESTIMATED TOP OF LINER.
3. WELL DRILLING WILL NOT COMMENCE UNTIL EXISTING GRADE ELEVATIONS ARE IDENTIFIED AND VERIFIED BY PROJECT SURVEYOR, DESIGN ENGINEER, AND CQA REPRESENTATIVE.
4. WELL DRILLING TABLE WILL BE MANAGED BY OWNER OR DESIGNATED REPRESENTATIVE TO ENSURE ONLY THE VERIFIED WELL DEPTHS ARE PRESENT, AND THAT DRILLER AND CQA REPRESENTATIVE HAVE THE IDENTICAL INFORMATION PRIOR TO DRILLING.
5. NOTE THE Ds DIMENSION DOES NOT INCLUDE THE 4FT STICK UP.
6. FOAM SEALANT TO BE FOAM CONCEPTS POUR SYSTEM ES 24-005

LANDFILL GAS VERTICAL EXTRACTION WELL (TYP)

NOT TO SCALE

1
00C-02



- 6"ø SDR 11 HDPE
- 3/4" PERFORATIONS
- PERFORATIONS SPACED 90-DEGREES APART HORIZONTALLY
- PERFORATIONS SPACED 4" APART VERTICALLY
- 90 AND 270 DEGREE ROWS STAGGERED 2" BELOW 0 AND 180 DEGREE ROWS

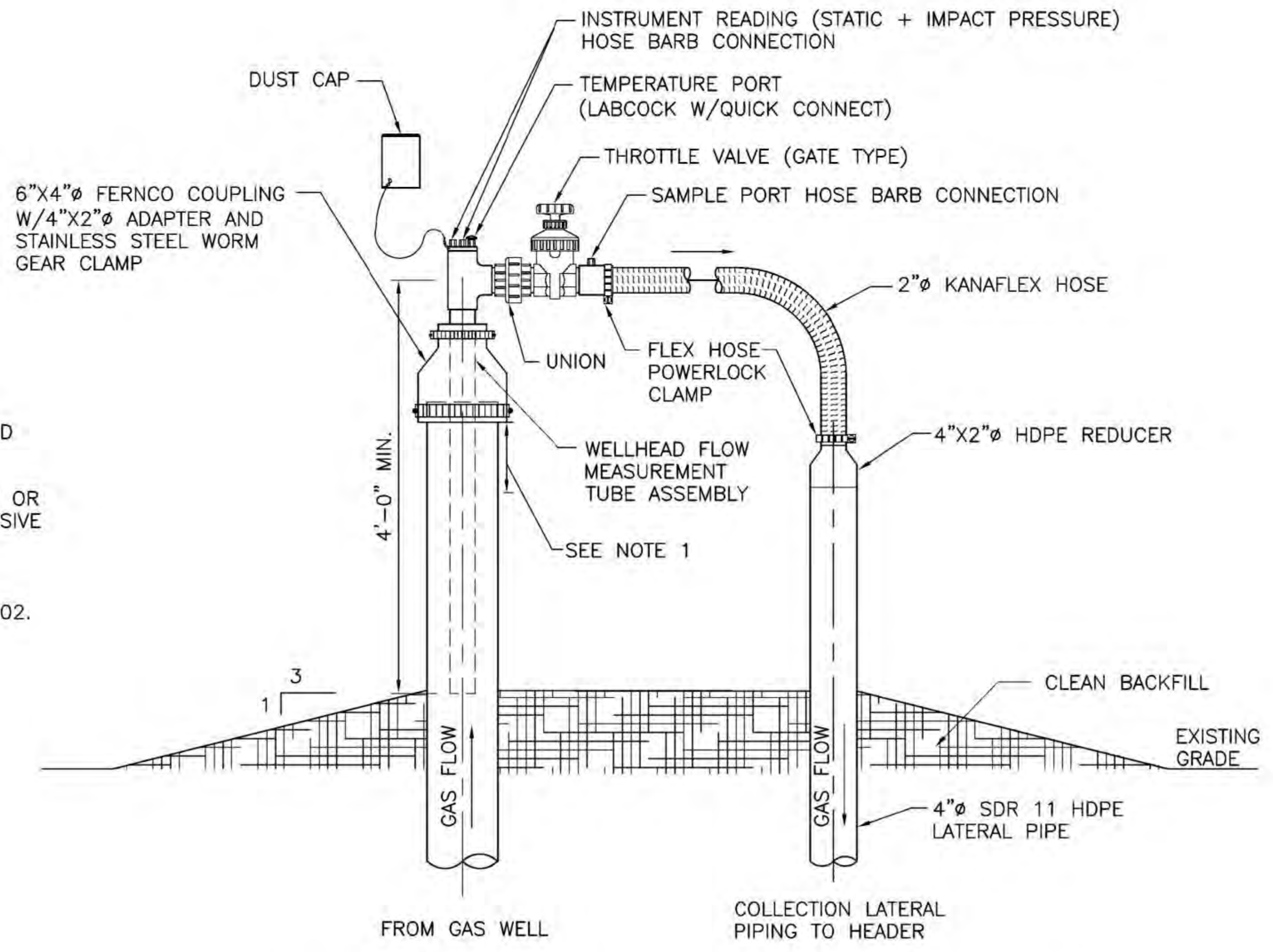
VERTICAL EXTRACTION WELL PERFORATION (TYP)

NOT TO SCALE

2
–

NOTES:

1. PROVIDE HIGH VISIBILITY TAPE AROUND TOP 1-FOOT OF WELL CASING.
2. LABEL ALL WELL RISERS WITH IDENTIFICATION NUMBER WITH YELLOW OR WHITE PAINT AND STENCILS OR ADHESIVE LABEL AT 2" MINIMUM HEIGHT AND LOCATED IMMEDIATELY BELOW HIGH VISIBILITY TAPE.
3. REFER TO DETAIL 1 ON SHEET 00D-02.



WELLHEAD ASSEMBLY

NOT TO SCALE

3
–

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PROJECT ENGINEER	C. KOEHLER, P.E.
DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill
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789 Campbell Road
Woodleaf, NC 27054
NORTH CAROLINA

GAS COLLECTION SYSTEM DETAILS -1

0 1" 2"

FILENAME 00D-01.DWG
SCALE AS SHOWN

SHEET
00D-01

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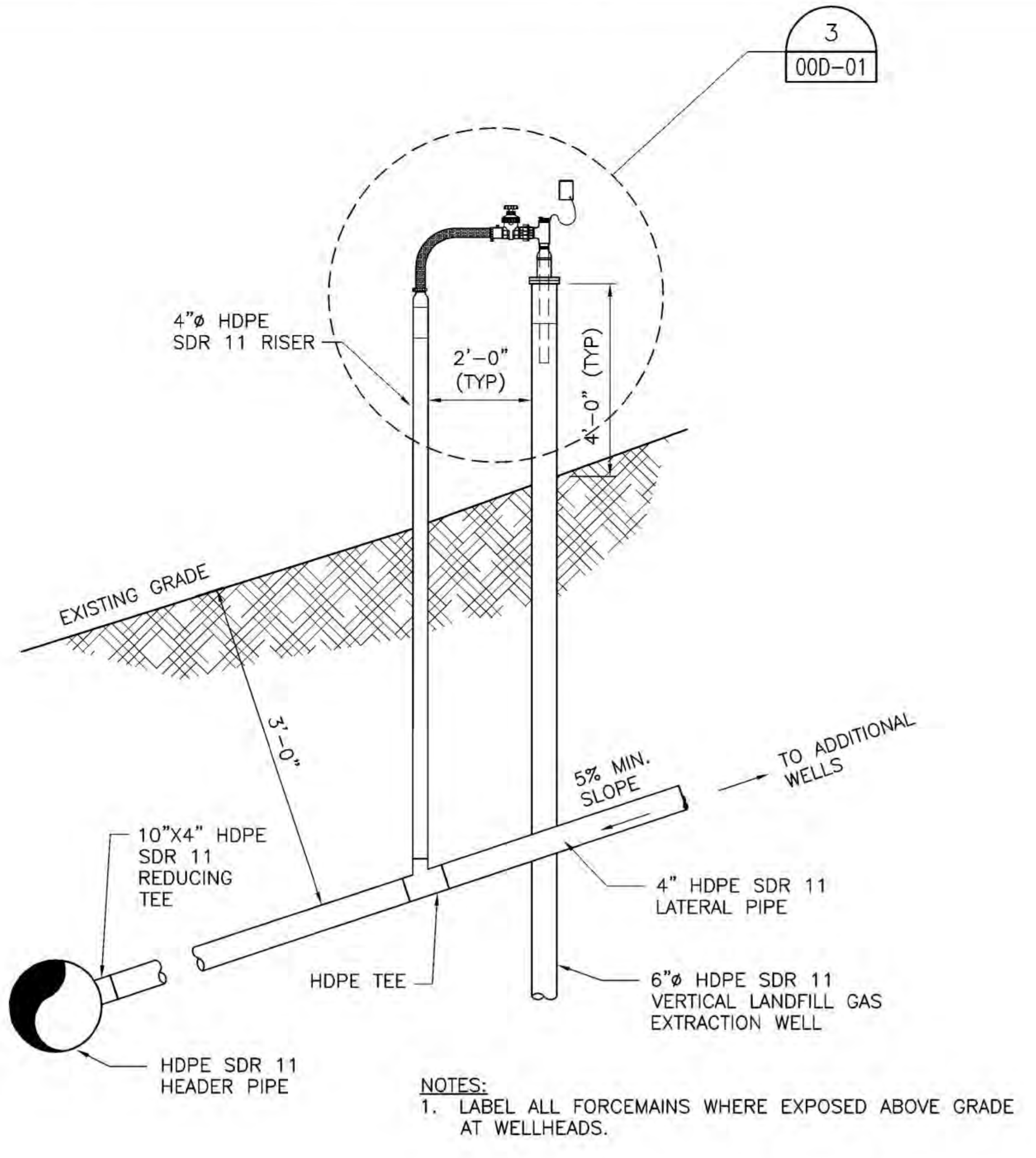
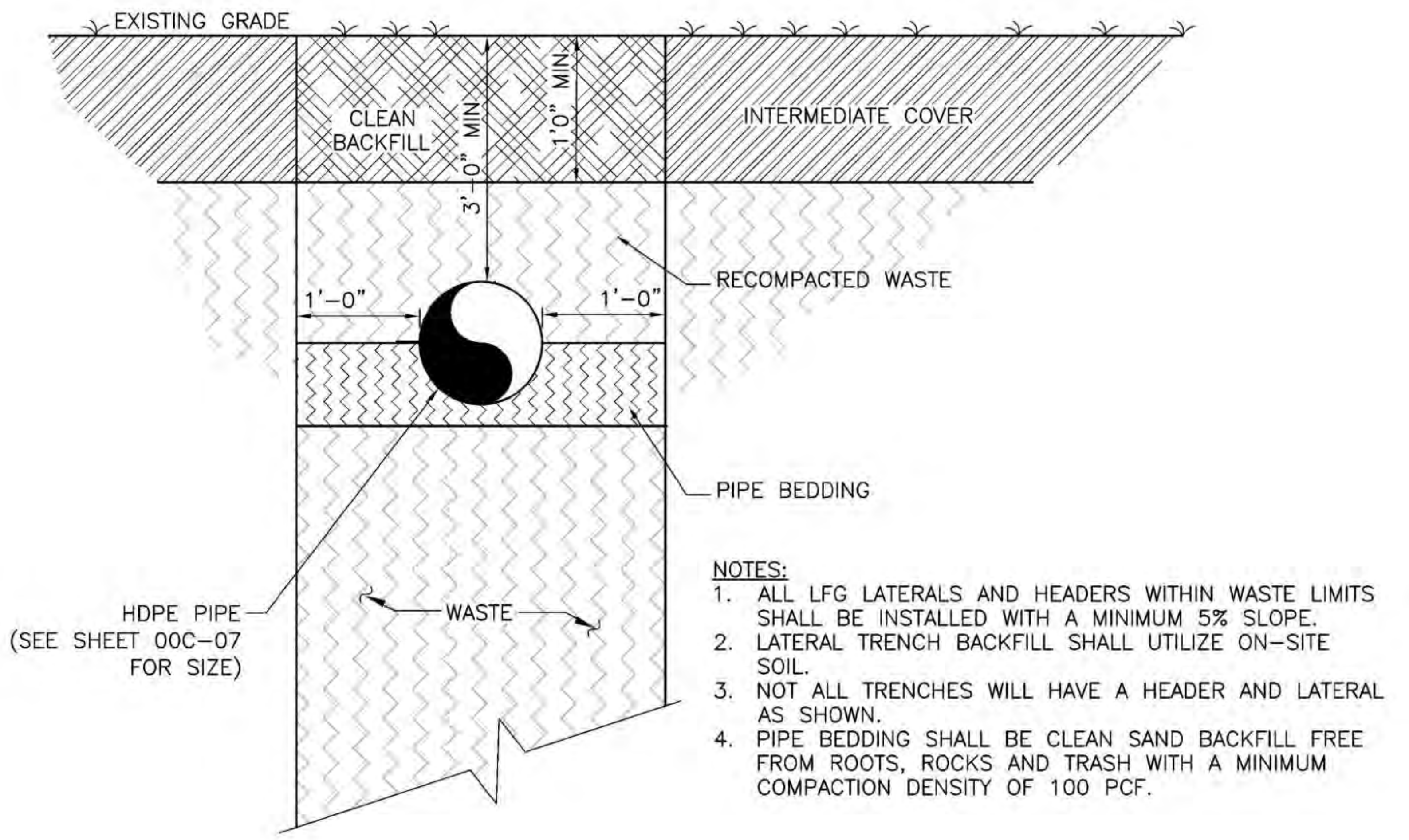


NOTES:
1. LABEL ALL FORCEMAINS WHERE EXPOSED ABOVE GRADE AT WELLHEADS.

WELL HEADER CONSTRUCTION

NOT TO SCALE

1
00D-01

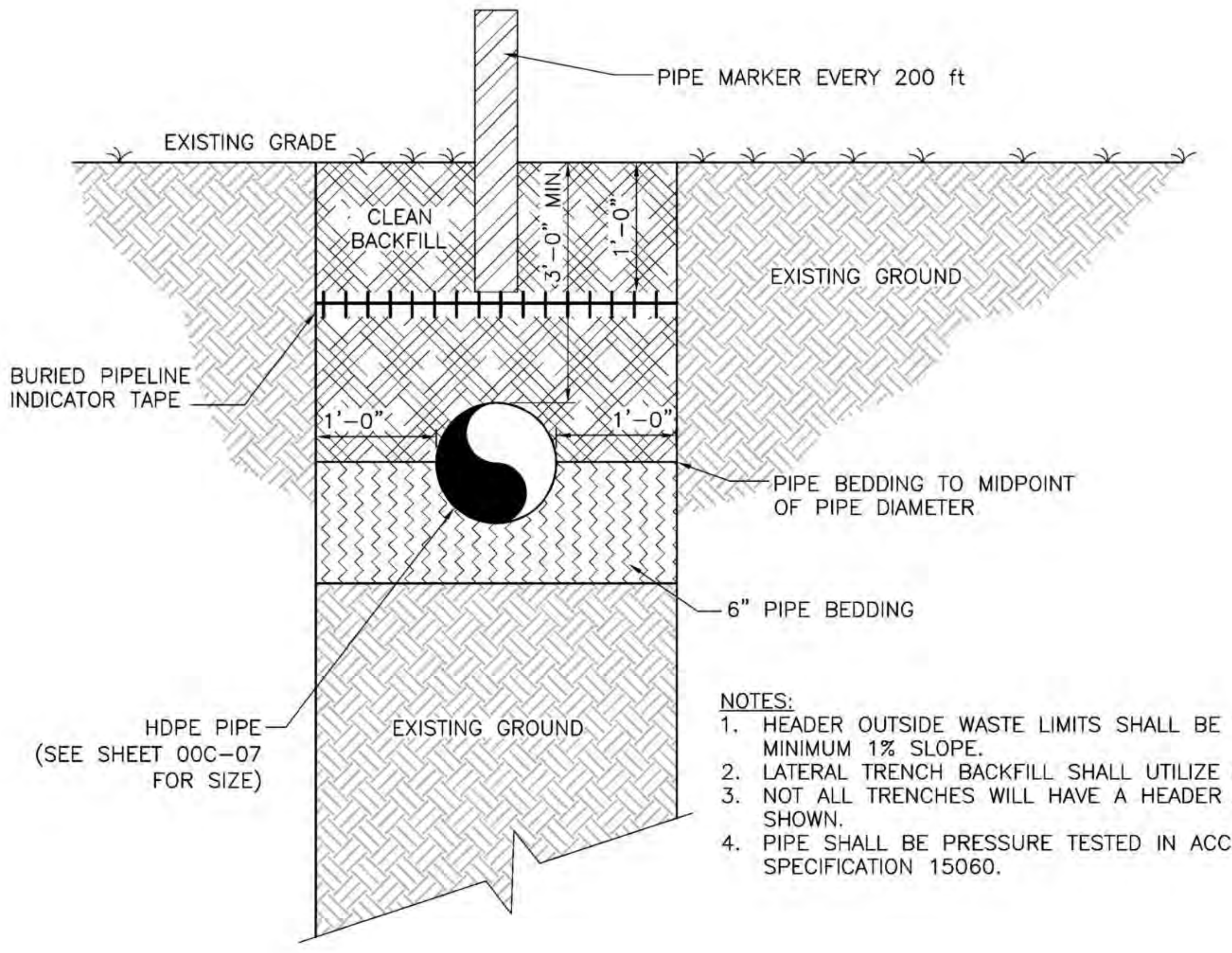


NOTES:
1. ALL LFG LATERALS AND HEADERS WITHIN WASTE LIMITS SHALL BE INSTALLED WITH A MINIMUM 5% SLOPE.
2. LATERAL TRENCH BACKFILL SHALL UTILIZE ON-SITE SOIL.
3. NOT ALL TRENCHES WILL HAVE A HEADER AND LATERAL AS SHOWN.
4. PIPE BEDDING SHALL BE CLEAN SAND BACKFILL FREE FROM ROOTS, ROCKS AND TRASH WITH A MINIMUM COMPACTION DENSITY OF 100 PCF.

LANDFILL GAS PIPING IN WASTE TRENCH (TYP)

NOT TO SCALE

3
00C-02

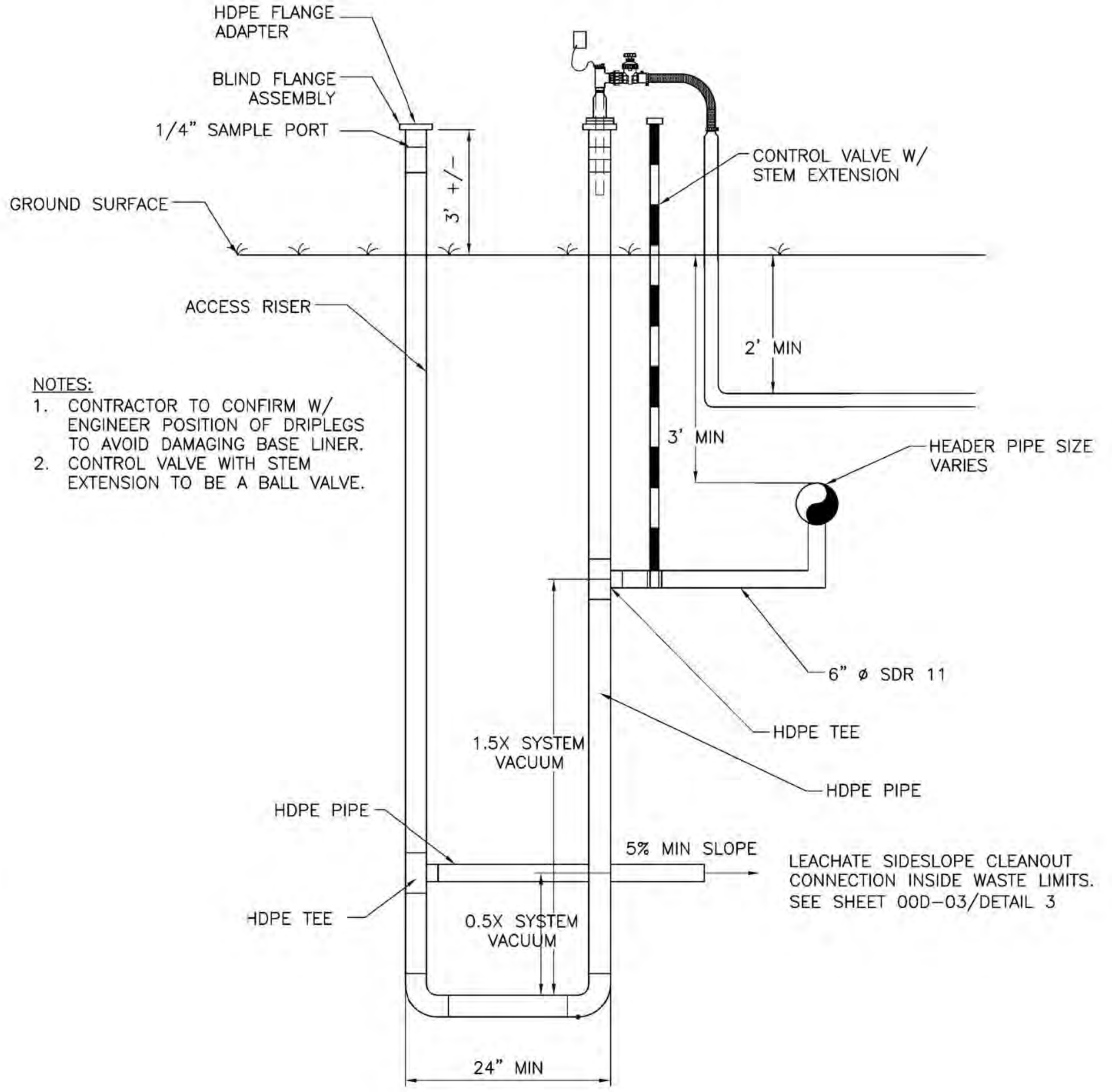


NOTES:
1. HEADER OUTSIDE WASTE LIMITS SHALL BE INSTALLED WITH A MINIMUM 1% SLOPE.
2. LATERAL TRENCH BACKFILL SHALL UTILIZE ON-SITE SOIL.
3. NOT ALL TRENCHES WILL HAVE A HEADER AND LATERAL AS SHOWN.
4. PIPE SHALL BE PRESSURE TESTED IN ACCORDANCE WITH SPECIFICATION 15060.

LANDFILL GAS PIPING OUTSIDE OF WASTE TRENCH (TYP)

NOT TO SCALE

4
00C-02



NOTES:
1. CONTRACTOR TO CONFIRM W/ ENGINEER POSITION OF DRIPLEGS TO AVOID DAMAGING BASE LINER.
2. CONTROL VALVE WITH STEM EXTENSION TO BE A BALL VALVE.

CONDENSATE DRIP LEG (TYP)

NOT TO SCALE

5
–

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PROJECT ENGINEER C. KOEHLER, P.E.
DRAWN BY Z. PRIESTER
PROJECT NUMBER 10030178

ROWAN COUNTY

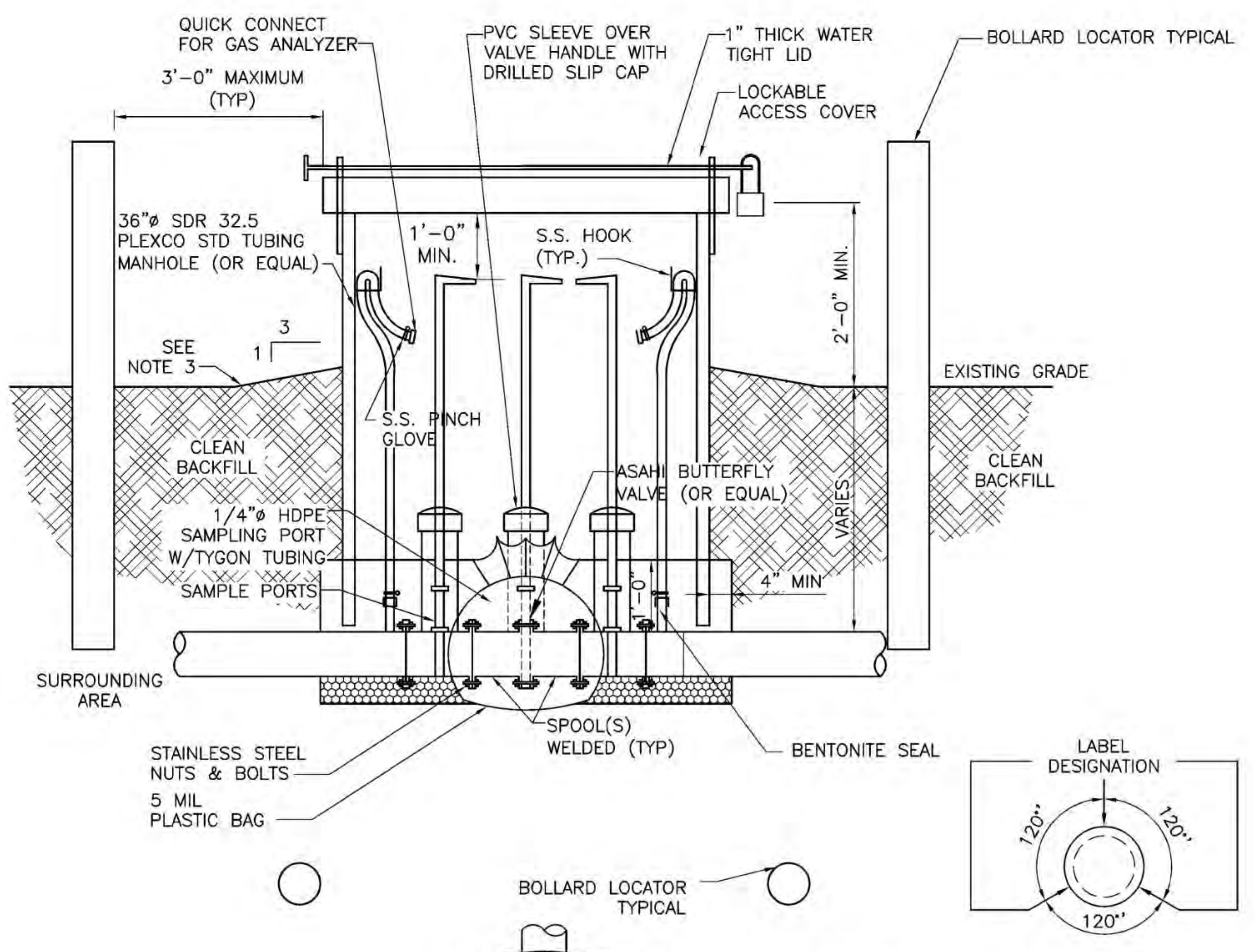
Rowan County Landfill

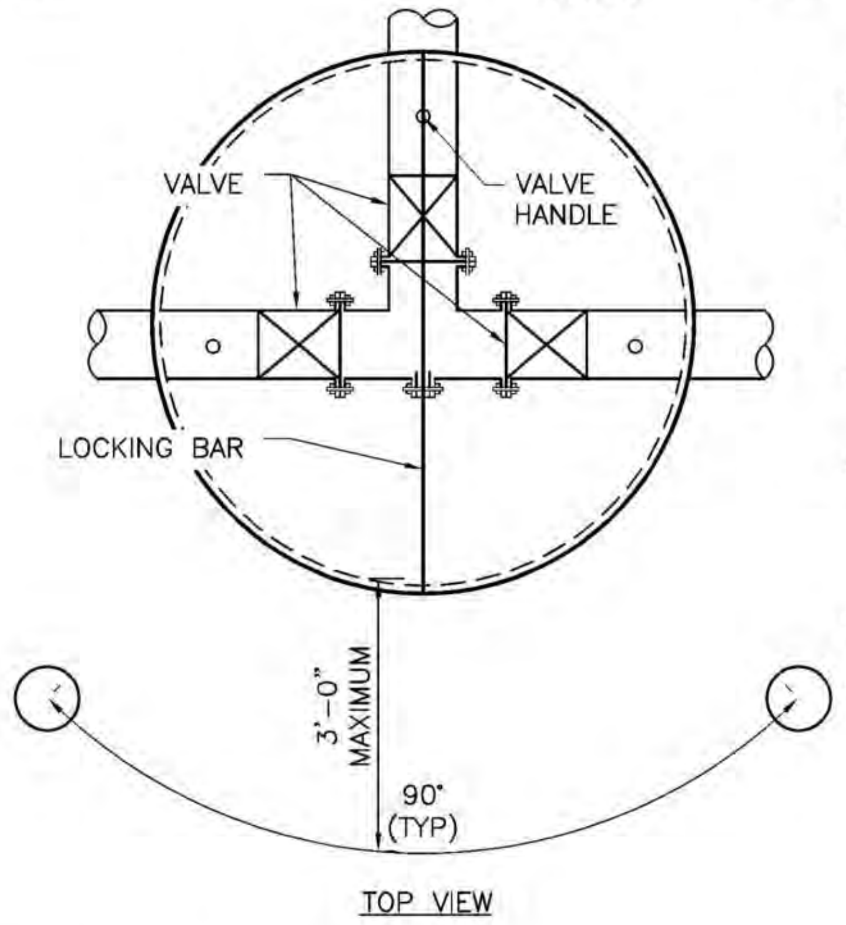
Landfill Gas Collection
and Control System
789 Campbell Road
Woodleaf, NC 27054
NORTH CAROLINA

GAS COLLECTION SYSTEM DETAILS - 2

0 1" 2"

FILENAME 00D-02.DWG
SCALE AS SHOWN
SHEET 00D-02





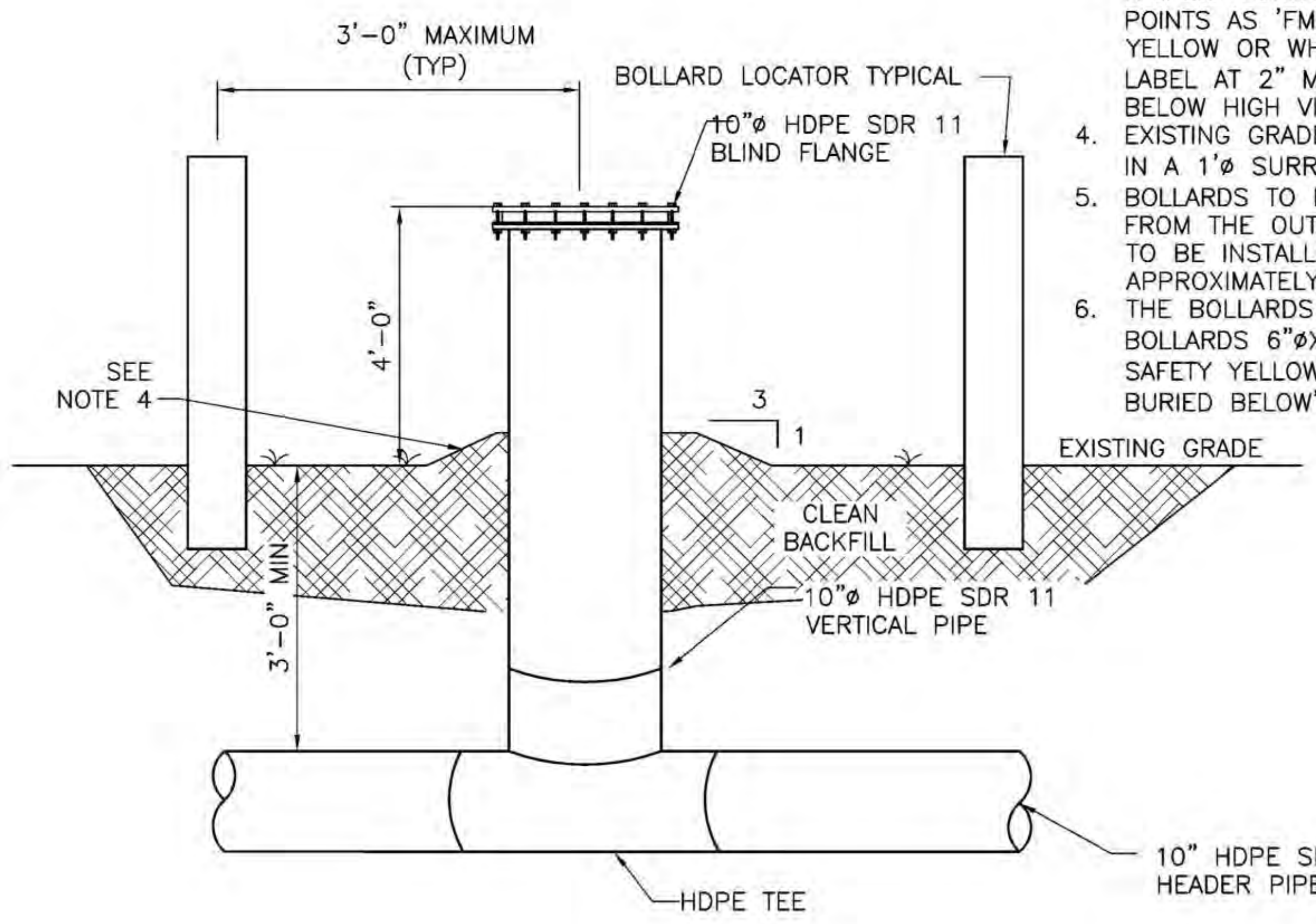
NOTES:

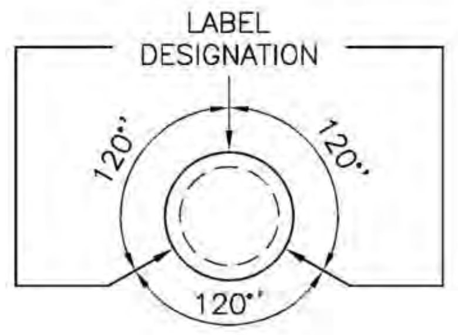
1. HOOK FOR SAMPLE PORT SHALL BE CONNECTED TO WALL OF VALVE PIT WITHIN REACH OF TOP OF VALVE PIT.
2. LABEL ALL VALVE PITS WITH IDENTIFICATION NUMBER WITH YELLOW OR WHITE PAINT AND STENCILS OR ADHESIVE LABEL AT 2" MINIMUM HEIGHT AND LOCATED IMMEDIATELY BELOW HIGH VISIBILITY TAPE.
3. EXISTING GRADE TO BE SLOPED FOR POSITIVE DRAINAGE IN A 1'ø SURROUNDING SURFACE EXPRESSION.
4. BOLLARDS TO BE INSTALLED NO MORE THAN 3'-0" FROM THE OUTSIDE OF THE VALVE PIT. BOLLARDS TO BE INSTALLED ON FOUR SIDES OFFSET BY APPROXIMATELY 90 DEGREES.
5. A 10" to 18" REDUCER IS REQUIRED AT THE VALVE PIT BY FLARE STATION.
6. INDIVIDUAL MANHOLES FOR THE VALVES MAY BE INSTALLED IN LIEU OF ONE LARGE MANHOLE.

HEADER LINE ISOLATION VALVE PIT (TYP)

NOT TO SCALE

1
–





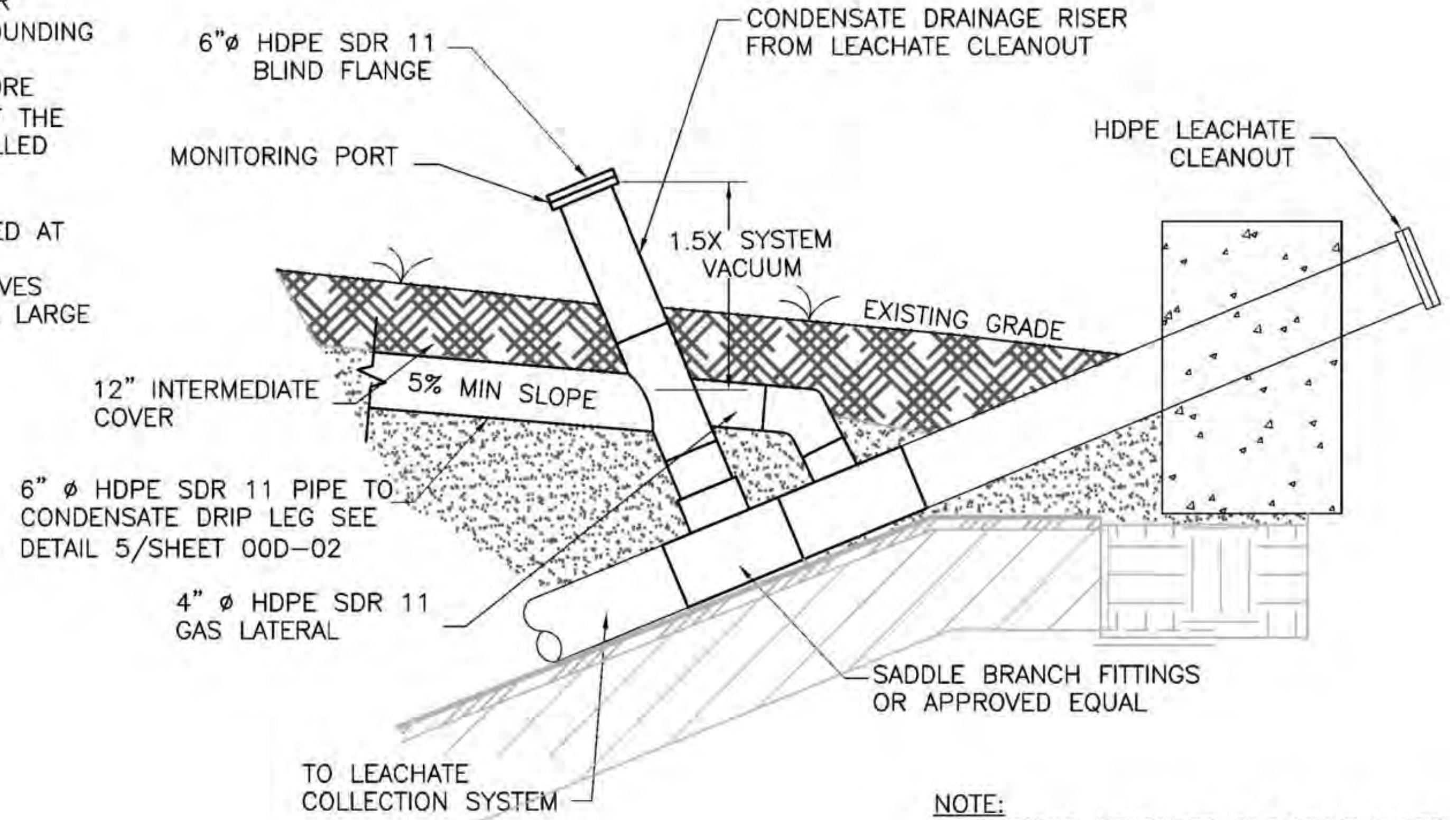
NOTES:

1. ACTUAL DIMENSIONS AND LOCATIONS MAY VARY BASED ON FIELD CONDITIONS.
2. AIRLINE SHOWN OFFSET FOR CLARITY.
3. LABEL ALL HEADER ACCESS POINTS AS 'AP', AIRLINE ACCESS POINTS AS 'AIR AP' AND CONDENSATE ACCESS POINTS AS 'FM AP' WITH IDENTIFICATION NUMBER WITH YELLOW OR WHITE PAINT AND STENCILS OR ADHESIVE LABEL AT 2" MINIMUM HEIGHT AND LOCATED IMMEDIATELY BELOW HIGH VISIBILITY TAPE ON ALL THREE SIDES.
4. EXISTING GRADE TO BE SLOPED FOR POSITIVE DRAINAGE IN A 1'ø SURROUNDING SURFACE EXPRESSION.
5. BOLLARDS TO BE INSTALLED NO MORE THAN 3'-0" FROM THE OUTSIDE OF THE ACCESS POINT. BOLLARDS TO BE INSTALLED ON FOUR SIDES OFFSET BY APPROXIMATELY 90 DEGREES.
6. THE BOLLARDS SHALL BE CONCRETE-FILLED STEEL PIPE BOLLARDS 6"øX8' TALL. BOLLARDS SHALL BE PAINTED SAFETY YELLOW AND LABELED "LANDFILL GAS PIPE BURIED BELOW".

HEADER ACCESS POINT (TYP)

NOT TO SCALE

2
00C-02



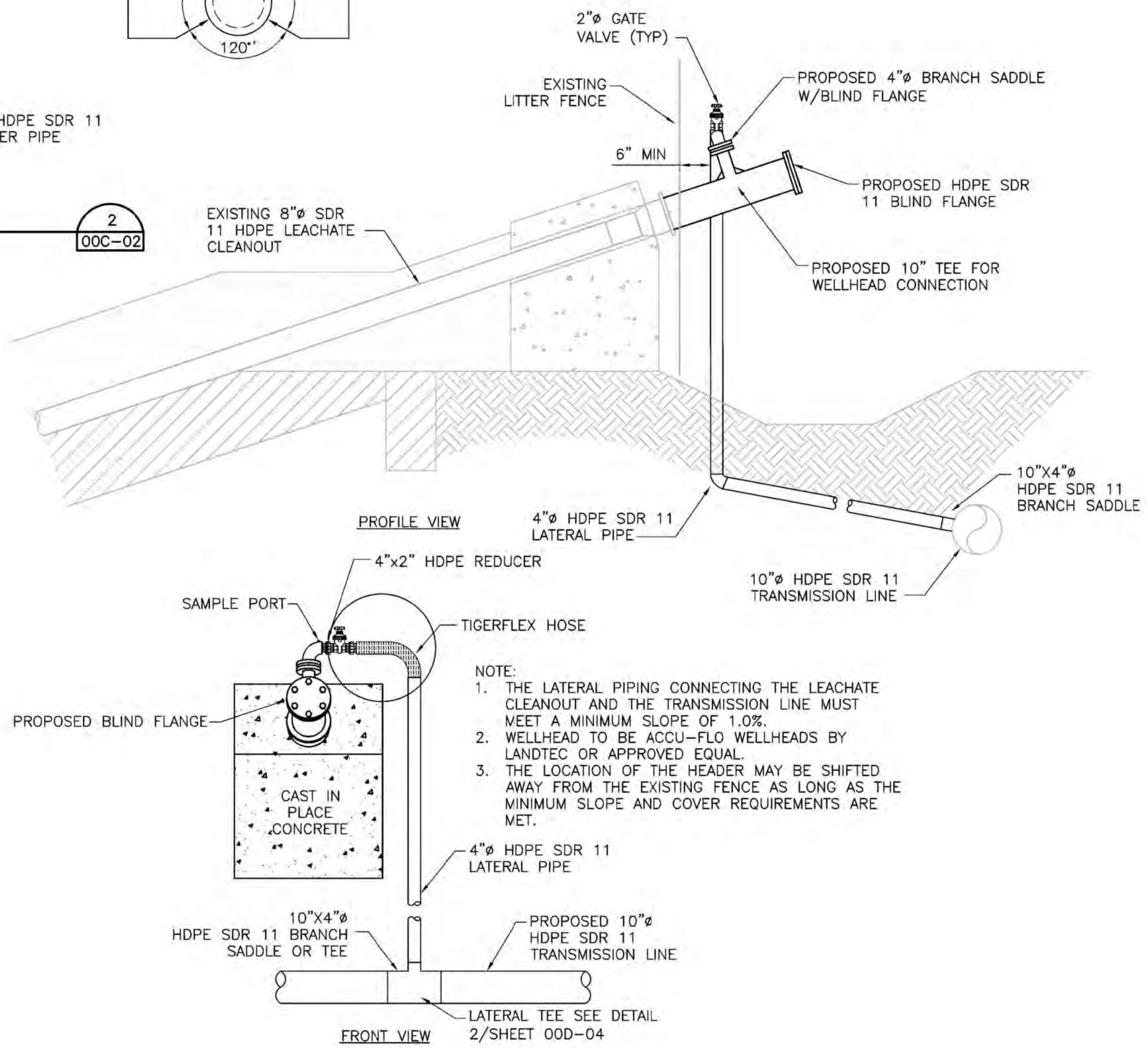
NOTE:

1. EXISTING LEACHATE CLEANOUT RISER PIPES ARE 8" IN PHASES I, II, III AND IV
2. THE LOCATION OF THE HEADER MAY BE SHIFTED FROM EXISTING FENCE AS LONG AS MINIMUM SLOPE AND COVER REQUIREMENTS ARE OBTAINED.

LEACHATE SIDESLOPE CLEANOUT RISER CONNECT INSIDE WASTE LIMITS

NOT TO SCALE

3
–



NOTE:

1. THE LATERAL PIPING CONNECTING THE LEACHATE CLEANOUT AND THE TRANSMISSION LINE MUST MEET A MINIMUM SLOPE OF 1.0%.
2. WELLHEAD TO BE ACCU-FLO WELLHEADS BY LANDTEC OR APPROVED EQUAL.
3. THE LOCATION OF THE HEADER MAY BE SHIFTED AWAY FROM THE EXISTING FENCE AS LONG AS THE MINIMUM SLOPE AND COVER REQUIREMENTS ARE MET.

LEACHATE CLEANOUT CONNECTION OUTSIDE WASTE LIMITS

NOT TO SCALE

4
00C-04

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DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill
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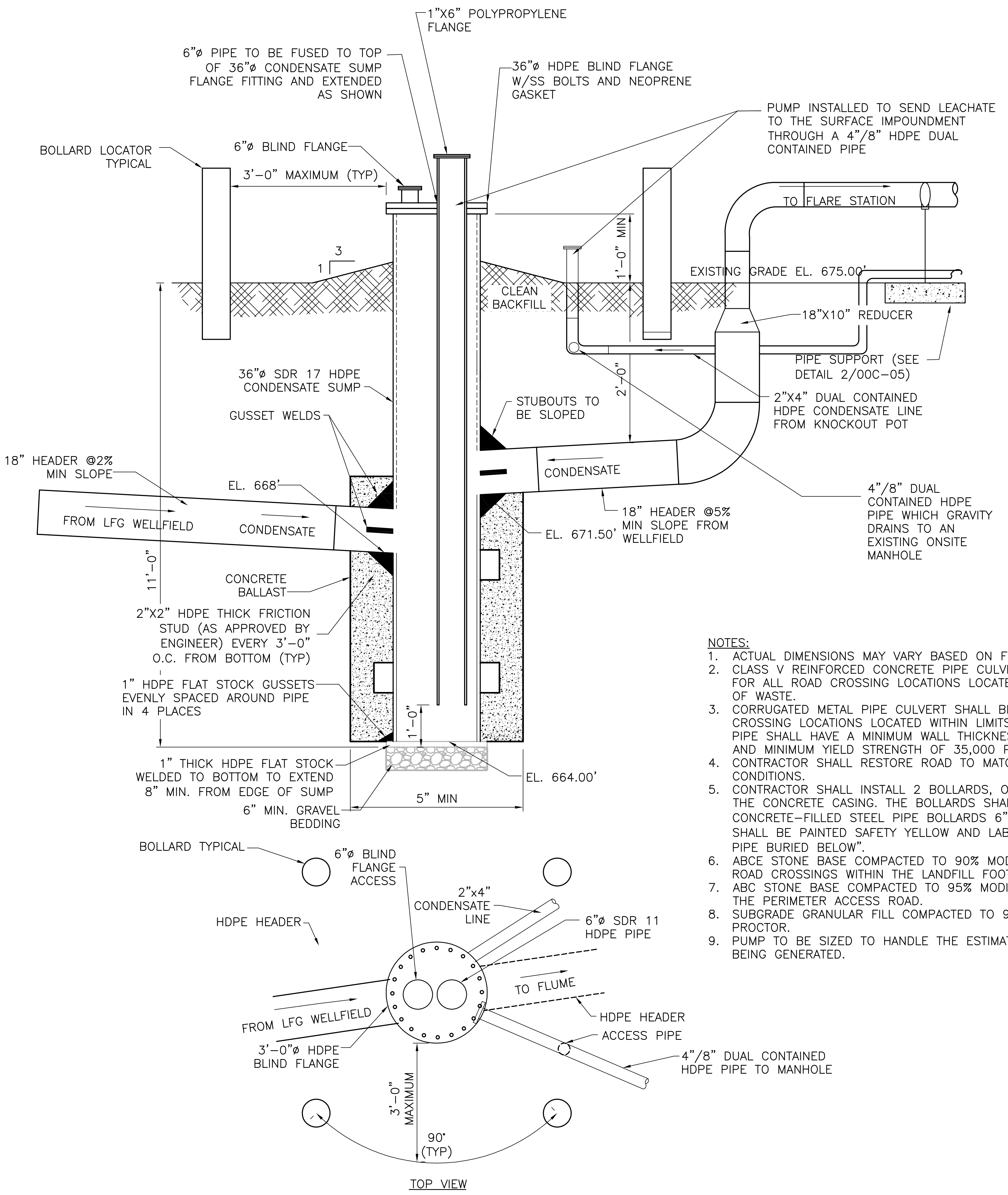
NORTH CAROLINA

GAS COLLECTION SYSTEM DETAILS - 3

0 1" 2"

FILENAME 00D-03.DWG
SCALE AS SHOWN

SHEET
00D-03



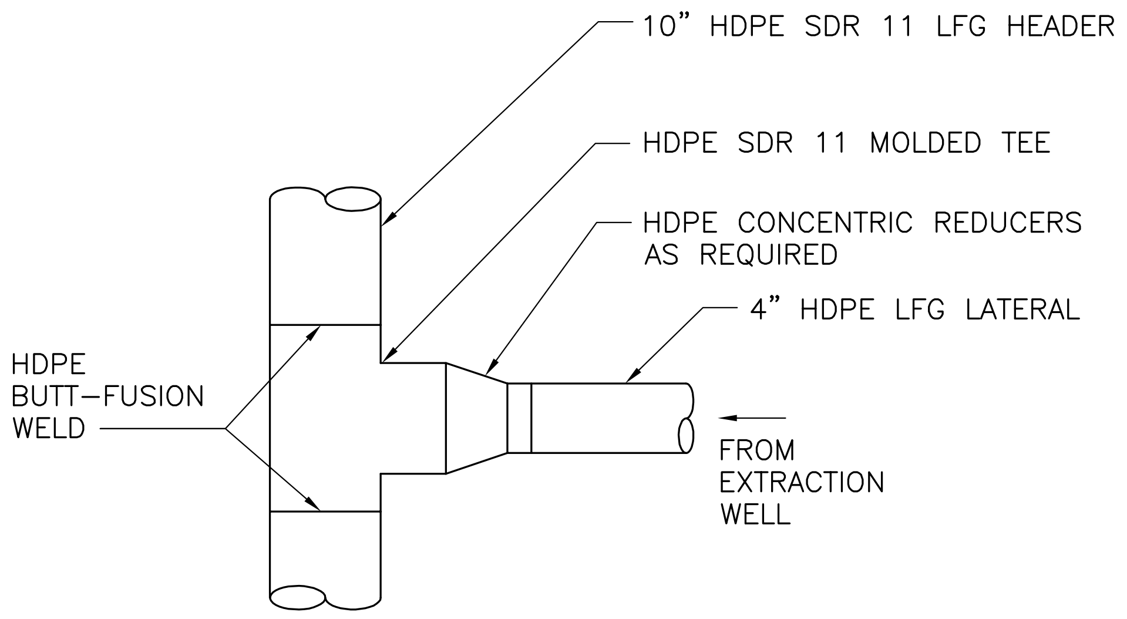
NOTES:

1. ACTUAL DIMENSIONS MAY VARY BASED ON FIELD CONDITIONS.
2. CLASS V REINFORCED CONCRETE PIPE CULVERT SHALL BE USED FOR ALL ROAD CROSSING LOCATIONS LOCATED OUTSIDE OF LIMITS OF WASTE.
3. CORRUGATED METAL PIPE CULVERT SHALL BE USED FOR ROAD CROSSING LOCATIONS LOCATED WITHIN LIMITS OF WASTE. STEEL PIPE SHALL HAVE A MINIMUM WALL THICKNESS OF 0.168 INCHES AND MINIMUM YIELD STRENGTH OF 35,000 PSI.
4. CONTRACTOR SHALL RESTORE ROAD TO MATCH ORIGINAL CONDITIONS.
5. CONTRACTOR SHALL INSTALL 2 BOLLARDS, ONE AT EACH END OF THE CONCRETE CASING. THE BOLLARDS SHALL BE CONCRETE-FILLED STEEL PIPE BOLLARDS 6"øX8' TALL. BOLLARDS SHALL BE PAINTED SAFETY YELLOW AND LABELED "LANDFILL GAS PIPE BURIED BELOW".
6. ABCE STONE BASE COMPACTED TO 90% MODIFIED PROCTOR FOR ROAD CROSSINGS WITHIN THE LANDFILL FOOTPRINT.
7. ABC STONE BASE COMPACTED TO 95% MODIFIED PROCTOR FOR THE PERIMETER ACCESS ROAD.
8. SUBGRADE GRANULAR FILL COMPACTED TO 95% MODIFIED PROCTOR.
9. PUMP TO BE SIZED TO HANDLE THE ESTIMATED CONDENSATE BEING GENERATED.

CONDENSATE SUMP (GRAVITY DRAIN)

NOT TO SCALE

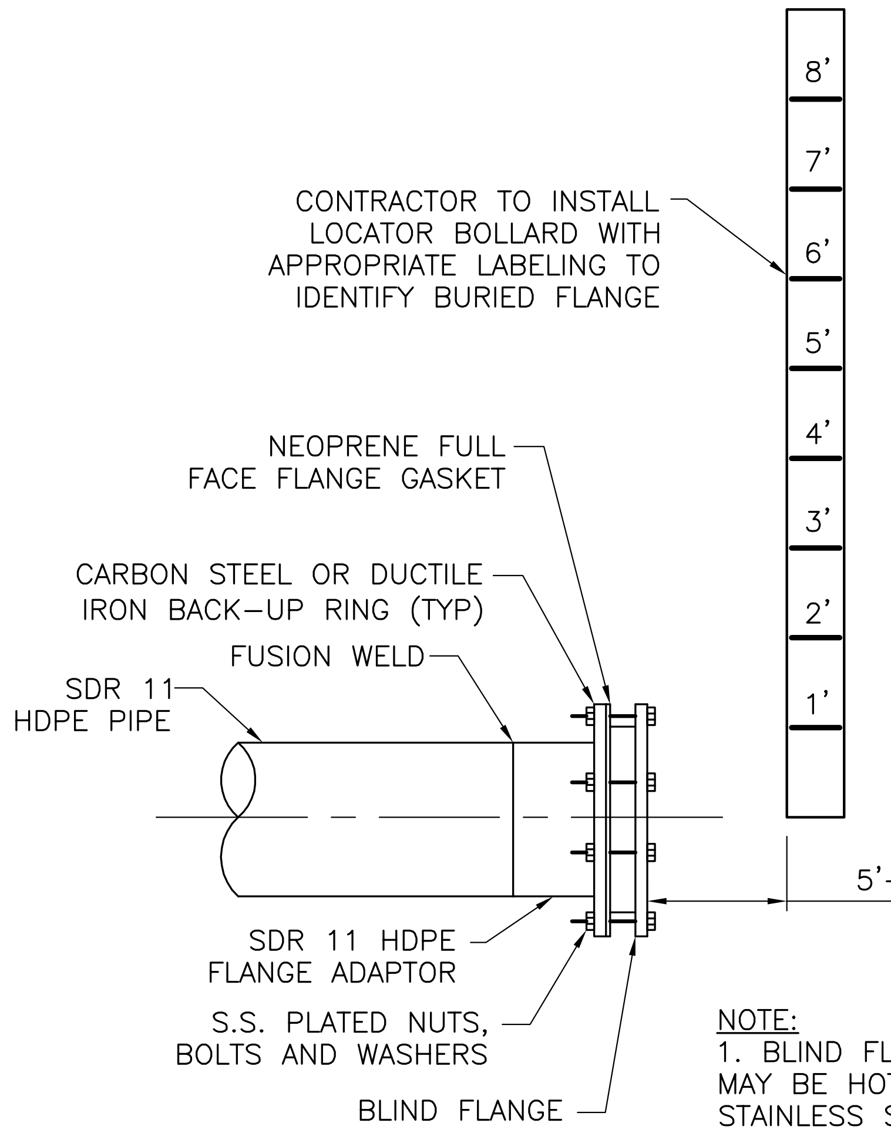
1
–



LATERAL TIE-IN W/TEE (TYP)

NOT TO SCALE

2
00D-03

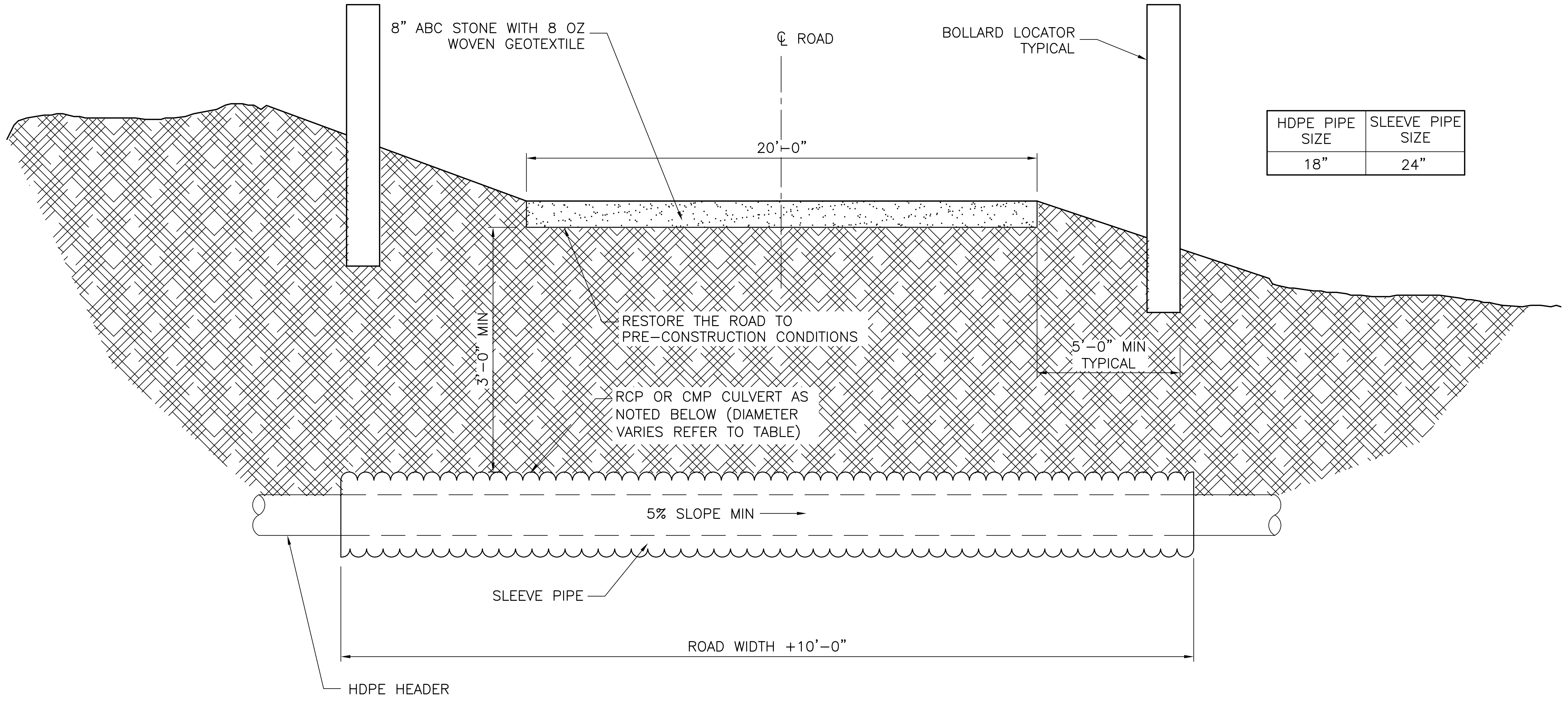


NOTE:
1. BLIND FLANGE BOLTS AND WASHERS MAY BE HOT DIPPED GALVANIZED OR STAINLESS STEEL.

BLIND FLANGE

NOT TO SCALE

3
00C-03



HDPE PIPE SIZE	SLEEVE PIPE SIZE
18"	24"

ACCESS ROAD CROSSING

4

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DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

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NORTH CAROLINA

GAS COLLECTION SYSTEM DETAILS - 4

0 1" 2"

FILENAME 00D-04.DWG
SCALE AS SHOWN

SHEET
00D-04

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B

Appendix B - Landfill Gas Generation Rate Modeling, Radius of Influence and Well Spacing Calculations, Condensate Generation Estimates, Headloss Analysis, and Flare PTE

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LandGEM - Version 3.02

US EPA Office of Research and Development

CLEAN
AIR
TECHNOLOGY
CENTER

LandGEM
Landfill Gas Emissions Model
Version 3.02

U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory (NRMRL)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina

May 2005

EPA

Summary Report

Landfill Name or Identifier: Rowan County Landfill - Landfill GCCS Application

Date: Monday, November 27, 2017

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{i j}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation (*m^3/year*)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*$year^{-1}$*)
L_o = potential methane generation capacity (*m^3/Mg*)
M_i = mass of waste accepted in the i^{th} year (*Mg*)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1989**	
Landfill Closure Year (with 80-year limit)	**2032**	
Actual Closure Year (without limit)	***2032***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.040**	*year* $^{-1}$
Potential Methane Generation Capacity, L_o	**100**	*m* ^{3} */Mg*
NMOC Concentration	**4,000**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1989	10,088	11,096	0	0
1990	10,088	11,096	10,088	11,096
1991	10,088	11,096	20,175	22,193
1992	10,088	11,096	30,263	33,289
1993	49,124	54,036	40,350	44,385
1994	91,874	101,061	89,474	98,422
1995	85,613	94,175	181,348	199,483
1996	67,594	74,353	266,961	293,657
1997	62,325	68,557	334,555	368,011
1998	61,495	67,645	396,880	436,568
1999	65,556	72,111	458,375	504,213
2000	68,123	74,935	523,931	576,324
2001	62,869	69,156	592,054	651,259
2002	64,628	71,091	654,923	720,415
2003	69,180	76,098	719,551	791,506
2004	70,166	77,183	788,731	867,604
2005	78,958	86,854	858,897	944,787
2006	87,630	96,392	937,855	1,031,641
2007	82,186	90,405	1,025,485	1,128,033
2008	101,287	111,415	1,107,671	1,218,438
2009	122,594	134,854	1,208,958	1,329,854
2010	120,391	132,430	1,331,552	1,464,707
2011	113,683	125,052	1,451,943	1,597,137
2012	106,835	117,518	1,565,626	1,722,189
2013	109,257	120,182	1,672,461	1,839,707
2014	111,028	122,131	1,781,718	1,959,889
2015	118,967	130,863	1,892,746	2,082,021
2016	119,423	131,365	2,011,713	2,212,884
2017	119,423	131,365	2,131,136	2,344,249
2018	119,423	131,365	2,250,559	2,475,614
2019	119,423	131,365	2,369,982	2,606,980
2020	119,423	131,365	2,489,404	2,738,345
2021	119,423	131,365	2,608,827	2,869,710
2022	119,423	131,365	2,728,250	3,001,075
2023	119,423	131,365	2,847,673	3,132,441
2024	119,423	131,365	2,967,096	3,263,806
2025	119,423	131,365	3,086,519	3,395,171
2026	119,423	131,365	3,205,942	3,526,536
2027	119,423	131,365	3,325,365	3,657,902
2028	119,423	131,365	3,444,788	3,789,267

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2029	119,423	131,365	3,564,211	3,920,632
2030	119,423	131,365	3,683,634	4,051,997
2031	119,423	131,365	3,803,057	4,183,362
2032	105,453	115,998	3,922,480	4,314,728
2033	0	0	4,027,933	4,430,726
2034	0	0	4,027,933	4,430,726
2035	0	0	4,027,933	4,430,726
2036	0	0	4,027,933	4,430,726
2037	0	0	4,027,933	4,430,726
2038	0	0	4,027,933	4,430,726
2039	0	0	4,027,933	4,430,726
2040	0	0	4,027,933	4,430,726
2041	0	0	4,027,933	4,430,726
2042	0	0	4,027,933	4,430,726
2043	0	0	4,027,933	4,430,726
2044	0	0	4,027,933	4,430,726
2045	0	0	4,027,933	4,430,726
2046	0	0	4,027,933	4,430,726
2047	0	0	4,027,933	4,430,726
2048	0	0	4,027,933	4,430,726
2049	0	0	4,027,933	4,430,726
2050	0	0	4,027,933	4,430,726
2051	0	0	4,027,933	4,430,726
2052	0	0	4,027,933	4,430,726
2053	0	0	4,027,933	4,430,726
2054	0	0	4,027,933	4,430,726
2055	0	0	4,027,933	4,430,726
2056	0	0	4,027,933	4,430,726
2057	0	0	4,027,933	4,430,726
2058	0	0	4,027,933	4,430,726
2059	0	0	4,027,933	4,430,726
2060	0	0	4,027,933	4,430,726
2061	0	0	4,027,933	4,430,726
2062	0	0	4,027,933	4,430,726
2063	0	0	4,027,933	4,430,726
2064	0	0	4,027,933	4,430,726
2065	0	0	4,027,933	4,430,726
2066	0	0	4,027,933	4,430,726
2067	0	0	4,027,933	4,430,726
2068	0	0	4,027,933	4,430,726

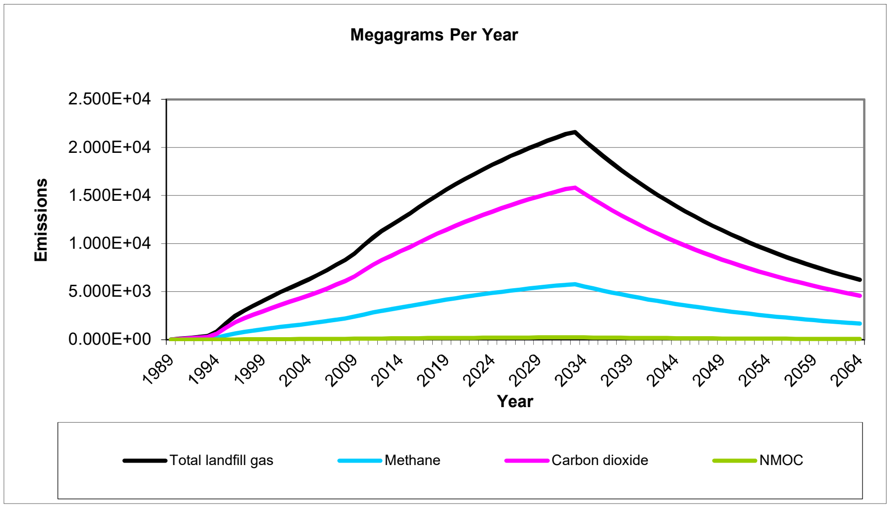
Pollutant Parameters

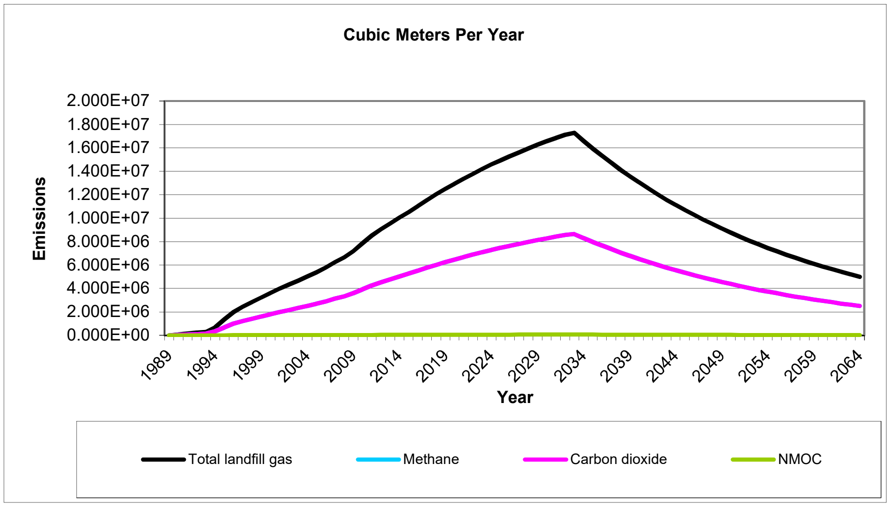
	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

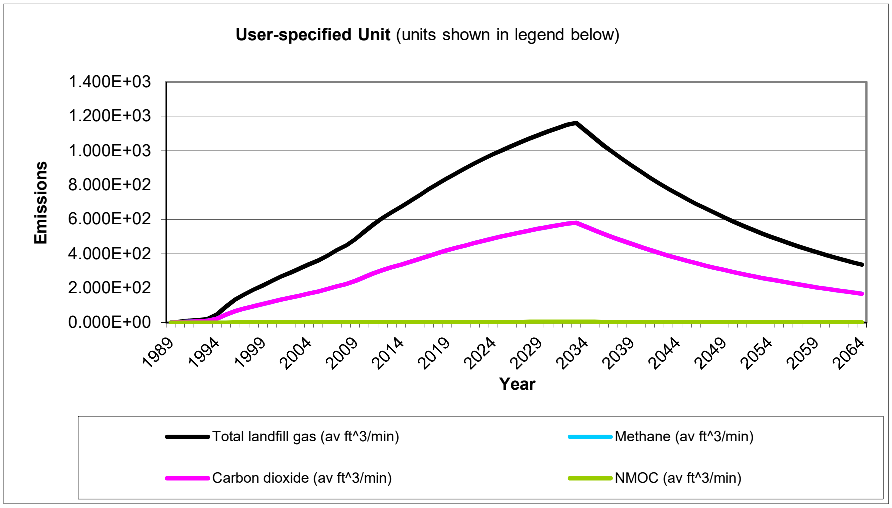
Pollutant Parameters (Continued)

		Gas / Pollutant Default Parameters:		*User-specified Pollutant Parameters:*	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
2.500E+04
2.000E+04
1.500E+04
1.000E+04
5.000E+03
0.000E+00
Emissions
1989
1994
1999
2004
2009
2014
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
2.000E+07
1.800E+07
1.600E+07
1.400E+07
1.200E+07
1.000E+07
8.000E+06
6.000E+06
4.000E+06
2.000E+06
0.000E+00
Emissions
1989
1994
1999
2004
2009
2014
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
1.400E+03
1.200E+03
1.000E+03
8.000E+02
6.000E+02
4.000E+02
2.000E+02
0.000E+00
Emissions
1989
1994
1999
2004
2009
2014
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1989	0	0	0	0	0	0
1990	9.899E+01	7.927E+04	5.326E+00	2.644E+01	3.963E+04	2.663E+00
1991	1.941E+02	1.554E+05	1.044E+01	5.185E+01	7.771E+04	5.221E+00
1992	2.855E+02	2.286E+05	1.536E+01	7.625E+01	1.143E+05	7.680E+00
1993	3.733E+02	2.989E+05	2.008E+01	9.970E+01	1.494E+05	1.004E+01
1994	8.407E+02	6.732E+05	4.523E+01	2.246E+02	3.366E+05	2.262E+01
1995	1.709E+03	1.369E+06	9.196E+01	4.566E+02	6.844E+05	4.598E+01
1996	2.482E+03	1.988E+06	1.336E+02	6.631E+02	9.939E+05	6.678E+01
1997	3.048E+03	2.441E+06	1.640E+02	8.142E+02	1.220E+06	8.200E+01
1998	3.540E+03	2.835E+06	1.905E+02	9.457E+02	1.418E+06	9.524E+01
1999	4.005E+03	3.207E+06	2.155E+02	1.070E+03	1.604E+06	1.077E+02
2000	4.491E+03	3.596E+06	2.416E+02	1.200E+03	1.798E+06	1.208E+02
2001	4.984E+03	3.991E+06	2.681E+02	1.331E+03	1.995E+06	1.341E+02
2002	5.405E+03	4.328E+06	2.908E+02	1.444E+03	2.164E+06	1.454E+02
2003	5.827E+03	4.666E+06	3.135E+02	1.557E+03	2.333E+06	1.568E+02
2004	6.278E+03	5.027E+06	3.378E+02	1.677E+03	2.514E+06	1.689E+02
2005	6.720E+03	5.381E+06	3.616E+02	1.795E+03	2.691E+06	1.808E+02
2006	7.232E+03	5.791E+06	3.891E+02	1.932E+03	2.895E+06	1.945E+02
2007	7.808E+03	6.252E+06	4.201E+02	2.086E+03	3.126E+06	2.100E+02
2008	8.308E+03	6.653E+06	4.470E+02	2.219E+03	3.326E+06	2.235E+02
2009	8.976E+03	7.188E+06	4.830E+02	2.398E+03	3.594E+06	2.415E+02
2010	9.827E+03	7.869E+06	5.287E+02	2.625E+03	3.935E+06	2.644E+02
2011	1.062E+04	8.507E+06	5.716E+02	2.838E+03	4.253E+06	2.858E+02
2012	1.132E+04	9.067E+06	6.092E+02	3.024E+03	4.533E+06	3.046E+02
2013	1.193E+04	9.551E+06	6.417E+02	3.186E+03	4.775E+06	3.208E+02
2014	1.253E+04	1.003E+07	6.742E+02	3.347E+03	5.017E+06	3.371E+02
2015	1.313E+04	1.051E+07	7.064E+02	3.507E+03	5.257E+06	3.532E+02
2016	1.378E+04	1.104E+07	7.415E+02	3.681E+03	5.518E+06	3.708E+02
2017	1.441E+04	1.154E+07	7.755E+02	3.850E+03	5.771E+06	3.877E+02
2018	1.502E+04	1.203E+07	8.081E+02	4.012E+03	6.014E+06	4.041E+02
2019	1.560E+04	1.249E+07	8.395E+02	4.168E+03	6.247E+06	4.197E+02
2020	1.616E+04	1.294E+07	8.696E+02	4.317E+03	6.471E+06	4.348E+02
2021	1.670E+04	1.337E+07	8.986E+02	4.461E+03	6.687E+06	4.493E+02
2022	1.722E+04	1.379E+07	9.264E+02	4.599E+03	6.894E+06	4.632E+02
2023	1.772E+04	1.419E+07	9.531E+02	4.732E+03	7.093E+06	4.766E+02
2024	1.819E+04	1.457E+07	9.788E+02	4.859E+03	7.284E+06	4.894E+02
2025	1.865E+04	1.493E+07	1.003E+03	4.982E+03	7.467E+06	5.017E+02
2026	1.909E+04	1.529E+07	1.027E+03	5.100E+03	7.644E+06	5.136E+02
2027	1.952E+04	1.563E+07	1.050E+03	5.213E+03	7.813E+06	5.250E+02
2028	1.992E+04	1.595E+07	1.072E+03	5.321E+03	7.976E+06	5.359E+02
2029	2.031E+04	1.627E+07	1.093E+03	5.426E+03	8.133E+06	5.464E+02
2030	2.069E+04	1.657E+07	1.113E+03	5.526E+03	8.283E+06	5.565E+02
2031	2.105E+04	1.685E+07	1.132E+03	5.622E+03	8.427E+06	5.662E+02
2032	2.140E+04	1.713E+07	1.151E+03	5.715E+03	8.566E+06	5.756E+02
2033	2.159E+04	1.729E+07	1.162E+03	5.767E+03	8.645E+06	5.808E+02
2034	2.074E+04	1.661E+07	1.116E+03	5.541E+03	8.306E+06	5.581E+02
2035	1.993E+04	1.596E+07	1.072E+03	5.324E+03	7.980E+06	5.362E+02
2036	1.915E+04	1.533E+07	1.030E+03	5.115E+03	7.667E+06	5.151E+02
2037	1.840E+04	1.473E+07	9.899E+02	4.914E+03	7.366E+06	4.949E+02
2038	1.768E+04	1.416E+07	9.511E+02	4.722E+03	7.078E+06	4.755E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2039	1.698E+04	1.360E+07	9.138E+02	4.537E+03	6.800E+06	4.569E+02
2040	1.632E+04	1.307E+07	8.780E+02	4.359E+03	6.533E+06	4.390E+02
2041	1.568E+04	1.255E+07	8.435E+02	4.188E+03	6.277E+06	4.218E+02
2042	1.506E+04	1.206E+07	8.105E+02	4.024E+03	6.031E+06	4.052E+02
2043	1.447E+04	1.159E+07	7.787E+02	3.866E+03	5.795E+06	3.893E+02
2044	1.391E+04	1.113E+07	7.481E+02	3.714E+03	5.567E+06	3.741E+02
2045	1.336E+04	1.070E+07	7.188E+02	3.569E+03	5.349E+06	3.594E+02
2046	1.284E+04	1.028E+07	6.906E+02	3.429E+03	5.139E+06	3.453E+02
2047	1.233E+04	9.876E+06	6.635E+02	3.294E+03	4.938E+06	3.318E+02
2048	1.185E+04	9.488E+06	6.375E+02	3.165E+03	4.744E+06	3.188E+02
2049	1.138E+04	9.116E+06	6.125E+02	3.041E+03	4.558E+06	3.063E+02
2050	1.094E+04	8.759E+06	5.885E+02	2.922E+03	4.379E+06	2.943E+02
2051	1.051E+04	8.416E+06	5.654E+02	2.807E+03	4.208E+06	2.827E+02
2052	1.010E+04	8.086E+06	5.433E+02	2.697E+03	4.043E+06	2.716E+02
2053	9.702E+03	7.769E+06	5.220E+02	2.591E+03	3.884E+06	2.610E+02
2054	9.321E+03	7.464E+06	5.015E+02	2.490E+03	3.732E+06	2.507E+02
2055	8.956E+03	7.171E+06	4.818E+02	2.392E+03	3.586E+06	2.409E+02
2056	8.604E+03	6.890E+06	4.629E+02	2.298E+03	3.445E+06	2.315E+02
2057	8.267E+03	6.620E+06	4.448E+02	2.208E+03	3.310E+06	2.224E+02
2058	7.943E+03	6.360E+06	4.273E+02	2.122E+03	3.180E+06	2.137E+02
2059	7.631E+03	6.111E+06	4.106E+02	2.038E+03	3.055E+06	2.053E+02
2060	7.332E+03	5.871E+06	3.945E+02	1.959E+03	2.936E+06	1.972E+02
2061	7.045E+03	5.641E+06	3.790E+02	1.882E+03	2.821E+06	1.895E+02
2062	6.769E+03	5.420E+06	3.642E+02	1.808E+03	2.710E+06	1.821E+02
2063	6.503E+03	5.207E+06	3.499E+02	1.737E+03	2.604E+06	1.749E+02
2064	6.248E+03	5.003E+06	3.362E+02	1.669E+03	2.502E+06	1.681E+02
2065	6.003E+03	4.807E+06	3.230E+02	1.604E+03	2.404E+06	1.615E+02
2066	5.768E+03	4.619E+06	3.103E+02	1.541E+03	2.309E+06	1.552E+02
2067	5.542E+03	4.437E+06	2.982E+02	1.480E+03	2.219E+06	1.491E+02
2068	5.324E+03	4.263E+06	2.865E+02	1.422E+03	2.132E+06	1.432E+02
2069	5.116E+03	4.096E+06	2.752E+02	1.366E+03	2.048E+06	1.376E+02
2070	4.915E+03	3.936E+06	2.644E+02	1.313E+03	1.968E+06	1.322E+02
2071	4.722E+03	3.781E+06	2.541E+02	1.261E+03	1.891E+06	1.270E+02
2072	4.537E+03	3.633E+06	2.441E+02	1.212E+03	1.817E+06	1.221E+02
2073	4.359E+03	3.491E+06	2.345E+02	1.164E+03	1.745E+06	1.173E+02
2074	4.188E+03	3.354E+06	2.253E+02	1.119E+03	1.677E+06	1.127E+02
2075	4.024E+03	3.222E+06	2.165E+02	1.075E+03	1.611E+06	1.083E+02
2076	3.866E+03	3.096E+06	2.080E+02	1.033E+03	1.548E+06	1.040E+02
2077	3.715E+03	2.975E+06	1.999E+02	9.922E+02	1.487E+06	9.993E+01
2078	3.569E+03	2.858E+06	1.920E+02	9.533E+02	1.429E+06	9.601E+01
2079	3.429E+03	2.746E+06	1.845E+02	9.159E+02	1.373E+06	9.225E+01
2080	3.295E+03	2.638E+06	1.773E+02	8.800E+02	1.319E+06	8.863E+01
2081	3.165E+03	2.535E+06	1.703E+02	8.455E+02	1.267E+06	8.515E+01
2082	3.041E+03	2.435E+06	1.636E+02	8.124E+02	1.218E+06	8.181E+01
2083	2.922E+03	2.340E+06	1.572E+02	7.805E+02	1.170E+06	7.861E+01
2084	2.807E+03	2.248E+06	1.510E+02	7.499E+02	1.124E+06	7.552E+01
2085	2.697E+03	2.160E+06	1.451E+02	7.205E+02	1.080E+06	7.256E+01
2086	2.592E+03	2.075E+06	1.394E+02	6.922E+02	1.038E+06	6.972E+01
2087	2.490E+03	1.994E+06	1.340E+02	6.651E+02	9.969E+05	6.698E+01
2088	2.392E+03	1.916E+06	1.287E+02	6.390E+02	9.578E+05	6.436E+01
2089	2.299E+03	1.841E+06	1.237E+02	6.140E+02	9.203E+05	6.183E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m ^{3} /year)*	*(av ft^3/min)*	*(Mg/year)*	*(m ^{3} /year)*	*(av ft^3/min)*
2090	2.208E+03	1.768E+06	1.188E+02	5.899E+02	8.842E+05	5.941E+01
2091	2.122E+03	1.699E+06	1.142E+02	5.668E+02	8.495E+05	5.708E+01
2092	2.039E+03	1.632E+06	1.097E+02	5.445E+02	8.162E+05	5.484E+01
2093	1.959E+03	1.568E+06	1.054E+02	5.232E+02	7.842E+05	5.269E+01
2094	1.882E+03	1.507E+06	1.013E+02	5.027E+02	7.535E+05	5.063E+01
2095	1.808E+03	1.448E+06	9.728E+01	4.830E+02	7.239E+05	4.864E+01
2096	1.737E+03	1.391E+06	9.347E+01	4.640E+02	6.955E+05	4.673E+01
2097	1.669E+03	1.337E+06	8.980E+01	4.458E+02	6.683E+05	4.490E+01
2098	1.604E+03	1.284E+06	8.628E+01	4.284E+02	6.421E+05	4.314E+01
2099	1.541E+03	1.234E+06	8.290E+01	4.116E+02	6.169E+05	4.145E+01
2100	1.480E+03	1.185E+06	7.965E+01	3.954E+02	5.927E+05	3.982E+01
2101	1.422E+03	1.139E+06	7.652E+01	3.799E+02	5.695E+05	3.826E+01
2102	1.367E+03	1.094E+06	7.352E+01	3.650E+02	5.471E+05	3.676E+01
2103	1.313E+03	1.051E+06	7.064E+01	3.507E+02	5.257E+05	3.532E+01
2104	1.261E+03	1.010E+06	6.787E+01	3.370E+02	5.051E+05	3.394E+01
2105	1.212E+03	9.705E+05	6.521E+01	3.237E+02	4.853E+05	3.260E+01
2106	1.164E+03	9.325E+05	6.265E+01	3.110E+02	4.662E+05	3.133E+01
2107	1.119E+03	8.959E+05	6.020E+01	2.989E+02	4.480E+05	3.010E+01
2108	1.075E+03	8.608E+05	5.784E+01	2.871E+02	4.304E+05	2.892E+01
2109	1.033E+03	8.270E+05	5.557E+01	2.759E+02	4.135E+05	2.778E+01
2110	9.923E+02	7.946E+05	5.339E+01	2.651E+02	3.973E+05	2.669E+01
2111	9.534E+02	7.634E+05	5.130E+01	2.547E+02	3.817E+05	2.565E+01
2112	9.160E+02	7.335E+05	4.928E+01	2.447E+02	3.668E+05	2.464E+01
2113	8.801E+02	7.047E+05	4.735E+01	2.351E+02	3.524E+05	2.368E+01
2114	8.456E+02	6.771E+05	4.549E+01	2.259E+02	3.386E+05	2.275E+01
2115	8.124E+02	6.506E+05	4.371E+01	2.170E+02	3.253E+05	2.186E+01
2116	7.806E+02	6.251E+05	4.200E+01	2.085E+02	3.125E+05	2.100E+01
2117	7.500E+02	6.005E+05	4.035E+01	2.003E+02	3.003E+05	2.018E+01
2118	7.206E+02	5.770E+05	3.877E+01	1.925E+02	2.885E+05	1.938E+01
2119	6.923E+02	5.544E+05	3.725E+01	1.849E+02	2.772E+05	1.862E+01
2120	6.652E+02	5.326E+05	3.579E+01	1.777E+02	2.663E+05	1.789E+01
2121	6.391E+02	5.117E+05	3.438E+01	1.707E+02	2.559E+05	1.719E+01
2122	6.140E+02	4.917E+05	3.304E+01	1.640E+02	2.458E+05	1.652E+01
2123	5.899E+02	4.724E+05	3.174E+01	1.576E+02	2.362E+05	1.587E+01
2124	5.668E+02	4.539E+05	3.050E+01	1.514E+02	2.269E+05	1.525E+01
2125	5.446E+02	4.361E+05	2.930E+01	1.455E+02	2.180E+05	1.465E+01
2126	5.232E+02	4.190E+05	2.815E+01	1.398E+02	2.095E+05	1.408E+01
2127	5.027E+02	4.026E+05	2.705E+01	1.343E+02	2.013E+05	1.352E+01
2128	4.830E+02	3.868E+05	2.599E+01	1.290E+02	1.934E+05	1.299E+01
2129	4.641E+02	3.716E+05	2.497E+01	1.240E+02	1.858E+05	1.248E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	***(m^3/year)***	***(av ft^3/min)***	***(Mg/year)***	***(m^3/year)***	***(av ft^3/min)***
1989	0	0	0	0	0	0
1990	7.255E+01	3.963E+04	2.663E+00	1.137E+00	3.171E+02	2.130E-02
1991	1.423E+02	7.771E+04	5.221E+00	2.228E+00	6.217E+02	4.177E-02
1992	2.092E+02	1.143E+05	7.680E+00	3.278E+00	9.144E+02	6.144E-02
1993	2.736E+02	1.494E+05	1.004E+01	4.286E+00	1.196E+03	8.033E-02
1994	6.161E+02	3.366E+05	2.262E+01	9.652E+00	2.693E+03	1.809E-01
1995	1.253E+03	6.844E+05	4.598E+01	1.962E+01	5.475E+03	3.679E-01
1996	1.819E+03	9.939E+05	6.678E+01	2.850E+01	7.951E+03	5.342E-01
1997	2.234E+03	1.220E+06	8.200E+01	3.500E+01	9.764E+03	6.560E-01
1998	2.595E+03	1.418E+06	9.524E+01	4.065E+01	1.134E+04	7.619E-01
1999	2.935E+03	1.604E+06	1.077E+02	4.598E+01	1.283E+04	8.619E-01
2000	3.292E+03	1.798E+06	1.208E+02	5.157E+01	1.439E+04	9.666E-01
2001	3.652E+03	1.995E+06	1.341E+02	5.722E+01	1.596E+04	1.073E+00
2002	3.961E+03	2.164E+06	1.454E+02	6.206E+01	1.731E+04	1.163E+00
2003	4.271E+03	2.333E+06	1.568E+02	6.691E+01	1.867E+04	1.254E+00
2004	4.601E+03	2.514E+06	1.689E+02	7.208E+01	2.011E+04	1.351E+00
2005	4.925E+03	2.691E+06	1.808E+02	7.716E+01	2.152E+04	1.446E+00
2006	5.300E+03	2.895E+06	1.945E+02	8.303E+01	2.316E+04	1.556E+00
2007	5.722E+03	3.126E+06	2.100E+02	8.964E+01	2.501E+04	1.680E+00
2008	6.089E+03	3.326E+06	2.235E+02	9.539E+01	2.661E+04	1.788E+00
2009	6.579E+03	3.594E+06	2.415E+02	1.031E+02	2.875E+04	1.932E+00
2010	7.202E+03	3.935E+06	2.644E+02	1.128E+02	3.148E+04	2.115E+00
2011	7.786E+03	4.253E+06	2.858E+02	1.220E+02	3.403E+04	2.286E+00
2012	8.298E+03	4.533E+06	3.046E+02	1.300E+02	3.627E+04	2.437E+00
2013	8.741E+03	4.775E+06	3.208E+02	1.369E+02	3.820E+04	2.567E+00
2014	9.184E+03	5.017E+06	3.371E+02	1.439E+02	4.014E+04	2.697E+00
2015	9.623E+03	5.257E+06	3.532E+02	1.507E+02	4.205E+04	2.826E+00
2016	1.010E+04	5.518E+06	3.708E+02	1.582E+02	4.414E+04	2.966E+00
2017	1.056E+04	5.771E+06	3.877E+02	1.655E+02	4.617E+04	3.102E+00
2018	1.101E+04	6.014E+06	4.041E+02	1.725E+02	4.811E+04	3.233E+00
2019	1.144E+04	6.247E+06	4.197E+02	1.791E+02	4.998E+04	3.358E+00
2020	1.185E+04	6.471E+06	4.348E+02	1.856E+02	5.177E+04	3.479E+00
2021	1.224E+04	6.687E+06	4.493E+02	1.918E+02	5.350E+04	3.594E+00
2022	1.262E+04	6.894E+06	4.632E+02	1.977E+02	5.515E+04	3.706E+00
2023	1.298E+04	7.093E+06	4.766E+02	2.034E+02	5.674E+04	3.813E+00
2024	1.333E+04	7.284E+06	4.894E+02	2.089E+02	5.827E+04	3.915E+00
2025	1.367E+04	7.467E+06	5.017E+02	2.141E+02	5.974E+04	4.014E+00
2026	1.399E+04	7.644E+06	5.136E+02	2.192E+02	6.115E+04	4.109E+00
2027	1.430E+04	7.813E+06	5.250E+02	2.241E+02	6.251E+04	4.200E+00
2028	1.460E+04	7.976E+06	5.359E+02	2.287E+02	6.381E+04	4.287E+00
2029	1.489E+04	8.133E+06	5.464E+02	2.332E+02	6.506E+04	4.371E+00
2030	1.516E+04	8.283E+06	5.565E+02	2.375E+02	6.626E+04	4.452E+00
2031	1.543E+04	8.427E+06	5.662E+02	2.417E+02	6.742E+04	4.530E+00
2032	1.568E+04	8.566E+06	5.756E+02	2.456E+02	6.853E+04	4.604E+00
2033	1.582E+04	8.645E+06	5.808E+02	2.479E+02	6.916E+04	4.647E+00
2034	1.520E+04	8.306E+06	5.581E+02	2.382E+02	6.644E+04	4.464E+00
2035	1.461E+04	7.980E+06	5.362E+02	2.288E+02	6.384E+04	4.289E+00
2036	1.403E+04	7.667E+06	5.151E+02	2.199E+02	6.134E+04	4.121E+00
2037	1.348E+04	7.366E+06	4.949E+02	2.112E+02	5.893E+04	3.960E+00
2038	1.296E+04	7.078E+06	4.755E+02	2.030E+02	5.662E+04	3.804E+00

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2039	1.245E+04	6.800E+06	4.569E+02	1.950E+02	5.440E+04	3.655E+00
2040	1.196E+04	6.533E+06	4.390E+02	1.874E+02	5.227E+04	3.512E+00
2041	1.149E+04	6.277E+06	4.218E+02	1.800E+02	5.022E+04	3.374E+00
2042	1.104E+04	6.031E+06	4.052E+02	1.729E+02	4.825E+04	3.242E+00
2043	1.061E+04	5.795E+06	3.893E+02	1.662E+02	4.636E+04	3.115E+00
2044	1.019E+04	5.567E+06	3.741E+02	1.596E+02	4.454E+04	2.993E+00
2045	9.792E+03	5.349E+06	3.594E+02	1.534E+02	4.279E+04	2.875E+00
2046	9.408E+03	5.139E+06	3.453E+02	1.474E+02	4.112E+04	2.763E+00
2047	9.039E+03	4.938E+06	3.318E+02	1.416E+02	3.950E+04	2.654E+00
2048	8.684E+03	4.744E+06	3.188E+02	1.360E+02	3.795E+04	2.550E+00
2049	8.344E+03	4.558E+06	3.063E+02	1.307E+02	3.647E+04	2.450E+00
2050	8.017E+03	4.379E+06	2.943E+02	1.256E+02	3.504E+04	2.354E+00
2051	7.702E+03	4.208E+06	2.827E+02	1.207E+02	3.366E+04	2.262E+00
2052	7.400E+03	4.043E+06	2.716E+02	1.159E+02	3.234E+04	2.173E+00
2053	7.110E+03	3.884E+06	2.610E+02	1.114E+02	3.107E+04	2.088E+00
2054	6.831E+03	3.732E+06	2.507E+02	1.070E+02	2.986E+04	2.006E+00
2055	6.563E+03	3.586E+06	2.409E+02	1.028E+02	2.868E+04	1.927E+00
2056	6.306E+03	3.445E+06	2.315E+02	9.879E+01	2.756E+04	1.852E+00
2057	6.059E+03	3.310E+06	2.224E+02	9.492E+01	2.648E+04	1.779E+00
2058	5.821E+03	3.180E+06	2.137E+02	9.119E+01	2.544E+04	1.709E+00
2059	5.593E+03	3.055E+06	2.053E+02	8.762E+01	2.444E+04	1.642E+00
2060	5.374E+03	2.936E+06	1.972E+02	8.418E+01	2.349E+04	1.578E+00
2061	5.163E+03	2.821E+06	1.895E+02	8.088E+01	2.256E+04	1.516E+00
2062	4.961E+03	2.710E+06	1.821E+02	7.771E+01	2.168E+04	1.457E+00
2063	4.766E+03	2.604E+06	1.749E+02	7.466E+01	2.083E+04	1.400E+00
2064	4.579E+03	2.502E+06	1.681E+02	7.174E+01	2.001E+04	1.345E+00
2065	4.400E+03	2.404E+06	1.615E+02	6.892E+01	1.923E+04	1.292E+00
2066	4.227E+03	2.309E+06	1.552E+02	6.622E+01	1.847E+04	1.241E+00
2067	4.061E+03	2.219E+06	1.491E+02	6.362E+01	1.775E+04	1.193E+00
2068	3.902E+03	2.132E+06	1.432E+02	6.113E+01	1.705E+04	1.146E+00
2069	3.749E+03	2.048E+06	1.376E+02	5.873E+01	1.639E+04	1.101E+00
2070	3.602E+03	1.968E+06	1.322E+02	5.643E+01	1.574E+04	1.058E+00
2071	3.461E+03	1.891E+06	1.270E+02	5.422E+01	1.513E+04	1.016E+00
2072	3.325E+03	1.817E+06	1.221E+02	5.209E+01	1.453E+04	9.764E-01
2073	3.195E+03	1.745E+06	1.173E+02	5.005E+01	1.396E+04	9.381E-01
2074	3.070E+03	1.677E+06	1.127E+02	4.809E+01	1.341E+04	9.014E-01
2075	2.949E+03	1.611E+06	1.083E+02	4.620E+01	1.289E+04	8.660E-01
2076	2.834E+03	1.548E+06	1.040E+02	4.439E+01	1.238E+04	8.321E-01
2077	2.722E+03	1.487E+06	9.993E+01	4.265E+01	1.190E+04	7.994E-01
2078	2.616E+03	1.429E+06	9.601E+01	4.098E+01	1.143E+04	7.681E-01
2079	2.513E+03	1.373E+06	9.225E+01	3.937E+01	1.098E+04	7.380E-01
2080	2.415E+03	1.319E+06	8.863E+01	3.783E+01	1.055E+04	7.090E-01
2081	2.320E+03	1.267E+06	8.515E+01	3.634E+01	1.014E+04	6.812E-01
2082	2.229E+03	1.218E+06	8.181E+01	3.492E+01	9.741E+03	6.545E-01
2083	2.142E+03	1.170E+06	7.861E+01	3.355E+01	9.359E+03	6.289E-01
2084	2.058E+03	1.124E+06	7.552E+01	3.223E+01	8.992E+03	6.042E-01
2085	1.977E+03	1.080E+06	7.256E+01	3.097E+01	8.640E+03	5.805E-01
2086	1.899E+03	1.038E+06	6.972E+01	2.975E+01	8.301E+03	5.577E-01
2087	1.825E+03	9.969E+05	6.698E+01	2.859E+01	7.975E+03	5.359E-01
2088	1.753E+03	9.578E+05	6.436E+01	2.747E+01	7.663E+03	5.149E-01
2089	1.685E+03	9.203E+05	6.183E+01	2.639E+01	7.362E+03	4.947E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2090	1.619E+03	8.842E+05	5.941E+01	2.536E+01	7.074E+03	4.753E-01
2091	1.555E+03	8.495E+05	5.708E+01	2.436E+01	6.796E+03	4.566E-01
2092	1.494E+03	8.162E+05	5.484E+01	2.341E+01	6.530E+03	4.387E-01
2093	1.436E+03	7.842E+05	5.269E+01	2.249E+01	6.274E+03	4.215E-01
2094	1.379E+03	7.535E+05	5.063E+01	2.161E+01	6.028E+03	4.050E-01
2095	1.325E+03	7.239E+05	4.864E+01	2.076E+01	5.791E+03	3.891E-01
2096	1.273E+03	6.955E+05	4.673E+01	1.995E+01	5.564E+03	3.739E-01
2097	1.223E+03	6.683E+05	4.490E+01	1.916E+01	5.346E+03	3.592E-01
2098	1.175E+03	6.421E+05	4.314E+01	1.841E+01	5.137E+03	3.451E-01
2099	1.129E+03	6.169E+05	4.145E+01	1.769E+01	4.935E+03	3.316E-01
2100	1.085E+03	5.927E+05	3.982E+01	1.700E+01	4.742E+03	3.186E-01
2101	1.042E+03	5.695E+05	3.826E+01	1.633E+01	4.556E+03	3.061E-01
2102	1.002E+03	5.471E+05	3.676E+01	1.569E+01	4.377E+03	2.941E-01
2103	9.623E+02	5.257E+05	3.532E+01	1.507E+01	4.205E+03	2.826E-01
2104	9.245E+02	5.051E+05	3.394E+01	1.448E+01	4.041E+03	2.715E-01
2105	8.883E+02	4.853E+05	3.260E+01	1.392E+01	3.882E+03	2.608E-01
2106	8.534E+02	4.662E+05	3.133E+01	1.337E+01	3.730E+03	2.506E-01
2107	8.200E+02	4.480E+05	3.010E+01	1.285E+01	3.584E+03	2.408E-01
2108	7.878E+02	4.304E+05	2.892E+01	1.234E+01	3.443E+03	2.313E-01
2109	7.569E+02	4.135E+05	2.778E+01	1.186E+01	3.308E+03	2.223E-01
2110	7.273E+02	3.973E+05	2.669E+01	1.139E+01	3.178E+03	2.136E-01
2111	6.987E+02	3.817E+05	2.565E+01	1.095E+01	3.054E+03	2.052E-01
2112	6.713E+02	3.668E+05	2.464E+01	1.052E+01	2.934E+03	1.971E-01
2113	6.450E+02	3.524E+05	2.368E+01	1.010E+01	2.819E+03	1.894E-01
2114	6.197E+02	3.386E+05	2.275E+01	9.708E+00	2.708E+03	1.820E-01
2115	5.954E+02	3.253E+05	2.186E+01	9.328E+00	2.602E+03	1.748E-01
2116	5.721E+02	3.125E+05	2.100E+01	8.962E+00	2.500E+03	1.680E-01
2117	5.496E+02	3.003E+05	2.018E+01	8.611E+00	2.402E+03	1.614E-01
2118	5.281E+02	2.885E+05	1.938E+01	8.273E+00	2.308E+03	1.551E-01
2119	5.074E+02	2.772E+05	1.862E+01	7.948E+00	2.217E+03	1.490E-01
2120	4.875E+02	2.663E+05	1.789E+01	7.637E+00	2.131E+03	1.432E-01
2121	4.684E+02	2.559E+05	1.719E+01	7.337E+00	2.047E+03	1.375E-01
2122	4.500E+02	2.458E+05	1.652E+01	7.050E+00	1.967E+03	1.321E-01
2123	4.324E+02	2.362E+05	1.587E+01	6.773E+00	1.890E+03	1.270E-01
2124	4.154E+02	2.269E+05	1.525E+01	6.508E+00	1.816E+03	1.220E-01
2125	3.991E+02	2.180E+05	1.465E+01	6.253E+00	1.744E+03	1.172E-01
2126	3.835E+02	2.095E+05	1.408E+01	6.007E+00	1.676E+03	1.126E-01
2127	3.684E+02	2.013E+05	1.352E+01	5.772E+00	1.610E+03	1.082E-01
2128	3.540E+02	1.934E+05	1.299E+01	5.545E+00	1.547E+03	1.039E-01
2129	3.401E+02	1.858E+05	1.248E+01	5.328E+00	1.486E+03	9.987E-02

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Rowan County Landfill

Vertical Wells Radius of Influence Calculation

Assumptions:

1. Steady state flow conditions exist
2. The pore space of the refuse is 100% saturated with the flowing fluid (LFG)
3. The viscosity of the flowing fluid is constant
4. Flow is laminar, horizontal, and linear since refuse grain size is relatively small and the velocity of the fluid is low

Methodology:

Utilization of an individual gas extraction well's Darcy Radius of Influence (ROI) to determine well spacings to distribute an induced vacuum uniformly throughout the waste disposal area. ROI calculation is based on modified Darcy's Equation - as indicated below:

$$r_1 = \left[\frac{2 g_C \, K T_S (h_S \; / \; h_T)}{P_S (dG \; / \; dt) \rho \mu T} (P_1^2 - P_0^2) \right]^{1/2}$$

Where,

g_c	Acceleration of gravity constant = 32.2 (lbM·ft/lbF·sec^2)
K	Absolute permeability of the porous media (refuse) in (ft^2) units
T_s	Standard temperature = 60(°F) = 520(°R) constant
h_S	Total vacuum well length in feet (perforated well depth)
h_T	Total extraction well length in feet (total well depth)
P_S	Standard pressure = zero inches W.C. = 14.7 (psia) = 2,116.8 (lb$_F$/ft^2) absolute
P_I	Pressure at extreme ROI (r1) convention pressure gradient (assumed zero inches W.C.)
P_0	Applied pressure/vacuum at extraction well
(dG/dt)	Landfill gas generation rate (scfm LFG per lb$_M$ waste)
μ	Absolute viscosity of the flowing fluid (landfill gas) in (lbM/ft·sec)
ρ	Density of refuse in lb$_M$/ft^3
T	Flowing temperature of the fluid (landfill gas)

g_c	**32.2**	lb$_M$*ft / lb$_f$*sec^2
K	**2.68E-11**	ft^2
T_s	**520**	°R
Length of Solid Pipe	**15**	ft
Length of Perf Pipe (h_S)	**41.6**	ft
h_S/h_T	0.735	
P_S	**2,116.8**	lb$_f$/ft^2 absolute
P_I	**2,116.8**	lb$_f$/ft^2 absolute
P_0	**0.5**	" W.C.
P_0	2114.2	lb$_f$/ft^2 absolute
LFG Flowrate	**1,162**	cfm **(2032 Value)**
Mass in Landfill	**7,788,950**	Mg
dG/dt	0.000149186	ft^3/Mg*min
dG/dt	1.12782E-09	ft^3/lb$_M$*sec

LFG Composition: CH_4	**50.0%**	
LFG Composition: CO_2	**50.0%**	
LFG Composition: Other Gases	**0.0%**	
μ (@ 60°F)	8.45E-06	lb_M/ft*sec

ρ	**1216**	lb_M / yd^3
ρ	45.04	lb_M / ft^3

T	**90**	°F
T	549.67	°R

ROI Calculated =	121	ft

CONDENSATE GENERATION CALCULATION
ROWAN COUNTY LANDFILL

Objective:

Estimate condensate volume produced during gas extraction system operation.

Assumptions:

1. The LFG is assumed to be saturated with water vapor.
2. The LFG is 50% methane and 50% carbon dioxide by volume.
3. The LFG enters the header system at 100 degrees F.
4. The LFG temperature at the header near the blower/flare station is 50 degrees F (during winter).

Calculations:

The following calculations were performed to determine the maximum quantity of condensate that could form in the header system under worst case conditions. Calculations were performed for the maximum expected LFG generation during the design period which is 1,162 cfm. The saturation humidity:

$$Hs = \frac{Ps}{(P - Ps)} \times \frac{MWw}{MWg}$$

Where:

Hs = Saturation humidity at temperature T

P = Absolute pressure (assumed 1 atmosphere or 14.7 psia)

Ps = Vapor pressure of water at temperature T

MWw = Molecular weight of water = 18 g/mole = 18 lb/lb-mole

MWg = Molecular weight of LFG = 30 g/mole = 30 lb/lb-mole

Ps at 100 degrees F = 0.9493 psia

Ps at 50 degrees F = 0.1781 psia

Hs at 100 degrees F = $\frac{0.9493}{(14.7 - 0.9493)} \times \frac{18}{30}$ = 0.041422 lb/lb dry LFG

Hs at 50 degrees F = $\frac{0.1781}{(14.7 - 0.1781)} \times \frac{18}{30}$ = 0.007359 lb/lb dry LFG

Change in humidity due to cooling of LFG:

ΔHs = Hs at 100 degrees F - Hs at 50 degrees F = 0.041422 - 0.007359 = 0.034063 lb/lb dry LFG

Using Ideal Gas Law, density of LFG:

$$\rho = \frac{P \times MWg}{R \times T}$$

Where:

ρ = Density of LFG at temperature T, K (50 degrees F = 283 K)

P = Absolute pressure, 1 atm (1 atm)

R = Universal gas constant, (0.0821 L atm/mole K)

T = Temperature, degrees K (50 degrees F = 283 K)

MWg = Molecular weight of LFG, g/mole (30 g/mole)

ρ at 50 degrees F = $\frac{1 \times 30}{0.0821 \times 283}$ = 1.2916 g/L = 0.080633 lb/ft^3

Condensate generation:

$$C = Q \times \rho \times \Delta Hs$$

Where:

C = Condensate Generation, gal/day

Q= LFG flow, ft^3/min

ρ = Density of LFG, lb/ft^3

ΔHs = Change in humidity due to cooling of LFG, lb/lb dry LFG

$$C = 1{,}162 \; \frac{ft3}{min} \times 1{,}440 \; \frac{min}{day} \times 0.080633 \; \frac{lb\ LFG}{ft3} \times 0.034063 \; \frac{lb\ condensate}{lb\ LFG} \times \frac{1\ gal}{8.34\ lb}$$

= **551 gal/day**

Similar calculations using LFG temperature of 80 degrees F near the blower/flare station was performed and the condensate generation was calculated to be **305 gal/day**.

The actual volume of condensate formed in the header pipes is less than the value calculated above for several reasons:

1) The actual average gas temperature at the wellheads is less than 100 degrees F
2) The actual average temperature of the fill surrounding the header pipe is typically higher as the pipe is insulated by burying below the frost depth.
3) The insulating properties of the pipe walls were neglected and it was assumed that the pipe wall temperature was equal to that of the surrounding fill.

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Memorandum

To:	Michael Plummer, HDR Charlotte		
From:	Karam Singh, HDR Orlando	Project:	
CC:			
Date:	November 27, 2017	Job No:	

N:\!users\Gail\Stationery & Forms\Forms\memo.doc

RE: Rowan Landfill's KY Pipe Modeling Results

This memo is organized in three sections: (1) Background; (2) Methodology; and (3) Results. KY Pipe report is provided as attachment to this memo.

1. **Background**: KYGAS was developed by Dr. Don J. Wood and Dr. James E. Funk at the University of Kentucky. The program was modeled after KYPIPE, which models water distribution systems. KYGAS is used to determine head losses, system pressures, and velocities in piping systems controlled under vacuum. KYGAS operates under the assumptions that all flow in the piping system is steady, one-dimensional, isothermal flow for an ideal gas. The program uses the Darcy-Weisbach equation for head losses related to uncompressible flow and the Ideal Gas Law for pressure-temperature-density relationships.

   KYGAS has several useful options to develop a LFG system. The program allows the user to model any type of piping system material or configuration to coincide with field conditions. The program includes tabular and graphic interfaces for the input of information regarding the system. Multiple blower locations may be used in the program to simulate actual field conditions. In addition, blower performance curves may be entered into the program for comparison to operational and actual field conditions. KYGAS is capable of running multiple scenarios for any piping configuration including looped header systems. LFG flow units and pressure values at the wells are user specified for comparison to values obtained in the field.

2. **Methodology**: The following parameters are required for operation of KYGAS.

   - Pipe diameter (varies)
   - Pipe length (varies)
   - Roughness within the pipe (0.1 millifeet)
   - LFG flow rate into the system at each well or node (see text below)
   - LFG operating temperature (86 deg F)
   - Specific gravity of the LFG (1.037)
   - Ratio of specific heats (1.3)
   - Absolute viscosity of LFG (2.7 x 10^{-7} lb*sec/ft2)

   The design process begins with the development of the LFG flow rates for use in the program. The LFG flow is determined from the USEPA LandGEM LFG model. The LFG model is developed based on site-specific information relating to waste inflow, composition, landfill capacity, and site life. The second step involves evaluating the conceptual design of the LFG system to be installed. Based on the conceptual design and a general understanding of the planned phasing of the landfill, the total LFG flow for a landfill is divided into various amounts to simulate varied flow rates at the wellheads over the life of the site. For Rowan Landfill 1,162 scfm was used as total flowrate based on: (a) 38 exterior wells were assumed to contribute 19 scfm each; and (b) 22 interior wells with better waste depths were assumed to contribute 20 scfm each.

   KYGAS allows the user to input information in either a tabular or graphical method. The graphical method is called KYCAD. KYCAD allows the user to input the piping network to scale in an AutoCAD format. The user constructs the system in the computer by drawing the system as it will appear in the field, and then adjusts the necessary pipe lengths and locations of wells (nodes) as required. Site-specific conditions are considered when laying out a system. No elevations are used for the various nodes in this analysis. It is assumed that all LFG flow will proceed through the system regardless of node elevations.

Once all of the required information is in the program, the user can begin to evaluate the system. Evaluation of the system is an iterative process. The initial design is the based on the engineer's previous design experience for similar sized systems. Once the results of the initial model are reviewed, the iterative process begins by balancing the system to control LFG velocity, pressure loss, and pipe diameter for various parts of the system.

The initial flow rates and their input locations into the system remain unchanged throughout this process. The main factor adjusted for every iteration is the pipe diameter. The inside pipe diameter determines the LFG velocity and pressure drop in each pipe. Once the velocities in the system piping and the vacuum pressure remaining at the furthest node meet design requirements, the engineer may proceed with developing and finalizing the system for construction.

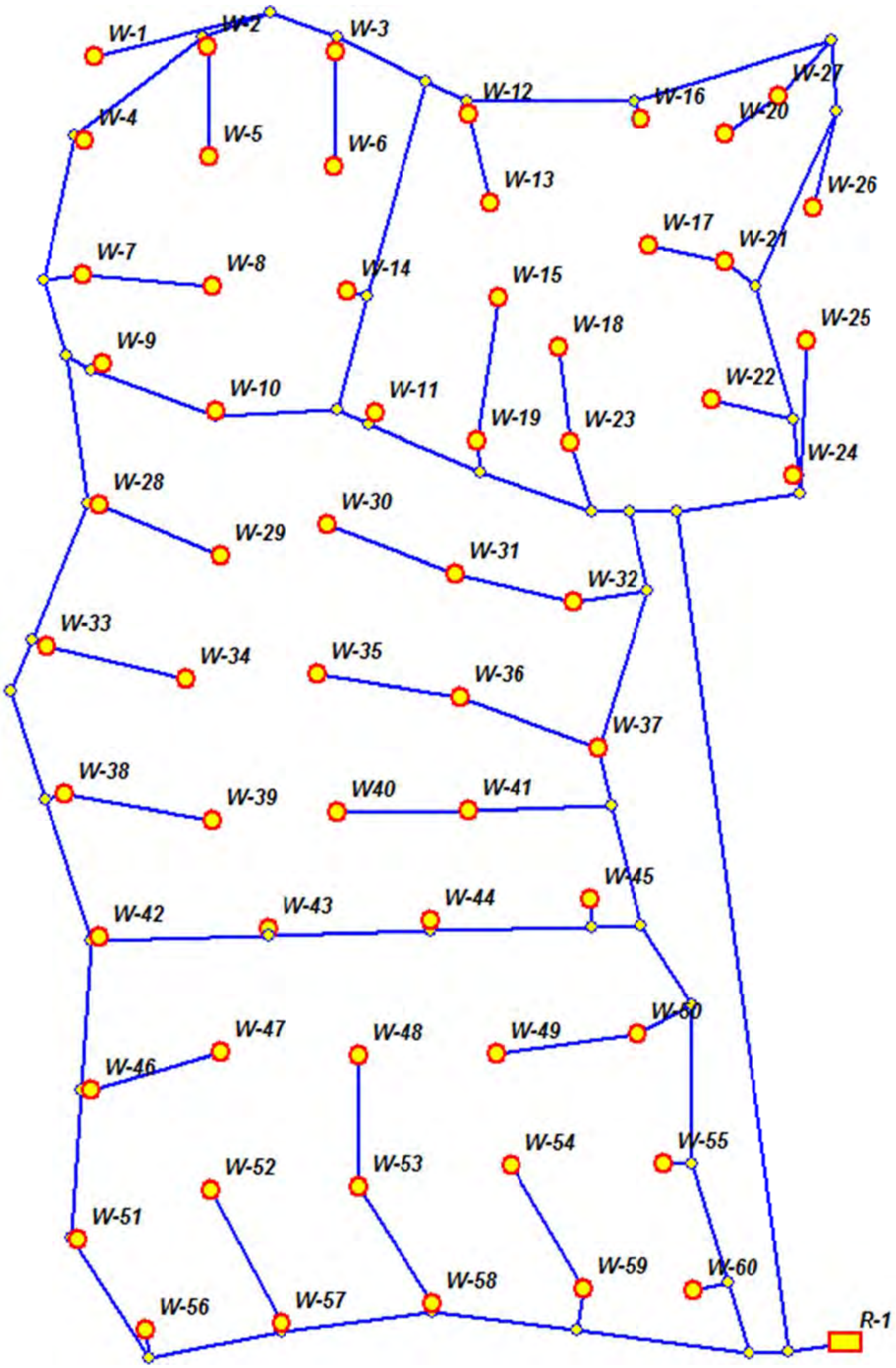
The design criteria for the header system are:

- *Maximum Con-Current Velocity 40 fps*
- *Maximum Counter-Current Velocity 20 fps*
- *Maximum Pressure Drop 1" w.c. per 100 feet of pipe*

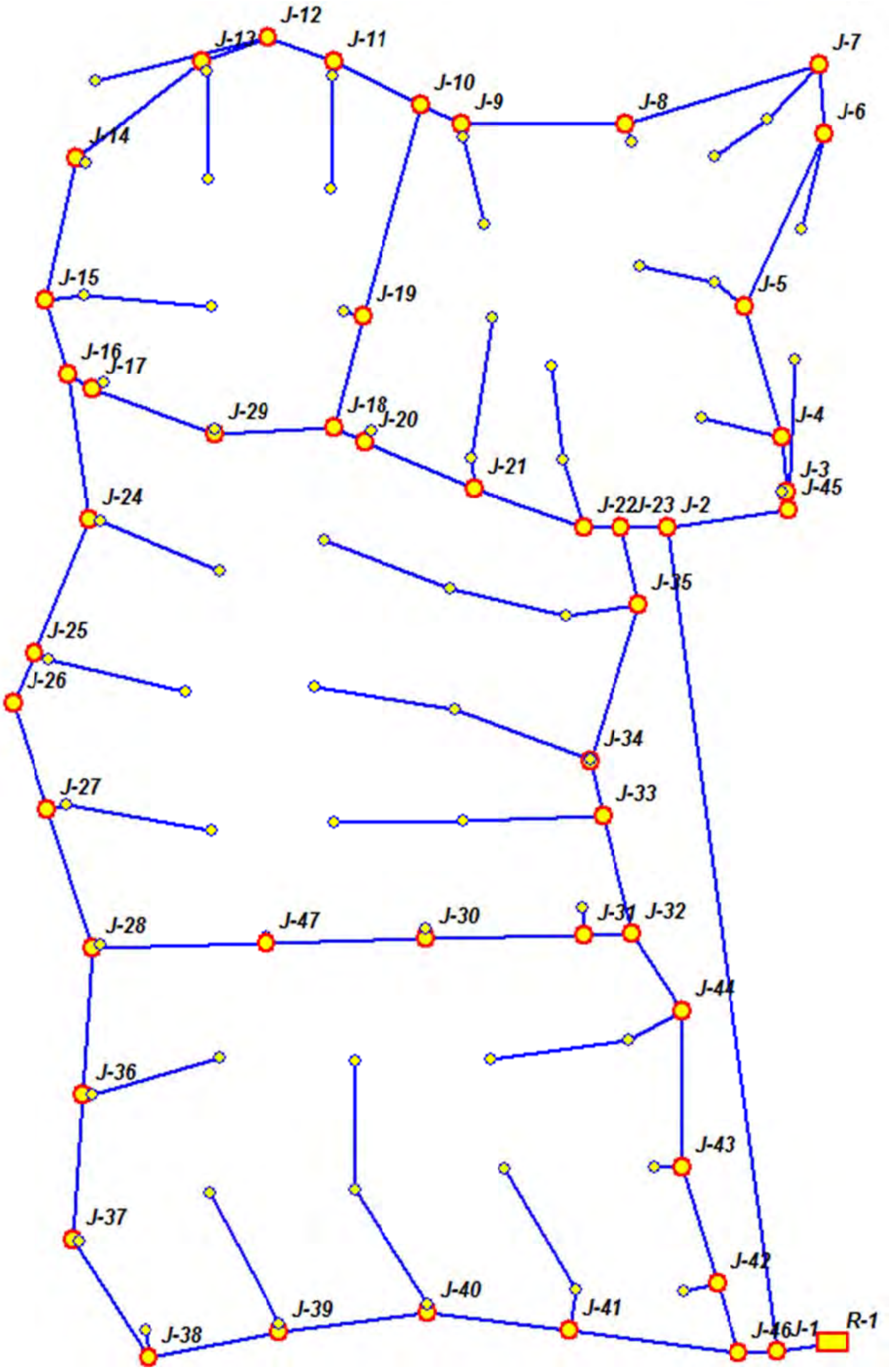
3. **Results**: The results of the KYGAS analysis indicate a total system pressure drop of approximately 2" w.c. Please refer to the attached KYGAS output files. Maximum individual pipe head loss should occur at Pipe P-111, and this head loss is well below the maximum pressure drop criteria. The maximum con-current velocity is 28.83 fps (Pipe P-111), which is below the maximum 40 fps con-current criteria. The counter-current flows were not encountered in this model results. All values are well within allowable operational ranges. The design flow used for the KYGAS analysis is 1,162 standard cubic feet per minute.

Attachment:
KY Pipe Report

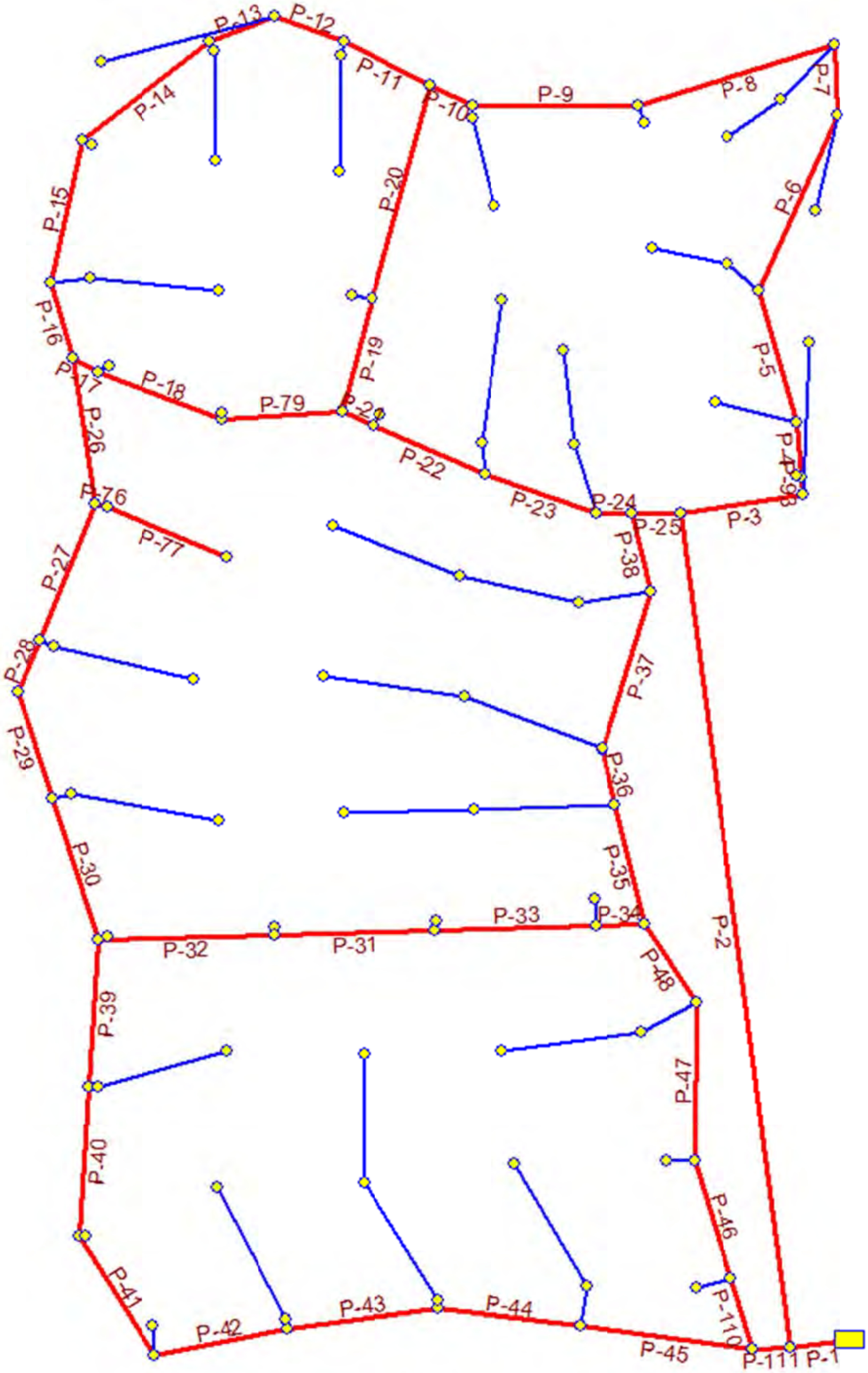
Extraction Well Nodes



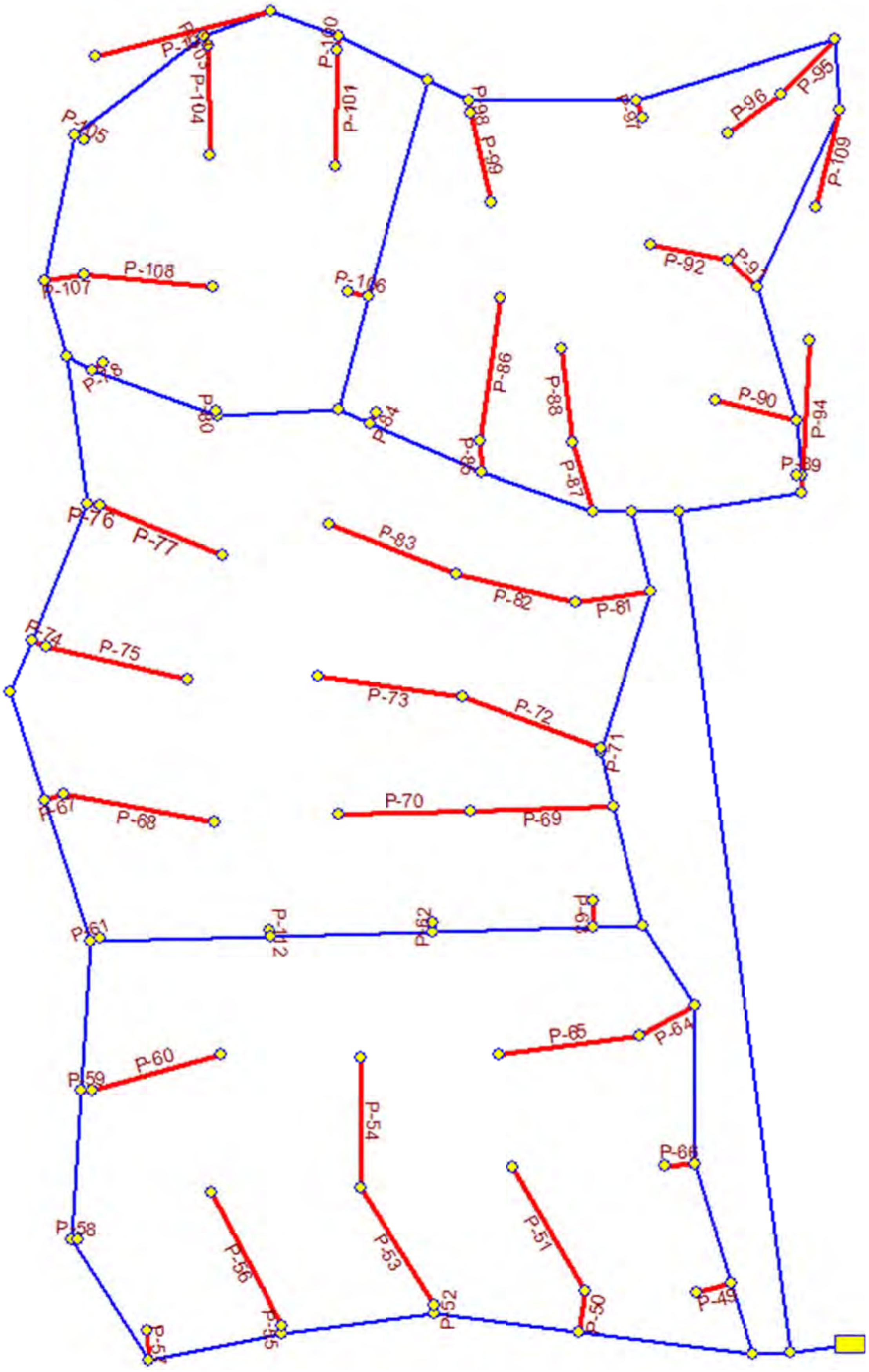
Other Junction Nodes



Header Piping – Assigned Pipe Numbers



Lateral Piping – Assigned Pipe Numbers



```
* * * * * * * * * * * * * K Y G A S * * * * * * * * * * * * *
*                                                            *
*  Gas Network Analysis Software                             *
*                                                            *
*  CopyRighted by KYPIPE LLC (www.kypipe.com)                *
*  Version: 8.014  01/11/2016                                *
*  Serial #:  10-10289534                                    *
*  Interface:  Classic                                       *
*  Licensed for Pipe2014                                     *
*                                                            *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 INPUT DATA FILE NAME FOR THIS SIMULATION  = C:\00HDRW~1\karam\CHRISK~1\rowan\VE
 RSIO~2\ROWANG~1.KYP\rowan_gc.DAT
 OUTPUT DATA FILE NAME FOR THIS SIMULATION = C:\00HDRW~1\karam\CHRISK~1\rowan\VE
 RSIO~2\ROWANG~1.KYP\rowan_gc.OT2

 DATE FOR THIS COMPUTER RUN       : 11-27-2017
 START TIME FOR THIS COMPUTER RUN : 18:46: 6:36


 SUMMARY OF DISTRIBUTION SYSTEM CHARACTERISTICS:
 ------------------------------------------------


 NUMBER OF PIPES          =   113
 NUMBER OF JUNCTION NODES =   108

 UNITS SPECIFIED          = ENGLISH



 PROPERTIES OF THE GAS FOR THIS ANALYSIS ARE:

  OPERATING TEMPERATURE                =     86.000 DEGREES FAHRENHEIT
  REFERENCE DENSITY (@ STD. PRESSURE) =    .75E-01 POUNDS/CUBIC FOOT
  GAS MOLECULAR WEIGHT                 =     30.030
  GAS SPECIFIC GRAVITY                 =      1.037
  RATIO OF SPECIFIC HEATS              =      1.300
  GAS CONSTANT                         =     51.460
  ABSOLUTE VISCOSITY                   =   .270E-06 POUND SECONDS/SQUARE FOOT


      USER SPEC. FLOW UNITS (USFU)      = SCF / MIN.
     USER SPEC. PRESSURE UNITS(USPU)   = INCHES OF WATER (GAUGE)


 -------  SUMMARY OF PIPE NETWORK GEOMETRIC AND OPERATING DATA  -------

------------------------------------------------------------------------
    PIPE    NODE    NODE  LENGTH  DIAM.  ROUGHNESS SUM-M PUMP ELEVATION
```

```
    NAME       #1        #2    (FT.)   (IN.)   (MILLIFEET) FACT.  ID     CHANGE
 ---------------------------------------------------------------------------------
     P-1      R-1       J-1     95.1   18.0        .100      .0    0         .0
     P-2      J-1       J-2   1354.1   10.0        .100      .0    0         .0
     P-3      J-2      J-45    198.9   10.0        .100      .0    0         .0
     P-4      J-3       J-4     88.7   10.0        .100      .0    0         .0
     P-5      J-4       J-5    220.1   10.0        .100      .0    0         .0
     P-6      J-5       J-6    310.4   10.0        .100      .0    0         .0
     P-7      J-6       J-7    111.7   10.0        .100      .0    0         .0
     P-8      J-7       J-8    330.0   10.0        .100      .0    0         .0
     P-9      J-8       J-9    267.6   10.0        .100      .0    0         .0
    P-10      J-9      J-10     74.2   10.0        .100      .0    0         .0
    P-11     J-10      J-11    157.3   10.0        .100      .0    0         .0
    P-12     J-11      J-12    116.3   10.0        .100      .0    0         .0
    P-13     J-12      J-13    114.9   10.0        .100      .0    0         .0
    P-14     J-13      J-14    257.7   10.0        .100      .0    0         .0
    P-15     J-14      J-15    236.0   10.0        .100      .0    0         .0
    P-16     J-15      J-16    126.2   10.0        .100      .0    0         .0
    P-17     J-16      J-17     45.9   10.0        .100      .0    0         .0
    P-18     J-17      J-29    212.5   10.0        .100      .0    0         .0
    P-19     J-18      J-19    188.0   10.0        .100      .0    0         .0
    P-20     J-19      J-10    357.4   10.0        .100      .0    0         .0
    P-21     J-18      J-20     56.5   10.0        .100      .0    0         .0
    P-22     J-20      J-21    193.3   10.0        .100      .0    0         .0
    P-23     J-21      J-22    189.6   10.0        .100      .0    0         .0
    P-24     J-22      J-23     60.4   10.0        .100      .0    0         .0
    P-25     J-23       J-2     75.9   10.0        .100      .0    0         .0
    P-26     J-16      J-24    236.9   10.0        .100      .0    0         .0
    P-27     J-24      J-25    234.7   10.0        .100      .0    0         .0
    P-28     J-25      J-26     90.8   10.0        .100      .0    0         .0
    P-29     J-26      J-27    181.1   10.0        .100      .0    0         .0
    P-30     J-27      J-28    237.3   10.0        .100      .0    0         .0
    P-31     J-47      J-30    258.4   10.0        .100      .0    0         .0
    P-32     J-28      J-47    285.9   10.0        .100      .0    0         .0
    P-33     J-30      J-31    257.2   10.0        .100      .0    0         .0
    P-34     J-31      J-32     79.8   10.0        .100      .0    0         .0
    P-35     J-32      J-33    197.4   10.0        .100      .0    0         .0
    P-36     J-33      J-34     90.9   10.0        .100      .0    0         .0
    P-37     J-34      J-35    267.0   10.0        .100      .0    0         .0
    P-38     J-35      J-23    130.3   10.0        .100      .0    0         .0
    P-39     J-28      J-36    239.1   10.0        .100      .0    0         .0
    P-40     J-36      J-37    238.2   10.0        .100      .0    0         .0
    P-41     J-37      J-38    227.6   10.0        .100      .0    0         .0
    P-42     J-38      J-39    217.4   10.0        .100      .0    0         .0
    P-43     J-39      J-40    243.5   10.0        .100      .0    0         .0
    P-44     J-40      J-41    232.2   10.0        .100      .0    0         .0
    P-45     J-41      J-46    280.5   10.0        .100      .0    0         .0
    P-46     J-42      J-43    198.8   10.0        .100      .0    0         .0
    P-47     J-43      J-44    255.1   10.0        .100      .0    0         .0
    P-48     J-44      J-32    149.7   10.0        .100      .0    0         .0
    P-49     W-60      J-42     57.7    4.0        .100      .0    0         .0
    P-50     W-59      J-41     66.3    4.0        .100      .0    0         .0
```

```
   P-51    W-59     W-54   227.8    4.0      .100      .0   0        .0
   P-52    J-40     W-58    12.3    4.0      .100      .0   0        .0
   P-53    W-58     W-53   221.4    4.0      .100      .0   0        .0
   P-54    W-53     W-48   208.8    4.0      .100      .0   0        .0
   P-55    J-39     W-57    13.8    4.0      .100      .0   0        .0
   P-56    W-57     W-52   239.8    4.0      .100      .0   0        .0
   P-57    J-38     W-56    46.1    4.0      .100      .0   0        .0
   P-58    J-37     W-51    10.4    4.0      .100      .0   0        .0
   P-59    J-36     W-46    16.2    4.0      .100      .0   0        .0
   P-60    W-46     W-47   214.6    4.0      .100      .0   0        .0
   P-61    J-28     W-42    15.9    4.0      .100      .0   0        .0
   P-62    J-30     W-44    16.9    4.0      .100      .0   0        .0
   P-63    J-31     W-45    43.1    4.0      .100      .0   0        .0
   P-64    J-44     W-50   100.4    4.0      .100      .0   0        .0
   P-65    W-50     W-49   227.2    4.0      .100      .0   0        .0
   P-66    J-43     W-55    45.5    4.0      .100      .0   0        .0
   P-67    J-27     W-38    31.9    4.0      .100      .0   0        .0
   P-68    W-38     W-39   242.3    4.0      .100      .0   0        .0
   P-69    J-33     W-41   227.2    4.0      .100      .0   0        .0
   P-70    W-41      W40   210.1    4.0      .100      .0   0        .0
   P-71    J-34     W-37     4.1    4.0      .100      .0   0        .0
   P-72    W-37     W-36   235.2    4.0      .100      .0   0        .0
   P-73    W-36     W-35   231.5    4.0      .100      .0   0        .0
   P-74    J-25     W-33    25.4    4.0      .100      .0   0        .0
   P-75    W-33     W-34   229.7    4.0      .100      .0   0        .0
   P-76    J-24     W-28    20.8    4.0      .100      .0   0        .0
   P-77    W-28     W-29   209.5    4.0      .100      .0   0        .0
   P-78    J-17      W-9    20.0    4.0      .100      .0   0        .0
   P-79    J-29     J-18   193.0   10.0      .100      .0   0        .0
   P-80    J-29     W-10     8.5    4.0      .100      .0   0        .0
   P-81    J-35     W-32   119.5    4.0      .100      .0   0        .0
   P-82    W-32     W-31   195.6    4.0      .100      .0   0        .0
   P-83    W-31     W-30   218.7    4.0      .100      .0   0        .0
   P-84    J-20     W-11    19.8    4.0      .100      .0   0        .0
   P-85    J-21     W-19    50.0    4.0      .100      .0   0        .0
   P-86    W-19     W-15   231.7    4.0      .100      .0   0        .0
   P-87    J-22     W-23   114.8    4.0      .100      .0   0        .0
   P-88    W-23     W-18   153.2    4.0      .100      .0   0        .0
   P-89     J-3     W-24     8.1    4.0      .100      .0   0        .0
   P-90     J-4     W-22   134.5    4.0      .100      .0   0        .0
   P-91     J-5     W-21    64.2    4.0      .100      .0   0        .0
   P-92    W-21     W-17   125.3    4.0      .100      .0   0        .0
   P-93    J-45      J-3    29.0   10.0      .100      .0   0        .0
   P-94    J-45     W-25   244.4    4.0      .100      .0   0        .0
   P-95     J-7     W-27   122.2    4.0      .100      .0   0        .0
   P-96    W-27     W-20   104.8    4.0      .100      .0   0        .0
   P-97     J-8     W-16    30.3    4.0      .100      .0   0        .0
   P-98     J-9     W-12    19.8    4.0      .100      .0   0        .0
   P-99    W-12     W-13   146.3    4.0      .100      .0   0        .0
  P-100    J-11      W-3    23.4    4.0      .100      .0   0        .0
  P-101     W-3      W-6   184.8    4.0      .100      .0   0        .0
  P-102    J-12      W-1   289.4    4.0      .100      .0   0        .0
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  P-103    J-13     W-2   15.4    4.0      .100     .0   0       .0
  P-104     W-2     W-5  176.8    4.0      .100     .0   0       .0
  P-105    J-14     W-4   16.4    4.0      .100     .0   0       .0
  P-106    J-19    W-14   33.3    4.0      .100     .0   0       .0
  P-107    J-15     W-7   62.9    4.0      .100     .0   0       .0
  P-108     W-7     W-8  208.3    4.0      .100     .0   0       .0
  P-109     J-6    W-26  159.0    4.0      .100     .0   0       .0
  P-110    J-46    J-42  117.1   10.0      .100     .0   0       .0
  P-111    J-46     J-1   60.8   10.0      .100     .0   0       .0
  P-112    J-47    W-43   12.5    4.0      .100     .0   0       .0


 ----------------------------------------------------------------
 JUNCTION             NODE             ELEV     DEMAND      FPN
   NAME               TITLE                     (USFU)    PRESSURE
 ----------------------------------------------------------------
       W40                              .00     -20.00
       J-1                              .00        .00
       J-2                              .00        .00
       J-3                              .00        .00
       J-4                              .00        .00
       J-5                              .00        .00
       J-6                              .00        .00
       J-7                              .00        .00
       J-8                              .00        .00
       J-9                              .00        .00
      J-10                              .00        .00
      J-11                              .00        .00
      J-12                              .00        .00
      J-13                              .00        .00
      J-14                              .00        .00
      J-15                              .00        .00
      J-16                              .00        .00
      J-17                              .00        .00
      J-18                              .00        .00
      J-19                              .00        .00
      J-20                              .00        .00
      J-21                              .00        .00
      J-22                              .00        .00
      J-23                              .00        .00
      J-24                              .00        .00
      J-25                              .00        .00
      J-26                              .00        .00
      J-27                              .00        .00
      J-28                              .00        .00
      J-29                              .00        .00
      J-30                              .00        .00
      J-31                              .00        .00
      J-32                              .00        .00
      J-33                              .00        .00
      J-34                              .00        .00
      J-35                              .00        .00
      J-36                              .00        .00
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J-37	.00	.00	
J-38	.00	.00	
J-39	.00	.00	
J-40	.00	.00	
J-41	.00	.00	
J-42	.00	.00	
J-43	.00	.00	
J-44	.00	.00	
J-45	.00	.00	
J-46	.00	.00	
J-47	.00	.00	
R-1	.00	.00	-40.00
W-1	.00	-19.00	
W-2	.00	-19.00	
W-3	.00	-19.00	
W-4	.00	-19.00	
W-5	.00	-19.00	
W-6	.00	-19.00	
W-7	.00	-19.00	
W-8	.00	-20.00	
W-9	.00	-19.00	
W-10	.00	-20.00	
W-11	.00	-20.00	
W-12	.00	-19.00	
W-13	.00	-19.00	
W-14	.00	-20.00	
W-15	.00	-20.00	
W-16	.00	-19.00	
W-17	.00	-20.00	
W-18	.00	-20.00	
W-19	.00	-20.00	
W-20	.00	-19.00	
W-21	.00	-19.00	
W-22	.00	-19.00	
W-23	.00	-19.00	
W-24	.00	-19.00	
W-25	.00	-19.00	
W-26	.00	-19.00	
W-27	.00	-19.00	
W-28	.00	-19.00	
W-29	.00	-20.00	
W-30	.00	-20.00	
W-31	.00	-20.00	
W-32	.00	-19.00	
W-33	.00	-19.00	
W-34	.00	-20.00	
W-35	.00	-20.00	
W-36	.00	-20.00	
W-37	.00	-19.00	
W-38	.00	-19.00	
W-39	.00	-20.00	
W-41	.00	-20.00	

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     W-42                        .00      -19.00
     W-43                        .00      -20.00
     W-44                        .00      -20.00
     W-45                        .00      -19.00
     W-46                        .00      -19.00
     W-47                        .00      -20.00
     W-48                        .00      -20.00
     W-49                        .00      -20.00
     W-50                        .00      -19.00
     W-51                        .00      -19.00
     W-52                        .00      -19.00
     W-53                        .00      -19.00
     W-54                        .00      -19.00
     W-55                        .00      -19.00
     W-56                        .00      -19.00
     W-57                        .00      -19.00
     W-58                        .00      -19.00
     W-59                        .00      -19.00
     W-60                        .00      -19.00

=====================================================================
Set =  0





 ====================  RESULTS FOR THIS SIMULATION FOLLOW  =================


 Solution was obtained in   12 trials
  Flow Accuracy =  .7264E-04[ <  .500E-02]
    RV Accuracy =  .0000E+00[ <  .100E-02]


---------------------------------------------------------------------
     PIPE     NODE     NODE        FLOW     LOSS VELOCITY DENSITY FRICTION AREA
      NO.      #1       #2       (USFU)   (USPU)   (FT/S)  (#/CF ) FACTOR  RATIO
---------------------------------------------------------------------
      P-1      R-1      J-1   -1162.000      .04    12.78      .068   .0169  .020
      P-2      J-1      J-2    -353.306     1.01    12.58      .068   .0193  .020
      P-3      J-2     J-45    -196.351      .05     6.98      .068   .0217  .011
      P-4      J-3      J-4    -158.351      .02     5.63      .068   .0227  .009
      P-5      J-4      J-5    -139.351      .03     4.95      .068   .0233  .008
      P-6      J-5      J-6    -100.351      .02     3.57      .068   .0252  .006
      P-7      J-6      J-7     -81.351      .01     2.89      .068   .0265  .005
      P-8      J-7      J-8     -43.351      .01     1.54      .068   .0311  .002
      P-9      J-8      J-9     -24.351      .00      .87      .068   .0366  .001
     P-10      J-9     J-10      13.649      .00      .48      .068   .0438  .001
     P-11     J-10     J-11     -51.415      .00     1.83      .068   .0297  .003
     P-12     J-11     J-12     -13.415      .00      .48      .068   .0441  .001
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P-13	J-12	J-13	5.585	.00	.20	.068	.0446	.000
P-14	J-13	J-14	43.585	.00	1.55	.068	.0311	.002
P-15	J-14	J-15	62.585	.01	2.22	.068	.0283	.003
P-16	J-15	J-16	101.585	.01	3.61	.068	.0251	.006
P-17	J-16	J-17	6.118	.00	.22	.068	.0690	.000
P-18	J-17	J-29	25.118	.00	.89	.068	.0363	.001
P-19	J-18	J-19	-85.064	.01	3.02	.068	.0262	.005
P-20	J-19	J-10	-65.064	.01	2.31	.068	.0280	.004
P-21	J-18	J-20	130.182	.01	4.63	.068	.0237	.007
P-22	J-20	J-21	150.182	.03	5.34	.068	.0229	.008
P-23	J-21	J-22	190.182	.05	6.76	.068	.0218	.011
P-24	J-22	J-23	229.182	.02	8.15	.068	.0210	.013
P-25	J-23	J-2	156.955	.01	5.58	.068	.0227	.009
P-26	J-16	J-24	95.467	.02	3.39	.068	.0255	.005
P-27	J-24	J-25	134.467	.03	4.78	.068	.0235	.008
P-28	J-25	J-26	173.467	.02	6.16	.068	.0222	.010
P-29	J-26	J-27	173.467	.04	6.16	.068	.0222	.010
P-30	J-27	J-28	212.467	.07	7.55	.068	.0213	.012
P-31	J-47	J-30	92.261	.02	3.28	.068	.0257	.005
P-32	J-28	J-47	72.261	.01	2.57	.068	.0273	.004
P-33	J-30	J-31	112.261	.02	3.99	.068	.0245	.006
P-34	J-31	J-32	131.261	.01	4.67	.068	.0237	.007
P-35	J-32	J-33	-230.227	.07	8.18	.068	.0209	.013
P-36	J-33	J-34	-190.227	.02	6.76	.068	.0218	.011
P-37	J-34	J-35	-131.227	.03	4.66	.068	.0237	.007
P-38	J-35	J-23	-72.227	.01	2.57	.068	.0273	.004
P-39	J-28	J-36	159.205	.04	5.66	.068	.0227	.009
P-40	J-36	J-37	198.205	.06	7.05	.068	.0216	.011
P-41	J-37	J-38	217.205	.07	7.72	.068	.0212	.012
P-42	J-38	J-39	236.205	.08	8.40	.068	.0208	.013
P-43	J-39	J-40	274.205	.11	9.76	.068	.0202	.015
P-44	J-40	J-41	332.205	.15	11.82	.068	.0195	.019
P-45	J-41	J-46	370.205	.23	13.18	.068	.0191	.021
P-46	J-42	J-43	-419.489	.20	14.93	.068	.0186	.023
P-47	J-43	J-44	-400.489	.24	14.25	.068	.0188	.022
P-48	J-44	J-32	-361.489	.12	12.85	.068	.0192	.020
P-49	W-60	J-42	19.000	.02	4.23	.068	.0307	.007
P-50	W-59	J-41	38.000	.08	8.45	.068	.0260	.013
P-51	W-59	W-54	-19.000	.08	4.23	.068	.0307	.007
P-52	J-40	W-58	-58.000	.03	12.90	.068	.0237	.020
P-53	W-58	W-53	-39.000	.26	8.67	.068	.0258	.014
P-54	W-53	W-48	-20.000	.08	4.44	.068	.0303	.007
P-55	J-39	W-57	-38.000	.02	8.45	.068	.0260	.013
P-56	W-57	W-52	-19.000	.08	4.22	.068	.0307	.007
P-57	J-38	W-56	-19.000	.02	4.22	.068	.0307	.007
P-58	J-37	W-51	-19.000	.00	4.22	.068	.0307	.007
P-59	J-36	W-46	-39.000	.02	8.67	.068	.0258	.014
P-60	W-46	W-47	-20.000	.08	4.44	.068	.0303	.007
P-61	J-28	W-42	-19.000	.01	4.22	.068	.0307	.007
P-62	J-30	W-44	-20.000	.01	4.44	.068	.0303	.007
P-63	J-31	W-45	-19.000	.01	4.22	.068	.0307	.007
P-64	J-44	W-50	-39.000	.12	8.67	.068	.0258	.014

P-65	W-50	W-49	-20.000	.08	4.44	.068	.0303	.007
P-66	J-43	W-55	-19.000	.02	4.23	.068	.0307	.007
P-67	J-27	W-38	-39.000	.04	8.66	.068	.0258	.014
P-68	W-38	W-39	-20.000	.09	4.44	.068	.0303	.007
P-69	J-33	W-41	-40.000	.28	8.88	.068	.0257	.014
P-70	W-41	W40	-20.000	.08	4.44	.068	.0303	.007
P-71	J-34	W-37	-59.000	.01	13.11	.068	.0236	.021
P-72	W-37	W-36	-40.000	.29	8.88	.068	.0257	.014
P-73	W-36	W-35	-20.000	.08	4.44	.068	.0303	.007
P-74	J-25	W-33	-39.000	.03	8.66	.068	.0258	.014
P-75	W-33	W-34	-20.000	.08	4.44	.068	.0303	.007
P-76	J-24	W-28	-39.000	.02	8.66	.068	.0258	.014
P-77	W-28	W-29	-20.000	.08	4.44	.068	.0303	.007
P-78	J-17	W-9	-19.000	.01	4.22	.068	.0307	.007
P-79	J-29	J-18	45.118	.00	1.60	.068	.0308	.003
P-80	J-29	W-10	-20.000	.00	4.44	.068	.0303	.007
P-81	J-35	W-32	-59.000	.30	13.10	.068	.0236	.021
P-82	W-32	W-31	-40.000	.24	8.88	.068	.0257	.014
P-83	W-31	W-30	-20.000	.08	4.44	.068	.0303	.007
P-84	J-20	W-11	-20.000	.01	4.44	.068	.0303	.007
P-85	J-21	W-19	-40.000	.06	8.88	.068	.0257	.014
P-86	W-19	W-15	-20.000	.08	4.44	.068	.0303	.007
P-87	J-22	W-23	-39.000	.14	8.66	.068	.0258	.014
P-88	W-23	W-18	-20.000	.06	4.44	.068	.0303	.007
P-89	J-3	W-24	-19.000	.00	4.22	.068	.0307	.007
P-90	J-4	W-22	-19.000	.04	4.22	.068	.0307	.007
P-91	J-5	W-21	-39.000	.08	8.66	.068	.0258	.014
P-92	W-21	W-17	-20.000	.05	4.44	.068	.0303	.007
P-93	J-45	J-3	-177.351	.01	6.30	.068	.0221	.010
P-94	J-45	W-25	-19.000	.08	4.22	.068	.0307	.007
P-95	J-7	W-27	-38.000	.14	8.44	.068	.0260	.013
P-96	W-27	W-20	-19.000	.03	4.22	.068	.0307	.007
P-97	J-8	W-16	-19.000	.01	4.22	.068	.0307	.007
P-98	J-9	W-12	-38.000	.02	8.44	.068	.0260	.013
P-99	W-12	W-13	-19.000	.05	4.22	.068	.0307	.007
P-100	J-11	W-3	-38.000	.03	8.44	.068	.0260	.013
P-101	W-3	W-6	-19.000	.06	4.22	.068	.0307	.007
P-102	J-12	W-1	-19.000	.10	4.22	.068	.0307	.007
P-103	J-13	W-2	-38.000	.02	8.44	.068	.0260	.013
P-104	W-2	W-5	-19.000	.06	4.22	.068	.0307	.007
P-105	J-14	W-4	-19.000	.01	4.22	.068	.0307	.007
P-106	J-19	W-14	-20.000	.01	4.44	.068	.0303	.007
P-107	J-15	W-7	-39.000	.07	8.66	.068	.0258	.014
P-108	W-7	W-8	-20.000	.08	4.44	.068	.0303	.007
P-109	J-6	W-26	-19.000	.05	4.22	.068	.0307	.007
P-110	J-46	J-42	-438.489	.13	15.62	.068	.0185	.025
P-111	J-46	J-1	808.694	.21	28.83	.068	.0167	.045
P-112	J-47	W-43	-20.000	.00	4.44	.068	.0303	.007
R-1	R-1	R-1	-1162.000	.00	.00	.068	.0461	.000

JUNCTION NAME	NODE TITLE	DEMAND (USFU)	PRESSURE (USPU)	PRESSURE (PSIA)	PRESSURE (PSIG)	DENSITY #/CF
W40		-20.00	-38.65	13.30	-1.39	.068
J-1		.00	-39.96	13.25	-1.44	.068
J-2		.00	-38.96	13.29	-1.41	.068
J-3		.00	-38.90	13.29	-1.40	.068
J-4		.00	-38.88	13.29	-1.40	.068
J-5		.00	-38.85	13.29	-1.40	.068
J-6		.00	-38.83	13.30	-1.40	.068
J-7		.00	-38.82	13.30	-1.40	.068
J-8		.00	-38.82	13.30	-1.40	.068
J-9		.00	-38.82	13.30	-1.40	.068
J-10		.00	-38.82	13.30	-1.40	.068
J-11		.00	-38.81	13.30	-1.40	.068
J-12		.00	-38.81	13.30	-1.40	.068
J-13		.00	-38.81	13.30	-1.40	.068
J-14		.00	-38.82	13.30	-1.40	.068
J-15		.00	-38.82	13.30	-1.40	.068
J-16		.00	-38.84	13.29	-1.40	.068
J-17		.00	-38.84	13.29	-1.40	.068
J-18		.00	-38.84	13.29	-1.40	.068
J-19		.00	-38.83	13.30	-1.40	.068
J-20		.00	-38.85	13.29	-1.40	.068
J-21		.00	-38.88	13.29	-1.40	.068
J-22		.00	-38.92	13.29	-1.40	.068
J-23		.00	-38.94	13.29	-1.41	.068
J-24		.00	-38.85	13.29	-1.40	.068
J-25		.00	-38.88	13.29	-1.40	.068
J-26		.00	-38.90	13.29	-1.40	.068
J-27		.00	-38.94	13.29	-1.40	.068
J-28		.00	-39.01	13.29	-1.41	.068
J-29		.00	-38.84	13.29	-1.40	.068
J-30		.00	-39.04	13.29	-1.41	.068
J-31		.00	-39.06	13.29	-1.41	.068
J-32		.00	-39.07	13.29	-1.41	.068
J-33		.00	-39.01	13.29	-1.41	.068
J-34		.00	-38.98	13.29	-1.41	.068
J-35		.00	-38.95	13.29	-1.41	.068
J-36		.00	-39.05	13.29	-1.41	.068
J-37		.00	-39.11	13.28	-1.41	.068
J-38		.00	-39.18	13.28	-1.41	.068
J-39		.00	-39.26	13.28	-1.42	.068
J-40		.00	-39.38	13.28	-1.42	.068
J-41		.00	-39.53	13.27	-1.43	.068
J-42		.00	-39.63	13.27	-1.43	.068
J-43		.00	-39.43	13.27	-1.42	.068
J-44		.00	-39.19	13.28	-1.41	.068
J-45		.00	-38.91	13.29	-1.40	.068
J-46		.00	-39.76	13.26	-1.43	.068
J-47		.00	-39.02	13.29	-1.41	.068

R-1	.00	-40.00	13.25	-1.44	.068
W-1	-19.00	-38.72	13.30	-1.40	.068
W-2	-19.00	-38.79	13.30	-1.40	.068
W-3	-19.00	-38.79	13.30	-1.40	.068
W-4	-19.00	-38.81	13.30	-1.40	.068
W-5	-19.00	-38.74	13.30	-1.40	.068
W-6	-19.00	-38.72	13.30	-1.40	.068
W-7	-19.00	-38.75	13.30	-1.40	.068
W-8	-20.00	-38.67	13.30	-1.40	.068
W-9	-19.00	-38.83	13.30	-1.40	.068
W-10	-20.00	-38.83	13.29	-1.40	.068
W-11	-20.00	-38.84	13.29	-1.40	.068
W-12	-19.00	-38.79	13.30	-1.40	.068
W-13	-19.00	-38.74	13.30	-1.40	.068
W-14	-20.00	-38.82	13.30	-1.40	.068
W-15	-20.00	-38.73	13.30	-1.40	.068
W-16	-19.00	-38.81	13.30	-1.40	.068
W-17	-20.00	-38.73	13.30	-1.40	.068
W-18	-20.00	-38.73	13.30	-1.40	.068
W-19	-20.00	-38.82	13.30	-1.40	.068
W-20	-19.00	-38.65	13.30	-1.39	.068
W-21	-19.00	-38.78	13.30	-1.40	.068
W-22	-19.00	-38.84	13.29	-1.40	.068
W-23	-19.00	-38.79	13.30	-1.40	.068
W-24	-19.00	-38.90	13.29	-1.40	.068
W-25	-19.00	-38.83	13.30	-1.40	.068
W-26	-19.00	-38.78	13.30	-1.40	.068
W-27	-19.00	-38.69	13.30	-1.40	.068
W-28	-19.00	-38.83	13.30	-1.40	.068
W-29	-20.00	-38.75	13.30	-1.40	.068
W-30	-20.00	-38.33	13.31	-1.38	.068
W-31	-20.00	-38.41	13.31	-1.39	.068
W-32	-19.00	-38.65	13.30	-1.39	.068
W-33	-19.00	-38.85	13.29	-1.40	.068
W-34	-20.00	-38.77	13.30	-1.40	.068
W-35	-20.00	-38.60	13.30	-1.39	.068
W-36	-20.00	-38.68	13.30	-1.40	.068
W-37	-19.00	-38.97	13.29	-1.41	.068
W-38	-19.00	-38.90	13.29	-1.40	.068
W-39	-20.00	-38.81	13.30	-1.40	.068
W-41	-20.00	-38.73	13.30	-1.40	.068
W-42	-19.00	-39.00	13.29	-1.41	.068
W-43	-20.00	-39.02	13.29	-1.41	.068
W-44	-20.00	-39.03	13.29	-1.41	.068
W-45	-19.00	-39.05	13.29	-1.41	.068
W-46	-19.00	-39.03	13.29	-1.41	.068
W-47	-20.00	-38.95	13.29	-1.41	.068
W-48	-20.00	-39.01	13.29	-1.41	.068
W-49	-20.00	-38.99	13.29	-1.41	.068
W-50	-19.00	-39.07	13.29	-1.41	.068
W-51	-19.00	-39.11	13.28	-1.41	.068
W-52	-19.00	-39.17	13.28	-1.41	.068

```
      W-53                     -19.00     -39.09     13.29     -1.41     .068
      W-54                     -19.00     -39.38     13.28     -1.42     .068
      W-55                     -19.00     -39.41     13.27     -1.42     .068
      W-56                     -19.00     -39.17     13.28     -1.41     .068
      W-57                     -19.00     -39.25     13.28     -1.42     .068
      W-58                     -19.00     -39.35     13.28     -1.42     .068
      W-59                     -19.00     -39.46     13.27     -1.42     .068
      W-60                     -19.00     -39.61     13.27     -1.43     .068

  * This designates the use of default density in a low pressure region



  THE NET SYSTEM DEMAND (USFU) =    -1162.000

  SUMMARY OF INFLOWS(+).AND.OUTFLOWS(-) :
  ----------------------------------------------------------
      NAME      FLOW (USFU)          FPN TITLE
  ----------------------------------------------------------
      R-1       -1162.0                                R-1


  MAXIMUM MACH NUMBER =   .03 IN LINE NO.P-111

  --------------------------------------------------------
  SUMMARY OF MINIMUM.AND.MAXIMUM VELOCITIES (FT/S)
  --------------------------------------------------------
        MINIMUM          MAXIMUM
  ----------------------------------------------
 R-1          .00  P-111       28.83
 P-13         .20  P-110       15.62
 P-17         .22  P-46        14.93
 P-12         .48  P-47        14.25
 P-10         .48  P-45        13.18


  --------------------------------------------------------
  SUMMARY OF MINIMUM.AND.MAXIMUM LOSS/1000. (PSI )
  --------------------------------------------------------
        MINIMUM          MAXIMUM
  ----------------------------------------------
 R-1          .00  P-111         .12
 P-13         .00  P-71          .09
 P-17         .00  P-81          .09
 P-12         .00  P-52          .09
 P-10         .00  P-69          .04


  -----------------------------------------------------
  SUMMARY OF MINIMUM.AND.MAXIMUM PRESSURES (USPU)
  -----------------------------------------------------
        MINIMUM          MAXIMUM
```

```
 ----------------------------------------
R-1      -40.00  W-30       -38.33
J-1      -39.96  W-31       -38.41
J-46     -39.76  W-35       -38.60
J-42     -39.63  W40        -38.65
W-60     -39.61  W-20       -38.65



 *************************    END OF KYGAS SIMULATION   ************************


 DATE FOR THIS COMPUTER RUN       : 11-27-2017
 START TIME FOR THIS COMPUTER RUN : 18:46: 6:37
```

Computation

Job No. 10028442

Project Rowan County Landfill

Computed MKD

Subject Flare Installation

Checked EJL

Task Potential to Emit Calculation

Sheet 1 of 1

NMOC (ppmv as hexane) =	595	*Fifth Edition AP-42, Section 2.4 (11/98) default values for landfills with no co-disposal of industrial waste*
Maximum LFG flow to flare (cfm) =	1500	*Flare Vendor*
LFG methane concentration =	55%	*Fifth Edition AP-42, Section 2.4 (11/98) default value*
Maximum methane flow to flare (cfm) =	825	*Methane Concentration * Flow Rate*
Maximum methane flow to flare (m^3/hr) =	1402	
Flare Control Efficiencies for LFG Constituents =	98%	*Fifth Edition AP-42, Section 2.4 (11/98), minimum typical value listed for a flare*
Flare Operating Time =	24 8760	*Hours per day* *Hours per year*
PM/PM_{10}/$PM_{2.5}$ emission factor (lb/10^6 dscf CH4) =	17	*Fifth Edition AP-42, Table 2.4-5 (11/98), assumes PM = PM_{10} = $PM_{2.5}$*
NO_x emission factor (lb/10^6 dscf CH4) =	40	*Fifth Edition AP-42, Table 2.4-5 (11/98)*
CO emission factor (lb/10^6 dscf CH4) =	750	*Fifth Edition AP-42, Table 2.4-5 (11/98)*
Portion of NMOC that is VOC (%) =	39%	*Fifth Edition AP-42,Table 2.4-2 (11/98), footnote c*
Concentration of sulfur containing compounds in LFG (ppmv) =	46.9	*Fifth Edition AP-42, Section 2.4.4.2 (11/98) default value*
Concentration of chlorine containing compounds in LFG (ppmv) =	42.0	*Fifth Edition AP-42, Section 2.4.4.2 (11/98) default value*

Pollutant	***Classification***	***CAS Number***	**Concentration [1]**	***Molecular Weight [1]***	***Potential Flare Emissions (SCC 50200410)***				
					Volumetric Basis [2]	*Mass Basis [3]*			
			ppmv	g/mol	m^3/hr	kg/hr	lb/hr	lb/day	ton/yr
PM/PM_{10}/$PM_{2.5}$	Criteria						0.84	20.2	3.69
SO_2	Criteria		46.9	64	0.12	0.31	0.69	16.6	3.02
NO_x	Criteria						1.98	47.5	8.7
CO	Criteria						37.1	891	163
VOC	Criteria						0.09	2.21	0.40
NMOC			595.0	86.18	0.030	0.11	0.24	5.66	1.03
Compounds Produced By Landfill And Controlled By Flare (i.e. no net increase in emissions because of proposed flare)									
1,1,1-Trichloroethane (methyl chloroform)	HAP/TAP	71-55-6	0.48	133.41	2.45E-05	1.34E-04	2.95E-04	7.07E-03	1.29E-03
1,1,2,2-Tetrachloroethane	HAP/TAP	79-34-5	1.11	167.85	5.66E-05	3.89E-04	8.57E-04	2.06E-02	3.75E-03
1,1-Dichloroethane (ethylidene dichloride)	HAP	75-34-3	2.35	98.97	1.20E-04	4.85E-04	1.07E-03	2.57E-02	4.69E-03
1,1-Dichloroethene (vinylidene chloride)	HAP/TAP	75-35-4	0.20	96.94	1.02E-05	4.05E-05	8.92E-05	2.14E-03	3.91E-04
1,2-Dichloroethane (ethylene dichloride)	HAP/TAP	107-06-2	0.41	98.96	2.09E-05	8.47E-05	1.87E-04	4.48E-03	8.18E-04
1,2-Dichloropropane (propylene dichloride)	HAP	78-87-5	0.18	112.99	9.18E-06	4.24E-05	9.36E-05	2.25E-03	4.10E-04
Acrylonitrile	HAP/TAP	107-13-1	6.33	53.06	3.23E-04	7.01E-04	1.55E-03	3.71E-02	6.77E-03
Benzene - No or Unknown Co-disposal	HAP/TAP	71-43-2	1.91	78.11	9.75E-05	3.11E-04	6.86E-04	1.65E-02	3.01E-03
Carbon disulfide	HAP/TAP	75-15-0	0.58	76.13	2.96E-05	9.21E-05	2.03E-04	4.88E-03	8.90E-04
Carbon tetrachloride	HAP/TAP	56-23-5	0.004	153.84	2.04E-07	1.28E-06	2.83E-06	6.79E-05	1.24E-05
Carbonyl sulfide	HAP	463-58-1	0.49	60.07	2.50E-05	6.14E-05	1.35E-04	3.25E-03	5.93E-04
Chlorobenzene	HAP/TAP	108-90-7	0.25	112.56	1.28E-05	5.87E-05	1.29E-04	3.11E-03	5.67E-04
Chloroethane (ethyl chloride)	HAP	75-00-3	1.25	64.52	6.38E-05	1.68E-04	3.71E-04	8.90E-03	1.63E-03
Chloroform	HAP/TAP	67-66-3	0.03	119.39	1.53E-06	7.47E-06	1.65E-05	3.95E-04	7.22E-05
Chloromethane	HAP	74-87-3	1.21	50.49	6.17E-05	1.27E-04	2.81E-04	6.75E-03	1.23E-03
Dichlorobenzene - para isomer	HAP/TAP	106-46-7	0.21	147	1.07E-05	6.44E-05	1.42E-04	3.41E-03	6.22E-04
Dichlorodifluoromethane	TAP	75-71-8	15.7	120.91	8.01E-04	3.96E-03	8.73E-03	2.10E-01	3.82E-02
Dichlorofluoromethane	TAP	75-43-4	2.62	102.92	1.34E-04	5.63E-04	1.24E-03	2.98E-02	5.43E-03
Dichloromethane (methylene chloride)	HAP/TAP	75-09-2	14.3	84.94	7.30E-04	2.53E-03	5.59E-03	1.34E-01	2.45E-02
Ethyl mercaptan (ethanethiol)	HAP/TAP	75-08-1	2.28	62.13	1.16E-04	2.96E-04	6.52E-04	1.56E-02	2.85E-03
Ethylbenzene	HAP	100-14-4	4.61	106.16	2.35E-04	1.02E-03	2.25E-03	5.40E-02	9.86E-03
Ethylene dibromide	HAP/TAP	106-93-4	0.001	187.88	5.10E-08	3.92E-07	8.64E-07	2.07E-05	3.79E-06
Fluorotrichloromethane (Trichlorofluoromethane)	TAP	75-69-4	2.62	102.92	1.34E-04	5.63E-04	1.24E-03	2.98E-02	5.43E-03
Hexane	HAP/TAP	110-54-3	6.57	86.18	3.35E-04	1.18E-03	2.60E-03	6.25E-02	1.14E-02
Hydrogen sulfide	HAP/TAP	7783-06-4	35.5	34.08	1.81E-03	2.52E-03	5.57E-03	1.34E-01	2.44E-02
Methyl ethyl ketone	TAP	78-93-3	7.09	72.11	3.62E-04	1.07E-03	2.35E-03	5.64E-02	1.03E-02
Methyl isobutyl ketone	HAP/TAP	108-10-1	1.87	100.16	9.54E-05	3.91E-04	8.62E-04	2.07E-02	3.77E-03
Methyl mercaptan	HAP/TAP	74-93-1	2.49	48.11	1.27E-04	2.50E-04	5.51E-04	1.32E-02	2.41E-03
Perchloroethylene (tetrachloroethylene)	HAP/TAP	127-18-4	3.73	165.83	1.90E-04	1.29E-03	2.85E-03	6.83E-02	1.25E-02
Toluene - No or Unknown Co-disposal	HAP/TAP	108-88-3	39.3	92.13	2.01E-03	7.56E-03	1.67E-02	4.00E-01	7.30E-02
Trichloroethylene (trichloroethene)	HAP/TAP	79-01-6	2.82	131.4	1.44E-04	7.73E-04	1.70E-03	4.09E-02	7.47E-03
Vinyl chloride	HAP/TAP	75-01-4	7.34	62.5	3.74E-04	9.57E-04	2.11E-03	5.06E-02	9.24E-03
Xylenes	HAP/TAP	1330-20-7	12.1	106.16	6.17E-04	2.68E-03	5.91E-03	1.42E-01	2.59E-02
Compounds Produced By Landfill And Not Controlled By Flare (i.e. no net increase in emissions because of proposed flare)									
Mercury (total)	HAP/TAP		2.92E-04	200.61	7.45E-07	6.11E-06	1.35E-05	3.23E-04	5.90E-05
Compounds Produced By Flare (i.e., new compound emitted by the flare)									
Hydrogen chloride	HAP/TAP	7647-01-0	42.0	36.46	0.11	0.16	0.35	8.5	1.54
Total HAP [4]	HAP/TAP						0.41	9.7	1.78

---

[1] Fifth Edition AP-42, Tables 2.4-1 and 2.4-2 (11/98) default values.

[2] Calculated using Fifth Edition AP-42, Equation (3) [11/98], including flare control efficiency except as noted.

[3] Calculated using Fifth Edition AP-42, Equation (4) [11/98].

[4] The total HAP emissions were calculated by summing each HAP constituent.

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C

Appendix C - Surface Emissions Monitoring Plan

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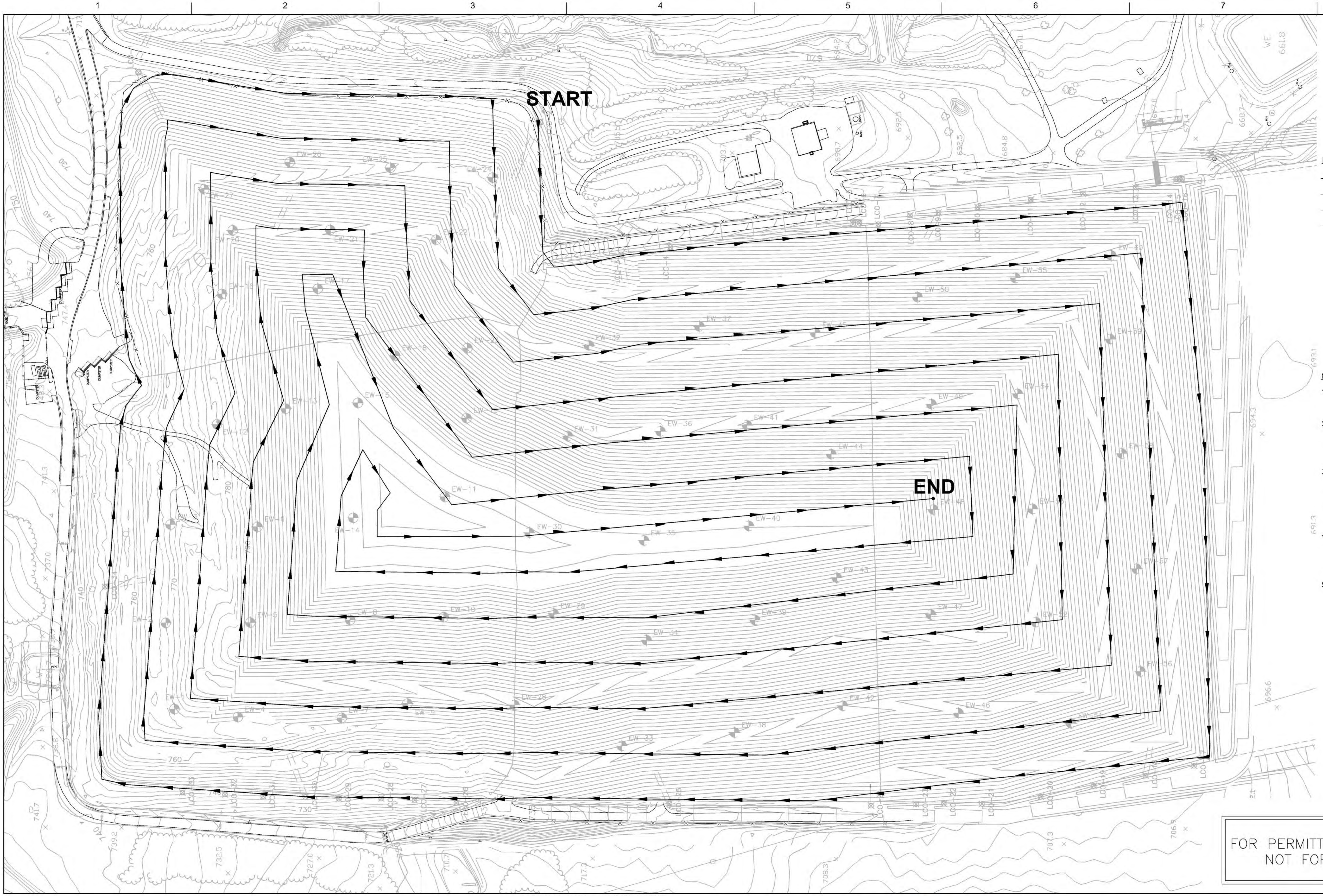

LEGEND

──►	MONITORING PATH
──	EXISTING MAJOR CONTOUR
──	EXISTING MINOR CONTOUR
──	PROPOSED HEADER AND LATERAL PIPE
EW-27	PROPOSED GAS EXTRACTION WELL
☐	PROPOSED VALVE BOX
(DL)	PROPOSED DRIP LINE
(AP)	PROPOSED ACCESS POINT

NOTES:

1. EXISTING TOPOGRAPHY PROVIDED BY SANBORN AERIAL PHOTOGRAPHY DATED MARCH 10, 2002.
2. PROPERTY LINE BY JAMES T. HILL PLS L–2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
3. SURFACE EMISSIONS MONITORING PATHWAY REPRESENTS FINAL GRADE CONDITIONS. INTERIM PATHWAYS WILL BE MONITORED BASED UPON THE SEQUENCE AND EXTENT OF WASTE PLACEMENT AND GCCS DEVELOPMENT IN ACCORDANCE WITH NSPS REGULATIONS.
4. TYPICAL SPACING FOR THE MONITORING PATH IS APPROXIMATELY 30 METERS (98 FEET). SOME LOCAL VARIATION MAY OCCUR TO ACCOMODATE FIELD CONDITION AT THE TIME OF MONITORING.
5. MONITORING TO BE PERFORMED IN ACCORDANCE WITH 40 CFR 60.755 (C).

FOR PERMITTING PURPOSES ONLY
NOT FOR CONSTRUCTION

HDR Engineering, Inc. of the Carolinas
440 S. Church Street, Suite 1000
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. License Number: F-0116

ISSUE	DATE	DESCRIPTION
C	11/2017	REVISED PER NCDEQ-DAQ COMMENTS
B	10/2017	REVISED PER NCDEQ-DAQ COMMENTS
A	06/2016	ISSUED FOR REVIEW

PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	C. KOEHLER, P.E.
DRAWN BY	Z. PRIESTER
PROJECT NUMBER	10030178

ROWAN COUNTY

Rowan County Landfill
Landfill Gas Collection
and Control System
789 Campbell Road
Woodleaf, NC 27054
NORTH CAROLINA

SURFACE EMISSIONS MONITORING PLAN

0 1" 2"

FILENAME SEM.DWG
SCALE 1"=100'

SHEET
SEM

C:\pwworking\tpa\d1120099\SEM.dwg, 11/22/2017 4:31:19 PM, Bluebeam PDF

D

Appendix D - County Consistency Determination Letter

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Rowan County Planning and Development Department
402 North Main Street ▪ Room 204 ▪ Salisbury, N.C. 28144-4341
Phone: 704-216-8588 ▪ Fax: 704-638-3130

ZONING CONSISTENCY DETERMINATION

July 21, 2016

RE: Rowan County Landfill Gas Collection / Control System

To Whom It May Concern:

The Rowan County Landfill located at 789 Campbell Road is located in Rowan County's planning jurisdiction and therefore subject to the County's subdivision and zoning ordinances. The proposed addition of a gas collection / control system is consistent with operation of the facility at this location and does not create a subdivision or zoning violation(s).

Questions or comments related to this determination or zoning standards should be directed to my office at 704-216-8588.

Respectfully,

Ed Muire, AICP, CFM
Planning Director

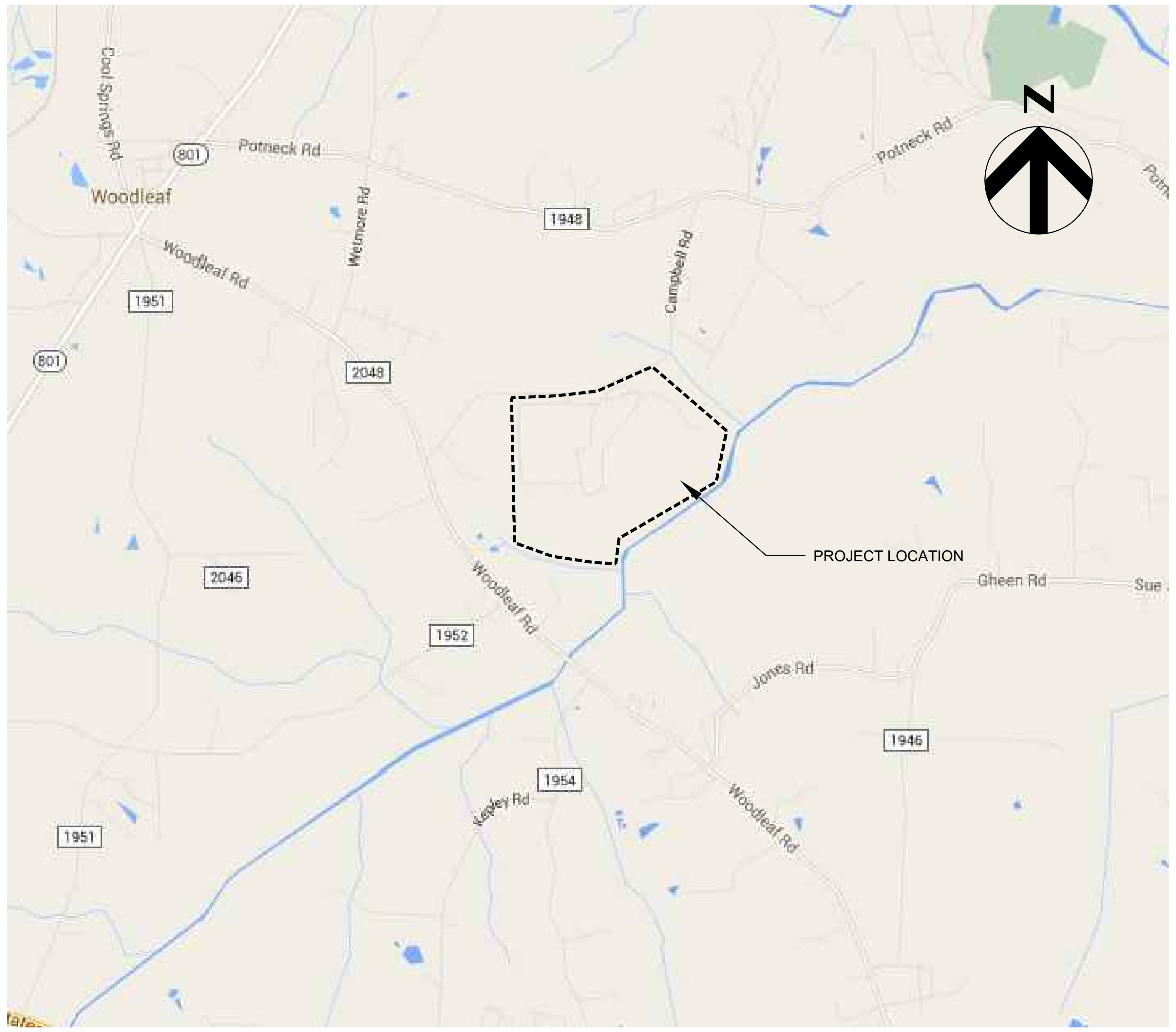
cc via email: Caleb Sinclair, Rowan County Environmental Management

ATTACHMENT B

Rowan LFG 2024 Expansion (Issued for Construction Drawing Set)

APRIL 12, 1753

HDR Engineering, Inc. of the Carolinas
440 S. Church St.
Suite 1200
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. F-0116



VICINITY MAP: ROWAN COUNTY, WOODLEAF, NC
NOT TO SCALE

Rowan County

Rowan LFG
2024 Expansion

Project No.
10335518

789 Campbell Road
Woodleaf, NC 27054

Issued for Construction
July 2024

INDEX OF DRAWINGS

GENERAL LEGEND

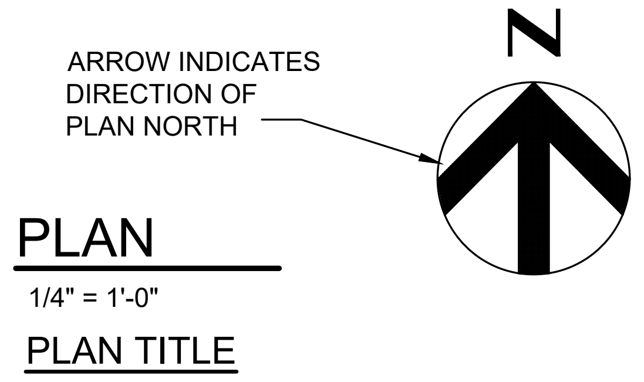
○ EX-14	EXISTING VERTICAL EXTRACTION WELL
○	EXISTING OVERHEAD ELECTRIC POLES
(DL)	CONDENSATE TRAP DRIP LEG
⊥	BLIND FLANGE (SIZE VARIES)
⋈	EXISTING VALVE (SIZE VARIES)
▷	EXISTING HDPE REDUCER (SIZE VARIES)
⊗	EXISTING LEACHATE CLEANOUT
▭	EXISTING BUILDING
(AP)	PROPOSED HEADER ACCESS POINT
⊕ EX-14	PROPOSED WELLHEAD
(S)	PROPOSED CONDENSATE SUMP
— — — — — —	PROPOSED HDPE 4" LATERAL
———————	PROPOSED HDPE 10" HEADER
— · — · — · —	PROPOSED HDPE 6" LATERAL
——— OHE ———	EXISTING OVERHEAD ELECTRIC LINE
——— X ———	EXISTING FENCE LINE
— L — L — L — L —	EXISTING LEACHATE COLLECTION LINE
▬ ▬ ▬ ▬ ▬	EXISTING CELL BOUNDARY
——— 780 ———	EXISTING MAJOR/MINOR CONTOURS
= = = = = =	EXISTING UNPAVED ROAD
═══════	EXISTING PAVED ROAD

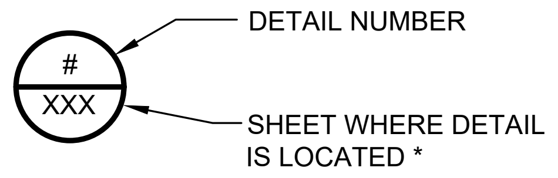
PATTERNS

CLEAN BACKFILL	▩
CONCRETE	░
INTERMEDIATE COVER	▨
GRAVEL	▒
WASTE	▭
EXISTING GROUND	▧
COMPACTED STRUCTURAL FILL	▦
PIPE BEDDING (DEFINED AS FIELD COMPACTED AND LEVELED BACKFILL OR EQ.)	▤

NOTE:
SYMBOLOGY IS REPRESENTATIVE OF MAJOR LANDFILL GAS COMPONENTS.

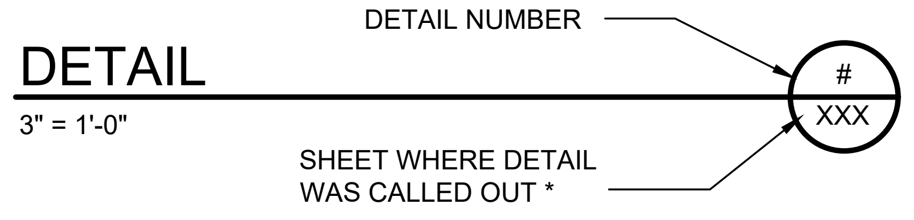
GENERAL SYMBOLOGY





DETAIL MARKER

FOR REFERENCING DETAILS INCLUDED IN DRAWING SET.



SURVEY

1. TOPOGRAPHY OUTSIDE THE LANDFILL AREA PROVIDED BY SANBORN OF AERIAL PHOTOGRAPHY DATED MARCH 10, 2002.
2. TOPOGRAPHY FOR EXISTING PHASES I. II, III, IV AND FUTURE PHASE V PROVIDED BY CARTOGRAPHIC AERIAL MAPPING, DATED MAY 4, 2023.
3. APPROXIMATE LOCATIONS OF LEACHATE CLEANOUTS BASED ON PHASE III AS-BUILTS AND EXISTING SITE CONDITION DRAWINGS PROVIDED BY S&ME.
4. HORIZONTAL DATUM: NAD-83 (2007), ZONE 3200, N.C. STATE PLANE COORDINATES, FEET. VERTICAL DATUM: NAVD-88, FEET

SPECIFIC NOTES

1. HOURS FOR CONSTRUCTION: 7:30 AM TO 4:00 PM MONDAY THRU FRIDAY, 8 AM TO 2 PM SATURDAY, NO WORK ALLOWED ON SUNDAY UNLESS OTHERWISE APPROVED BY OWNER AND PERMIT.
2. THESE HOURS ARE SUBJECT TO CHANGE SHOULD THE LANDFILL RECEIVE NOISE COMPLAINTS FROM THE NEIGHBORS.
3. CONTRACTOR MAY CONTAINERIZE WASTE AND TARP OVERNIGHT BASED ON OWNER APPROVAL.
4. EXCAVATED WASTE CAN BE PLACED AT THE WORKING FACE.

EROSION AND SEDIMENT CONTROL

1. CONTRACTOR WILL ADD EROSION AND SEDIMENT MEASURES AS NECESSARY TO PREVENT SEDIMENTATION AND DAMAGE TO ADJACENT AREAS AND AS DIRECTED BY THE OWNER'S REPRESENTATIVE.
2. CONTRACTOR WILL MAINTAIN AND REPAIR, AS NECESSARY, ANY EROSION AND SEDIMENT CONTROL DAILY AND FOLLOWING EACH RAIN.
3. EROSION AND SEDIMENT CONTROL WILL BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE MAINTAINED UNTIL PERMANENT GROUND COVER IS ESTABLISHED.
4. CONTRACTOR IS RESPONSIBLE FOR MONITORING DOWNSTREAM CONDITIONS THROUGHOUT THE CONSTRUCTION PERIOD AND CLEARING ANY DEBRIS AND SEDIMENT RESULTING FROM CONSTRUCTION.
5. ADDITIONAL EROSION AND SEDIMENT CONTROL MEASURES WILL BE INSTALLED IF DEEMED NECESSARY BY ON-SITE INSPECTION OF THE OWNER AND ENGINEER.
6. SILT FENCE, CHECK DAMS AND OTHER EROSION CONTROL & SEDIMENT CONTROL FEATURES TO BE CONSTRUCTED IN ACCORDANCE WITH NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES EROSION & SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

EARTHWORK

1. EXCAVATION IS UNCLASSIFIED AND INCLUDES REMOVAL OF EARTH FILLS, RUBBLE, TRASH, AND OTHER MATERIALS ENCOUNTERED IN EXCAVATION AND GRADING OPERATIONS TO DEPTH AND EXTENT SHOWN ON DRAWINGS OR SPECIFIED. THE OWNER'S REPRESENTATIVE SHALL BE THE FINAL AUTHORITY AND SHALL MAKE THE FINAL DECISION DURING CONSTRUCTION AS TO THE DEPTH AND EXTENT TO WHICH MATERIALS MUST BE REMOVED AND REPLACED.
2. SURVEY BENCHMARKS, MONUMENTS AND OTHER REFERENCE POINTS WILL BE PROTECTED FROM DAMAGE AND DISPLACEMENT. IF DISTURBED OR DESTROYED, THEY WILL BE REPLACED AT THE CONTRACTOR'S EXPENSE.
3. CONTRACTOR SHALL KEEP DIRT, DUST, NOISE AND OTHER OBJECTIONABLE NUISANCES TO A MINIMUM.
4. ALL FILL AREAS ARE TO BE COMPACTED AS DEFINED IN THE SPECIFICATIONS.

UTILITIES

1. THERE MAY BE OTHER UTILITIES NOT SHOWN ON THESE PLANS. THE ENGINEER ASSUMES NO RESPONSIBILITY FOR LOCATIONS SHOWN AND IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THE LOCATIONS OF ALL UTILITIES WITHIN THE LIMITS OF THE WORK PRIOR TO CONSTRUCTION.
2. ALL DAMAGE MADE TO EXISTING UTILITIES SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.
3. THE CONTRACTOR SHALL NOTIFY ALL UTILITY COMPANIES IN THE AREA AT LEAST 72 HOURS PRIOR TO BEGINNING CONSTRUCTION. ALL COORDINATION AND REQUIRED UTILITY COMPANY TEMPORARY PROTECTION SHALL BE AT THE CONTRACTOR'S EXPENSE.
4. IT IS THE CONTRACTOR'S RESPONSIBILITY TO ENSURE UNINTERRUPTION OF SERVICE AND REPLACEMENT OF DAMAGED UTILITIES.

AS-BUILT SURVEY DATA

1. IF SURVEY TUBES ARE USED THE CONTRACTOR SHALL BE RESPONSIBLE FOR MINIMIZING LANDFILL GAS EMISSIONS FROM SURVEY TUBES (E.G. SEAL TOP OF SURVEY TUBES).
2. THE CONTRACTOR SHALL PROVIDE SURVEY DATA TO THE ENGINEER SHOWING THE LANDFILL GAS SYSTEM HAS BEEN PROPERLY CONSTRUCTED AND MEETS THE MINIMUM SLOPES REQUIRED AS SHOWN ON THE DRAWINGS.
3. THE SURVEY DATA SUBMITTED TO THE ENGINEER SHALL BE GROUND SURFACE ELEVATIONS AND TOP OF PIPE ELEVATIONS AT 50 FOOT INTERVALS ON CENTER AND AT EACH FITTING, LATERAL CONNECTION, VALVE, BENDS AND OTHER SIGNIFICANT FEATURES
4. ALL REQUESTED SURVEY DATA MUST BE PROVIDED TO OWNER'S REPRESENTATIVE IN NORTH CAROLINA STATE PLANE COORDINATES AND BE PERFORMED BY A STATE OF NORTH CAROLINA CERTIFIED SURVEYOR.
5. REFER TO SPECIFICATION SECTION 01 32 23 FOR ADDITIONAL INFORMATION.

GENERAL NOTES

1. CONTRACTOR SHALL FIELD VERIFY ALL EXISTING SITE CONDITIONS PRIOR TO COMMENCING WORK.
2. PRIOR TO INITIATING WORK, THE CONTRACTOR SHALL SUBMIT FOR APPROVAL A SCHEDULE TO THE ENGINEER FOR THE PROJECT.
3. THE CONTRACTOR SHALL RESTORE TO THE OWNER'S SATISFACTION ALL AREAS DISTURBED BY CONSTRUCTION; INCLUDING PERIMETER ROADWAY SURFACES, ROADWAY SHOULDERS AND DITCHES, DRAINAGE STRUCTURES, LANDFILL SLOPES AND OTHER EXISTING FEATURES.
4. THESE DRAWINGS ACCOMPANY AND ARE PART OF THE TECHNICAL SPECIFICATIONS. ANY CONFLICTS BETWEEN THESE PLANS, SPECIFICATIONS, AND THE PERMIT SHOULD BE BROUGHT TO THE ATTENTION OF THE DESIGN ENGINEER (HDR ENGINEERING, INC. OF THE CAROLINAS).
5. ATTENTION IS DIRECTED TO THE FACT THAT AN ACTIVE LANDFILL AND OTHER FACILITIES WILL BE IN OPERATION DURING THE CONSTRUCTION PERIOD. WASTE HAULING TRUCKS WILL BE ACTIVE AT THE LANDFILL. THE CONTRACTOR SHALL NOT BLOCK WASTE HAULING OR LANDFILL OPERATIONS. IF NECESSARY, CONTRACTOR SHALL PROVIDE TRAFFIC CONTROL TO MAINTAIN LANDFILL ACTIVITIES.
6. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR SITE SAFETY ASSOCIATED WITH THE WORK UNDER THIS CONTRACT AND FOR COMPLIANCE WITH ALL FEDERAL, STATE, AND LOCAL HEALTH AND SAFETY LAWS, CODES, REGULATIONS AND ORDINANCES INCLUDING BUT NOT LIMITED TO THOSE MANDATED BY OSHA.
7. CONTRACTOR WILL BE RESPONSIBLE FOR DEWATERING ALL EXCAVATIONS. EXCAVATIONS WITHIN THE LANDFILL AREA MAY ENCOUNTER LEACHATE. CONTRACTOR SHALL TAKE ALL SAFETY AND ENVIRONMENTAL PRECAUTIONS TO PROTECT IT'S WORKERS AND SUBCONTRACTORS AT NO ADDITIONAL COST TO THE OWNER. COLLECTED LEACHATE MAY BE DISPOSED INTO THE LEACHATE COLLECTION SYSTEM.
8. CONTRACTOR MUST HAVE AN EMPLOYEE AVAILABLE ONSITE TO HANDLE ALL DELIVERIES AND OFF LOADING.

10. PROJECT SITE IS A SOLID WASTE LANDFILL AS SUCH, CONDITIONS ARE SUBJECT TO CHANGE WITH TIME. CONTROLS, IN PARTICULAR VERTICAL CONTROL, SHOULD BE EXPECTED (AND ANTICIPATED) TO VARY FROM THOSE SHOWN ON THESE DRAWINGS DUE TO ONGOING SUBSIDENCE RESULTING FROM REFUSE DECOMPOSITION. RELATIVE ELEVATION DIFFERENCES IN EXISTING AND PROPOSED ELEVATIONS SHOWN ON THE DRAWINGS SHALL BE ADJUSTED ACCORDINGLY. LOCATION OF STRUCTURES SHALL BE PLACED IN ACCORDANCE WITH HORIZONTAL CONTROLS. VERTICAL PLACEMENT OF STRUCTURES SHALL BE IN ACCORDANCE WITH CONSTRUCTION DOCUMENTS, OR AS APPROVED BY THE ENGINEER.
11. CONSTRUCTION OF LANDFILL GAS COLLECTION SYSTEM WILL INVOLVE REFUSE EXCAVATION. THE CONTRACTOR SHALL MAKE ALL SAFETY AND ENVIRONMENTAL PRECAUTIONS TO PROTECT ITS WORKERS AND SUBCONTRACTORS, AT NO ADDITIONAL COST TO THE OWNER. CONTRACTOR IS ADVISED THAT THE POTENTIAL FOR ENCOUNTERING ASBESTOS CONTAINING MATERIAL EXISTS. SHOULD SUSPECT ASBESTOS-CONTAINING MATERIAL BE ENCOUNTERED, IT SHALL BE MAINTAINED IN A MOIST CONDITION DURING THE REMOVAL AND TRANSFER PROCESS TO MINIMIZE/PREVENT EMISSIONS FROM SUCH.
12. ANY AND ALL FINES IMPOSED ON THE OWNER BY ANY REGULATORY AGENCY DUE TO ACTIONS OF THE CONTRACTOR SHALL BE PAID BY THE CONTRACTOR.
13. PROTECTIONS: INSTALL TEMPORARY BARRIERS, FENCES, BARRICADES, LIGHTS, WARNING SIGNS AND OTHER DEVICES NECESSARY TO PROTECT STRUCTURES, UTILITIES, LANDSCAPING, EXCAVATIONS, AND OTHER ITEMS AS NECESSARY. PROTECT SURVEY BENCHMARKS AND MONUMENTS FROM DISPLACEMENT.
14. ALL WORK SHALL BE PERFORMED IN A QUALITY WORKMANLIKE MANNER.
15. DEVIATIONS FROM THESE PLANS AND SPECIFICATIONS WITHOUT PRIOR WRITTEN CONSENT OF THE ENGINEER OR OWNER MAY CAUSE THE WORK TO BE UNACCEPTABLE AND WILL BE ADJUSTED OR REPAIRED AT THE CONTRACTOR'S EXPENSE.
16. THE CONTRACTOR SHALL OBTAIN AND PAY FOR ALL NECESSARY LICENSES AND PERMITS ASSOCIATED WITH THE CONSTRUCTION OF THIS PROJECT UNLESS NOTIFIED OTHERWISE IN WRITING BY THE OWNER.
17. LATERAL PIPING ALIGNMENTS ARE APPROXIMATE. PRIOR RO INSTALLATION CONTRACTOR TO FIELD VERIFY TO ASSURE REQUIRED SLOPE AND DIRECTION OF GAS AND CONDENSATE FLOW.
18. ALL WORK SHALL HAVE A ONE YEAR WARRANTY. ONE YEAR WARRANTY WILL BECOME EFFECTIVE WHEN THE PROJECT IS SUBSTANTIALLY COMPLETE, AS DETERMINED BY ENGINEER.
19. ACTUAL DIMENSIONS AND LOCATIONS MAY VARY BASED ON FIELD LOCATIONS.
20. INSTALLATION OF THE CLEANOUT CONNECTIONS MAY BE IN CLOSE PROXIMITY TO THE LINER. CONTRACTOR IS TO TAKE CARE NOT TO DAMAGE THE LINER IN THIS AREA.
21. TRENCH SAFETY PRECAUTIONS MAY BE REQUIRED (i.e. TRENCH BOX) TO PREVENT EXCESSIVE SOIL OR WASTE EXCAVATIONS.
22. CONTRACTOR WILL BE RESPONSIBLE FOR SAFETY DURING CONSTRUCTION FROM LANDFILL GAS AND TRENCHING HAZARDS.
23. WORK AREA INCLUDES ACTIVITIES IN MUNICIPAL SOLID WASTE (MSW). IT IS EXPECTED THAT COMBUSTIBLE, ASPIXIANT AND HAZARDOUS GASES WILL BE VENTING FROM TRENCHES AND EXCAVATIONS. WORK SHALL INCLUDE PROVISIONS FOR ALL EQUIPMENT AND PROCEDURES NECESSARY TO SAFELY INSTALL PIPING, WELLS AND COMPLETE ALL WORK UNDER THESE CONDITIONS. ALL WORK SHALL BE PERFORMED BY QUALIFIED WORKERS IN ACCORDANCE WITH BEST MANAGEMENT AND SAFETY PRACTICES AND STANDARDS.

HDR

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440 S. Church Street, Suite 1200
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. License Number: F-0116

ISSUE	DATE	DESCRIPTION
A	07/2024	ISSUED FOR CONSTRUCTION

PROJECT MANAGER M. PLUMMER, P.E.
PROJECT ENGINEER E. TUCKER, P.E.
DRAWN BY J. GAUL
PROJECT NUMBER 10335518

ROWAN COUNTY

Rowan County Landfill

Rowan LFG 2024 Expansion

789 Campbell Road
Woodleaf, NC 27054

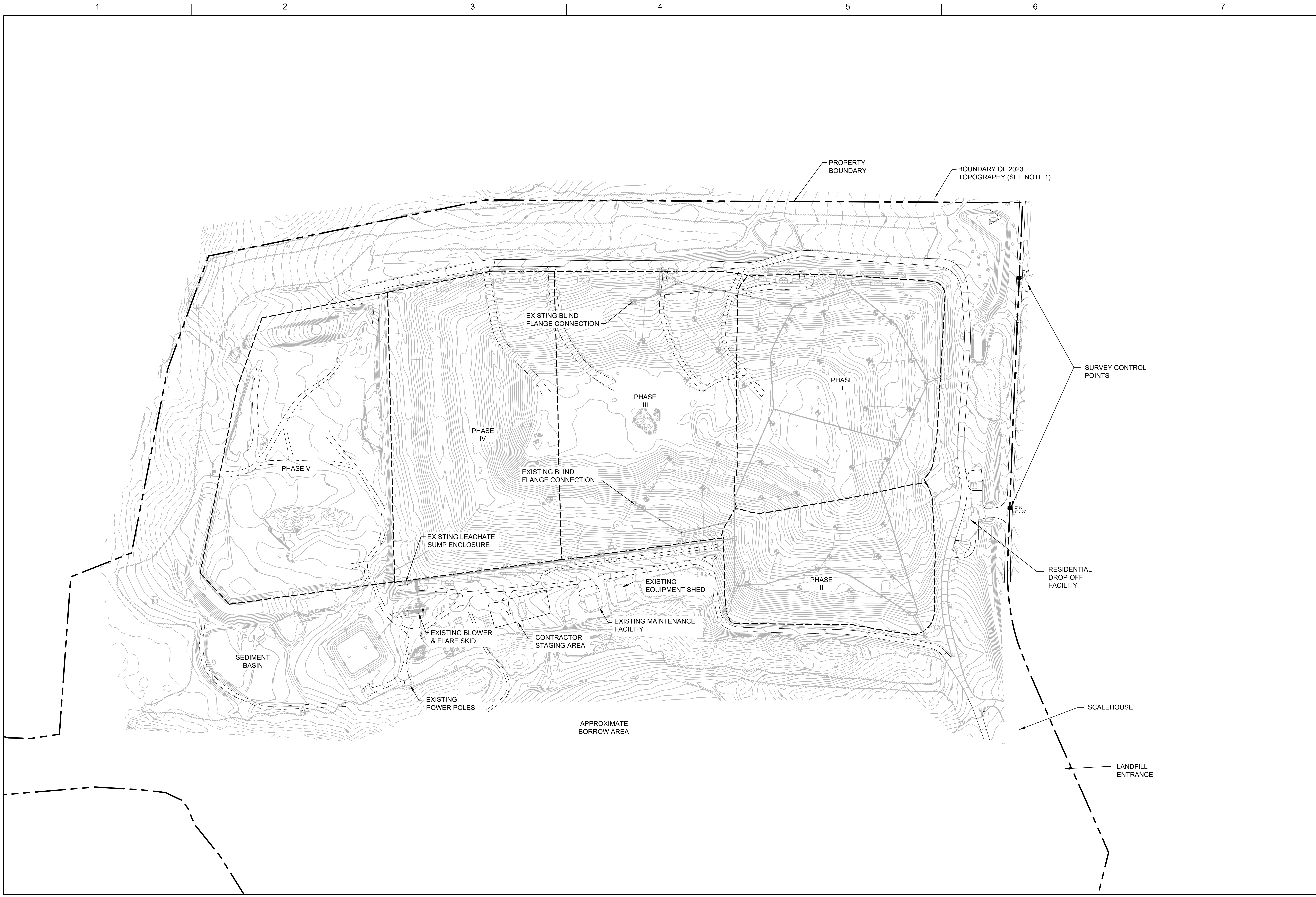
NORTH CAROLINA

LEGEND AND NOTES

0 1" 2"

FILENAME 01G-01.DWG
SCALE NO SCALE

SHEET
01G-01



N

D

NOTES:

1. TOPOGRAPHY FOR EXISTING PHASES I, II, III, IV AND FUTURE PHASE V PROVIDED BY CARTOGRAPHIC AERIAL MAPPING DATED MAY 04, 2023.
2. EXISTING TOPOGRAPHY OUTSIDE THE LANDFILL AREA PROVIDED BY SANBORN AERIAL PHOTOGRAPHY DATED MARCH 10, 2002.
3. PROPERTY LINE BY JAMES T. HILL PLS L-2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
4. HEADER PIPE IS 10" HDPE PIPE FOR PORTIONS INSIDE THE LANDFILL BOUNDARY.

C

LEGEND

—·—·—	PROPERTY BOUNDARY
– – –	PHASE BOUNDARY
——	EXISTING MAJOR CONTOUR
——	EXISTING MINOR CONTOUR
—◇—	POWER LINE
○ MW-10	MONITORING WELLS
⊠ LCO	EXISTING LEACHATE CLEANOUT
⊚	MANHOLES
——	EXISTING LFG HEADER
——	EXISTING LFG LATERAL
◐ EW−27	EXISTING LFG WELL
□	EXISTING VALVE BOX
(DL)	EXISTING DRIPLEG
(AP)	EXISTING ACCESS POINT

B

A

HDR

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PROJECT ENGINEER	E. TUCKER, P.E.
DRAWN BY	J. GAUL
PROJECT NUMBER	10335518

ROWAN COUNTY

Rowan County Landfill

Rowan LFG 2024 Expansion

789 Campbell Road
Woodleaf, NC 27054

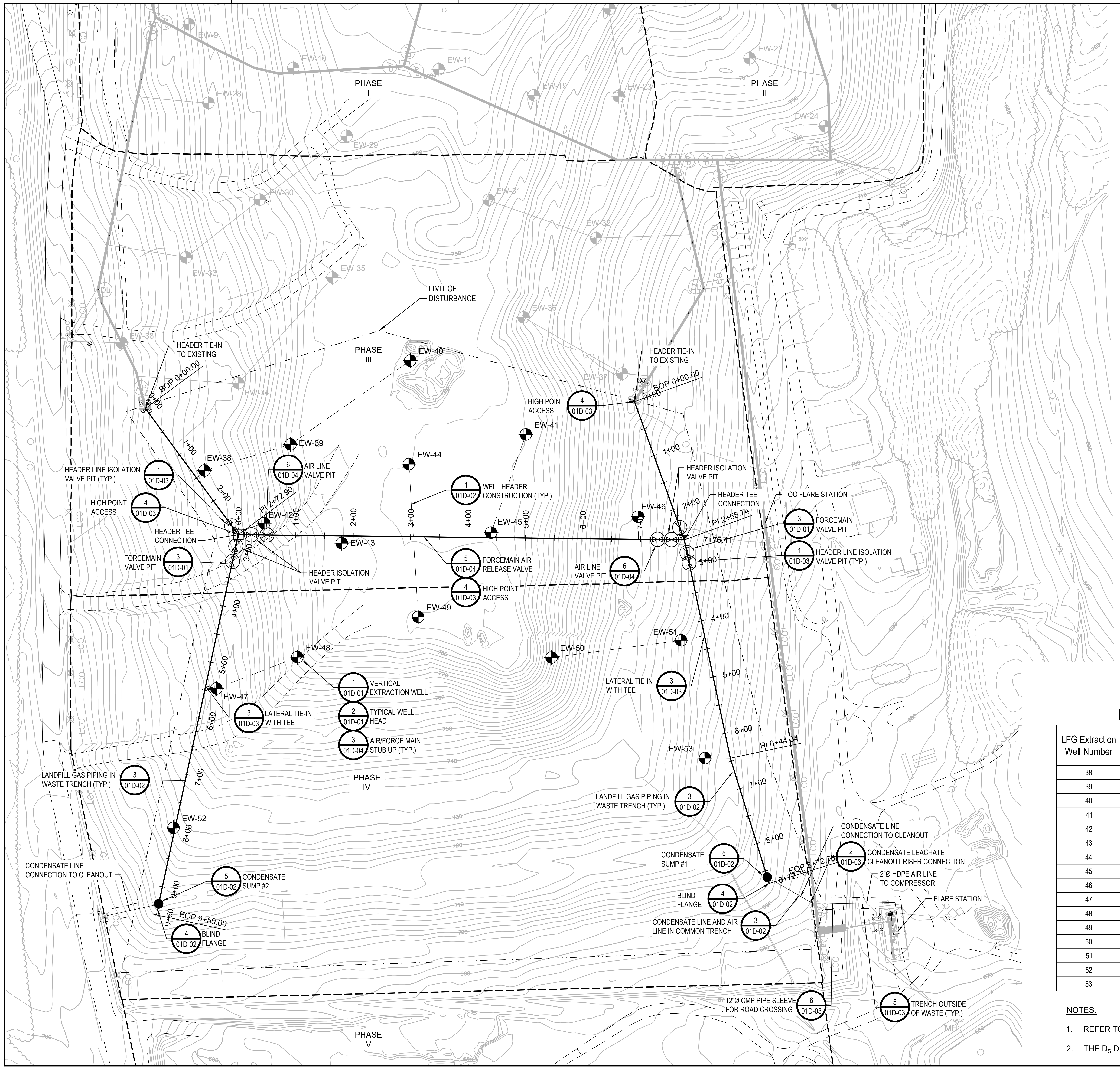
NORTH CAROLINA

EXISTING CONDITIONS

0 1" 2"

FILENAME 01C-01.DWG
SCALE 1" = 200'

SHEET
01C-01



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2. PROPERTY LINE BY JAMES T. HILL PLS L-2512 DATED FEBRUARY 19, 1997 AS PROVIDED BY S&ME'S APPLICATION TO CONSTRUCT PHASE III FOR ROWAN COUNTY LANDFILL.
3. LIMITS OF WASTE BASED ON ANCHOR TRENCH FROM PHASE III AS-BUILT AND EXISTING SITE CONDITIONS DRAWINGS PROVIDED BY S&ME. LIMITS ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED.
4. HEADER TIE-IN MAY BE MADE WITH ELECTROFUSION COUPLINGS OR BY BLIND FLANGE CONNECTIONS, CONTRACTOR TO VERIFY METHOD WITH ENGINEER ONCE EXISTING HEADER IS UNCOVERED.
5. 2 INCH DIAMETER HDPE SDR 9 AIR LINE TO BE INSTALLED WITH LANDFILL GAS COLLECTION AND HEADER PIPING.

N

LEGEND

— — — —	PHASE BOUNDARY/ LIMITS OF WASTE
———	EXISTING MAJOR CONTOUR
———	EXISTING MINOR CONTOUR
━━━	PROPOSED 10" HEADER PIPE
— — — —	PROPOSED 4" LATERAL PIPE
EW-27	PROPOSED GAS EXTRACTION WELL
☐	PROPOSED VALVE BOX
(DL)	PROPOSED DRIP LEG
(AP)	PROPOSED ACCESS POINT
⋈	PROPOSED VALVE PIT
LCO ⊗	EXISTING LEACHATE CLEANOUT RISER (APPROXIMATE LOCATION)
━━━	EXISTING HEADER PIPE
———	EXISTING LATERAL PIPE
	EXISTING WELL
☐	EXISTING VALVE BOX
(DL)	EXISTING DRIP LEG
(AP)	EXISTING ACCESS POINT

ROWAN COUNTY LANDFILL GAS EXTRACTION EXPANSION WELL SCHEDULE

LFG Extraction Well Number	Grid Coordinates		Existing Grade Elevation (ft)	Base Grade Elevation (ft)	Total Waste Thickness D_R(ft)	Proposed Well Depth D_B(ft)	Solid Pipe Length D_S(ft)^2	Proposed Perforated Length D_P(ft)
	Northing (ft)	Easting (ft)						
38	732413.62	1536929.00	755	704	51	36	15	21
39	732459.22	1537078.60	781	702	79	64	15	49
40	732605.01	1537287.15	807	703	104	89	15	74
41	732476.53	1537488.42	788	695	93	78	15	63
42	732321.97	1537032.90	767	701	66	51	15	36
43	732287.13	1537167.58	792	698	94	79	15	64
44	732424.88	1537284.66	784	698	86	71	15	56
45	732305.41	1537427.81	798	693	105	90	15	75
46	732333.14	1537683.48	739	689	50	35	15	20
47	732034.14	1536949.69	745	691	54	39	15	24
48	732088.78	1537090.60	772	678	94	79	15	64
49	732158.83	1537301.02	792	686	106	91	15	76
50	732088.01	1537533.23	766	684	82	67	15	52
51	732117.95	1537758.64	723	678	45	30	15	15
52	731791.52	1536874.93	727	686	42	27	15	12
53	731913.06	1537800.54	714	674	40	25	15	10

NOTES:

1. REFER TO SHEET 01D-01 FOR WELL CONSTRUCTION AND DIMENSIONS
2. THE D_S DIMENSION DOES NOT INCLUDE 4 FT STICK UP

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PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	E. TUCKER, P.E.
DRAWN BY	J. GAUL
PROJECT NUMBER	10335518

ROWAN COUNTY

Rowan County Landfill

Rowan LFG 2024 Expansion

789 Campbell Road
Woodleaf, NC 27054

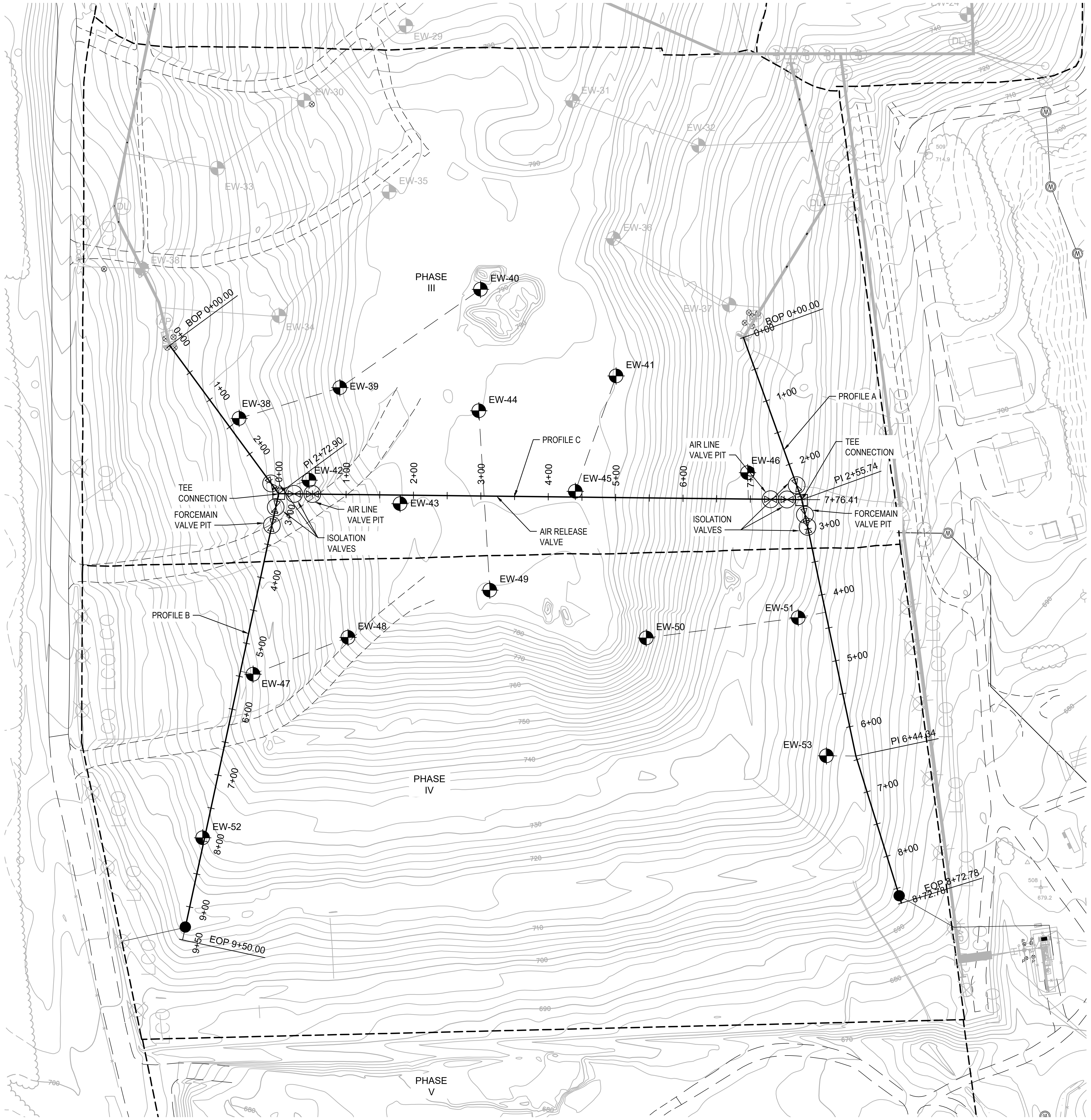
NORTH CAROLINA

GAS SYSTEM LAYOUT

0 1" 2"

FILENAME 01C-02.DWG
SCALE 1"=100'

SHEET
01C-02



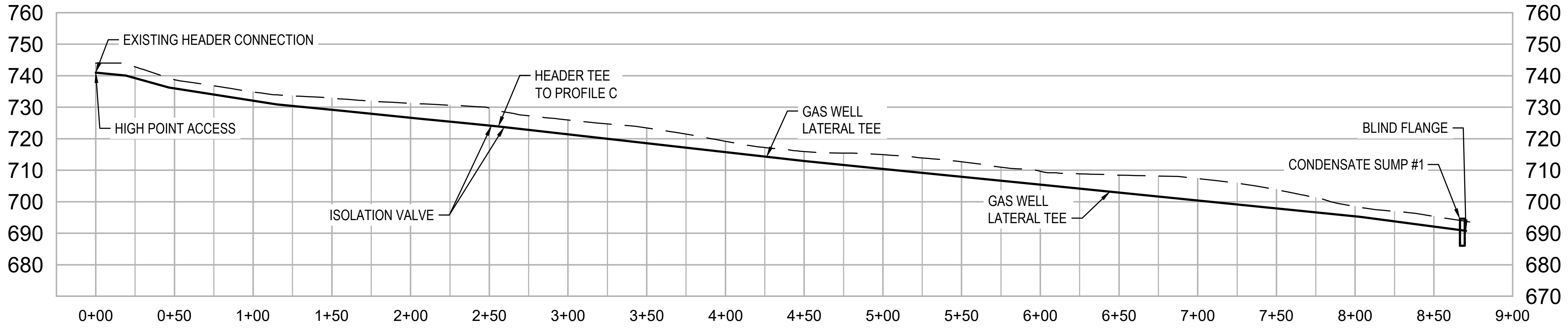
SCALE: 1" = 100'

N

(HORIZONTAL)
SCALE IN FEET
100 50 0 100 200

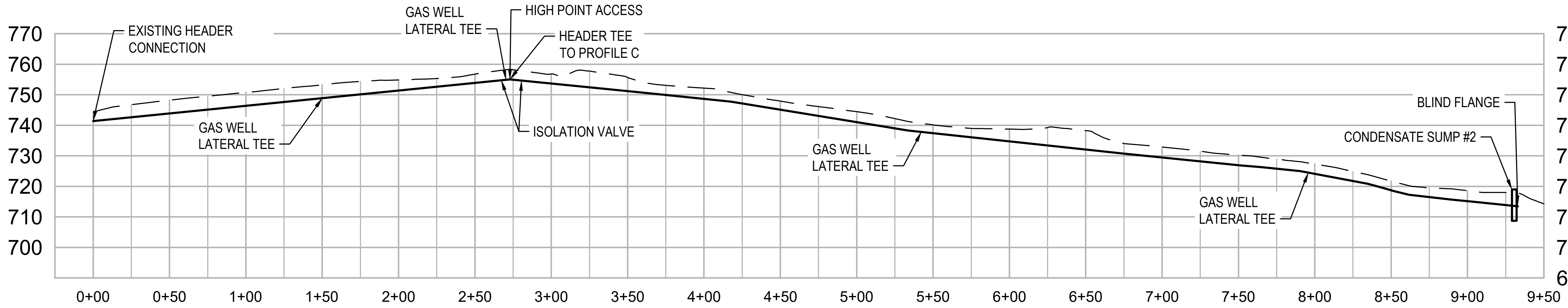
LEGEND

— — —	EXISTING GRADE CONTOUR
———	PROPOSED LANDFILL GAS COLLECTION SYSTEM HEADER



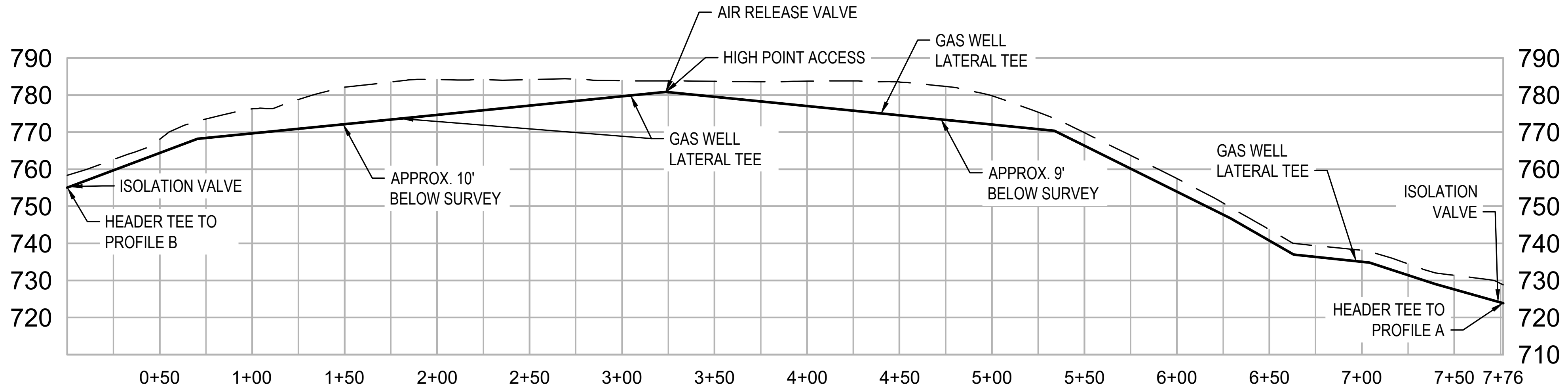
PROFILE A

SCALE: H:1" = 70' V:1"=35'



PROFILE B

SCALE: H:1" = 70' V:1"=35'



PROFILE C

SCALE: H:1" = 70' V:1"=35'

HDR

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ROWAN COUNTY

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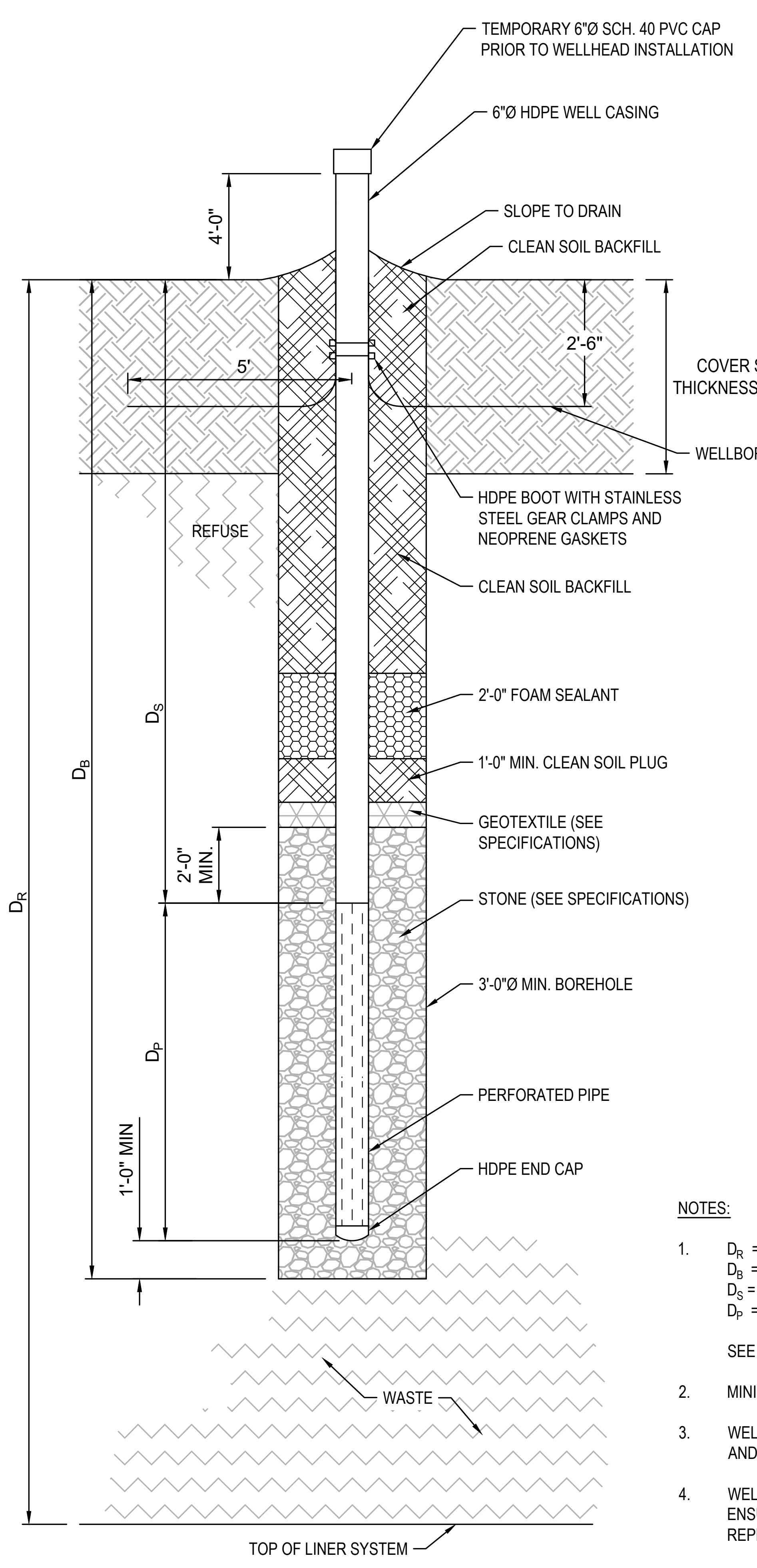
NORTH CAROLINA

HEADER LINE PROFILE

0 1" 2"

FILENAME 01C-03.dwg
SCALE AS SHOWN

SHEET
01C-03



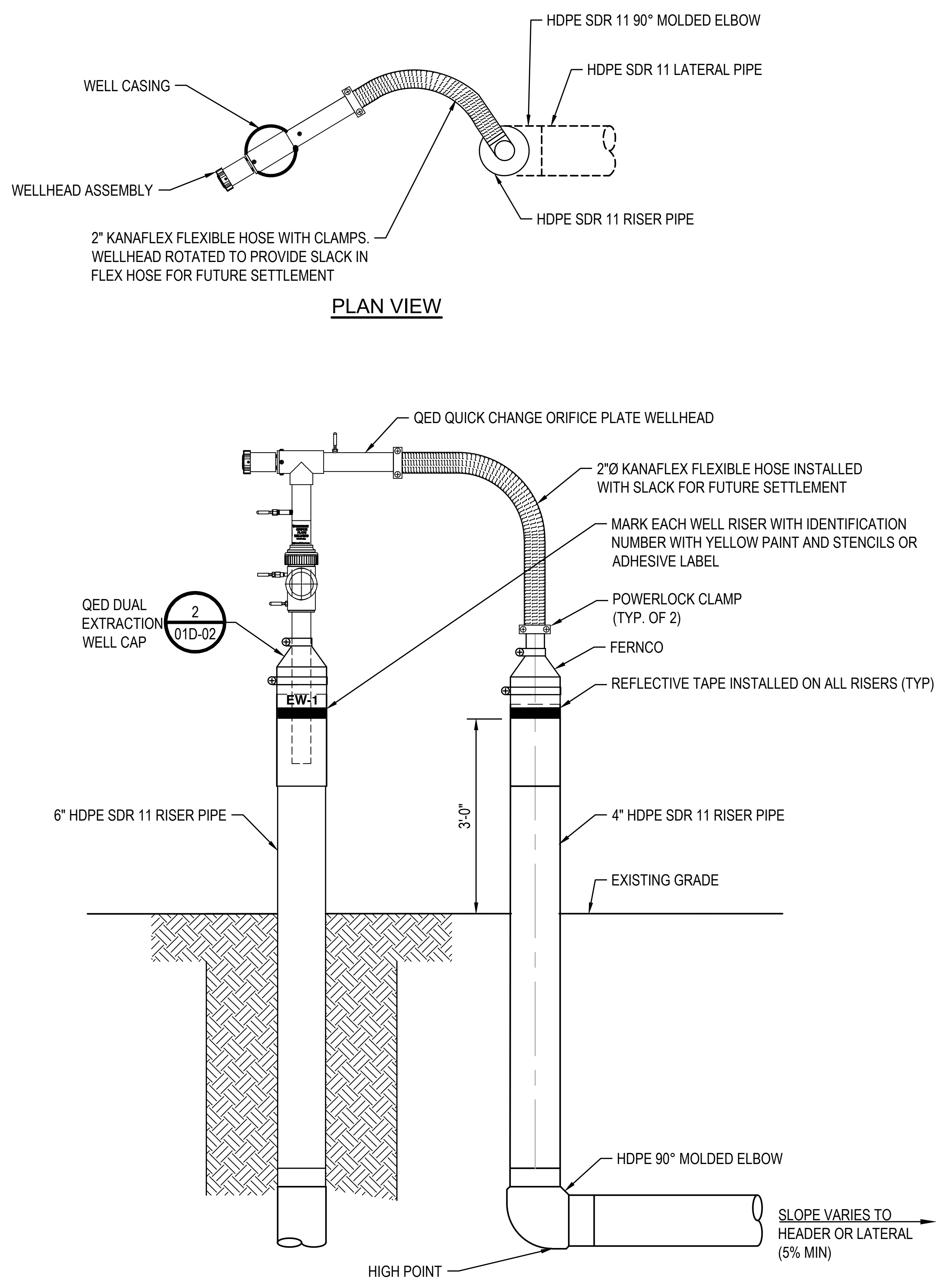
NOTES:

1. D_R = DEPTH OF REFUSE
   D_B = DEPTH OF BORING
   D_S = DEPTH OF SOLID PIPE (BELOW GRADE) - 10 FEET MINIMUM
   D_P = LENGTH OF PERFORATED PIPE

   SEE 01C-02 FOR WELL LOG.
2. MINIMUM 15 FEET SEPARATION BETWEEN BASE OF BORING AND ESTIMATED TOP OF LINER.
3. WELL DRILLING WILL NOT COMMENCE UNTIL EXISTING GRADE ELEVATIONS ARE IDENTIFIED AND VERIFIED BY PROJECT SURVEYOR, DESIGN ENGINEER, AND CQA REPRESENTATIVE.
4. WELL DRILLING TABLE WILL BE MANAGED BY OWNER OR DESIGNATED REPRESENTATIVE TO ENSURE ONLY THE VERIFIED WELL DEPTHS ARE PRESENT, AND THAT DRILLER AND CQA REPRESENTATIVE HAVE THE IDENTICAL INFORMATION PRIOR TO DRILLING.
5. NOTE THE D_S DIMENSION DOES NOT INCLUDE THE 4FT STICK UP.
6. FOAM SEALANT TO BE FOAM CONCEPTS POUR SYSTEM ES 24-005

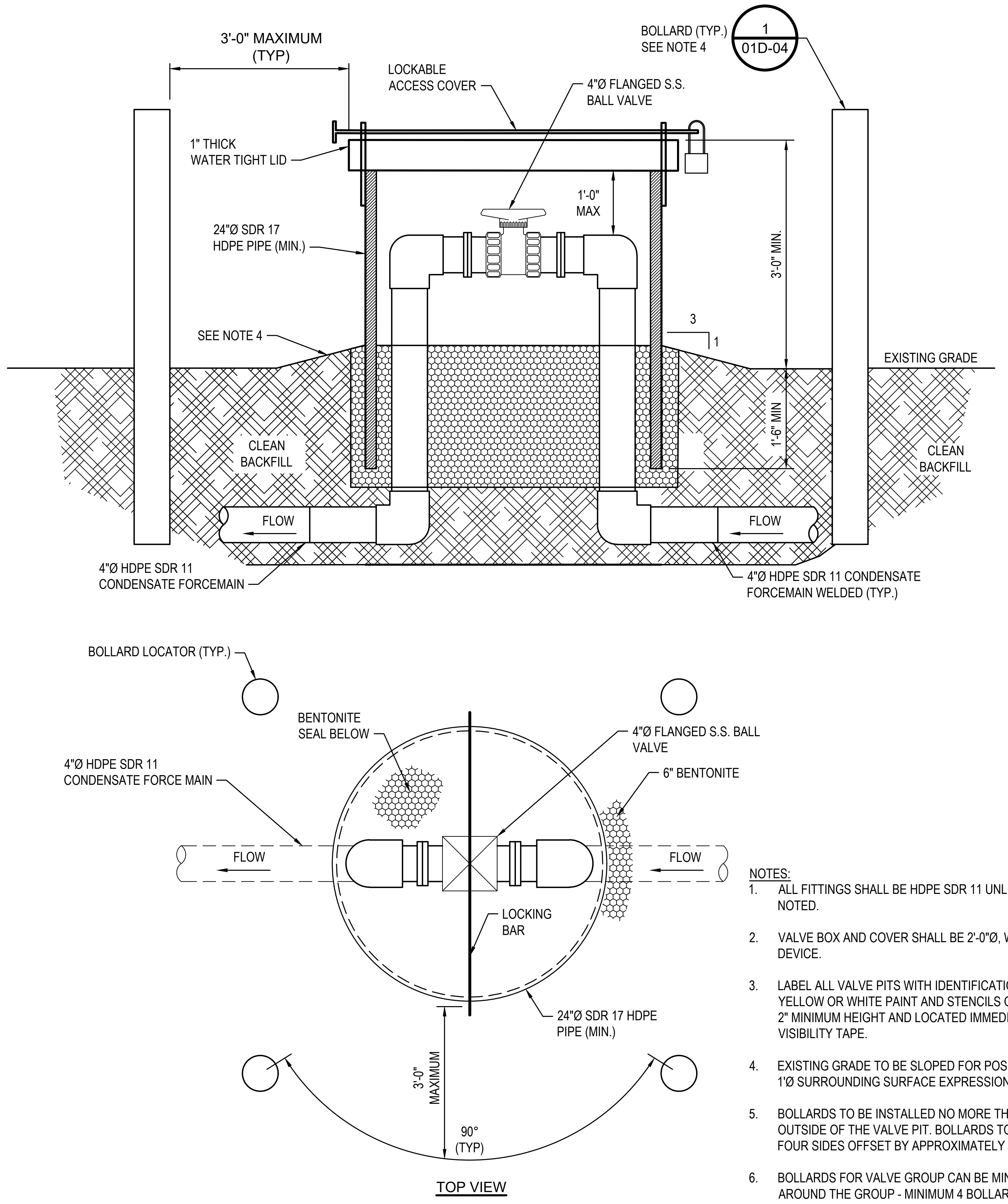
1 / 00C-02 LANDFILL GAS VERTICAL EXTRACTION WELL (TYP.)

NOT TO SCALE



2 / 01C-02 TYPICALWELL HEAD

NOT TO SCALE



NOTES:

1. ALL FITTINGS SHALL BE HDPE SDR 11 UNLESS OTHERWISE NOTED.
2. VALVE BOX AND COVER SHALL BE 2'-0"Ø, WITH LID AND LOCKING DEVICE.
3. LABEL ALL VALVE PITS WITH IDENTIFICATION NUMBER WITH YELLOW OR WHITE PAINT AND STENCILS OR ADHESIVE LABEL AT 2" MINIMUM HEIGHT AND LOCATED IMMEDIATELY BELOW HIGH VISIBILITY TAPE.
4. EXISTING GRADE TO BE SLOPED FOR POSITIVE DRAINAGE IN A 1'Ø SURROUNDING SURFACE EXPRESSION.
5. BOLLARDS TO BE INSTALLED NO MORE THAN 3'-O" FROM THE OUTSIDE OF THE VALVE PIT. BOLLARDS TO BE INSTALLED ON FOUR SIDES OFFSET BY APPROXIMATELY 90 DEGREES.
6. BOLLARDS FOR VALVE GROUP CAN BE MINIMIZED/ COMBINED AROUND THE GROUP - MINIMUM 4 BOLLARDS REQUIRED.

3 / 01C-02 FORCEMAIN VALVE PIT

NOT TO SCALE

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DRAWN BY	J. GAUL
PROJECT NUMBER	10335518

ROWAN COUNTY

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Rowan LFG 2024 Expansion

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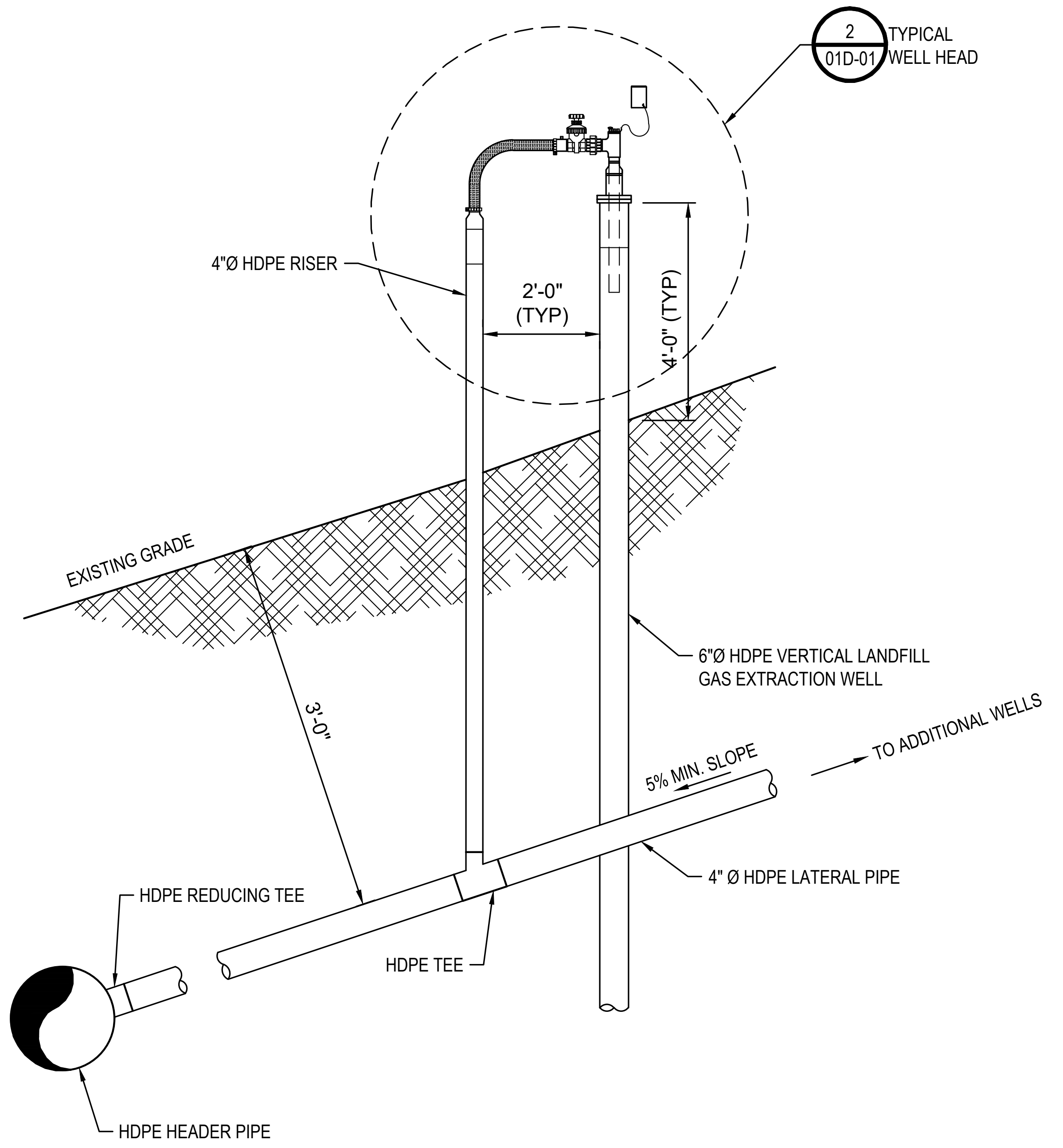
NORTH CAROLINA

GAS COLLECTION SYSTEM DETAILS (1 OF 4)

0 1" 2"

FILENAME 01D-01.DWG
SCALE AS SHOWN

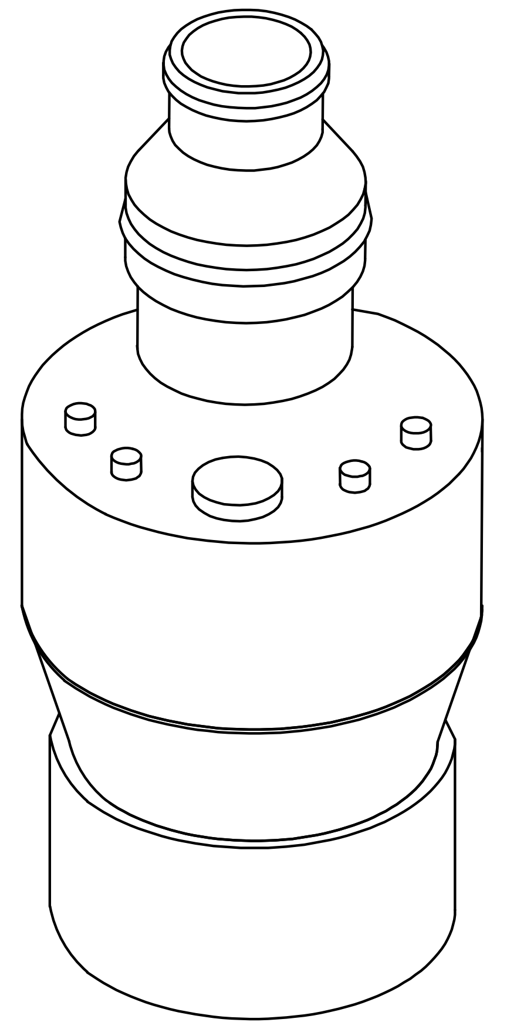
SHEET
01D-01



WELL HEADER CONSTRUCTION

1
01C-02

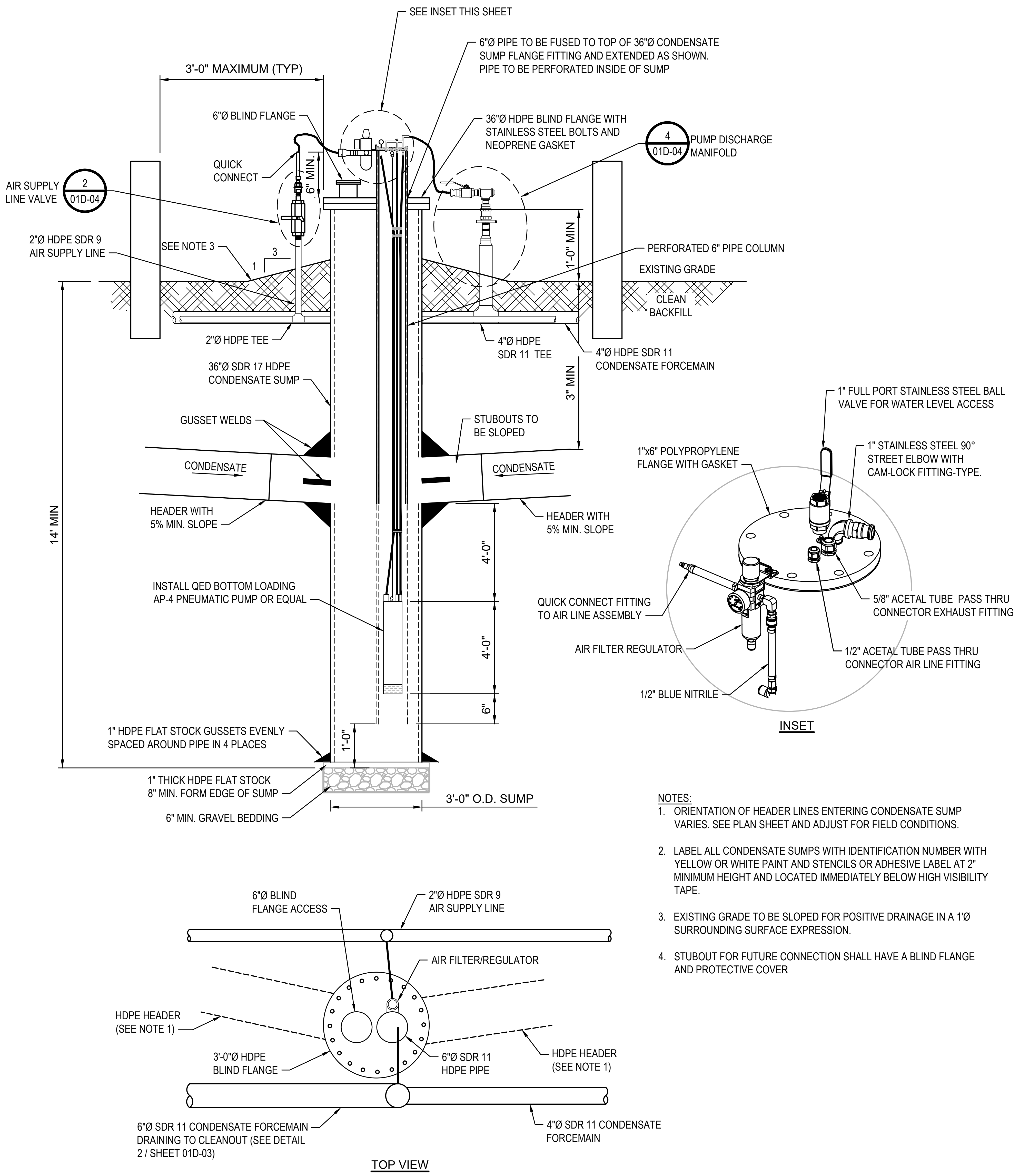
NOT TO SCALE



QED DUAL EXTRACTION WELL CAP

2
01D-01

NOT TO SCALE



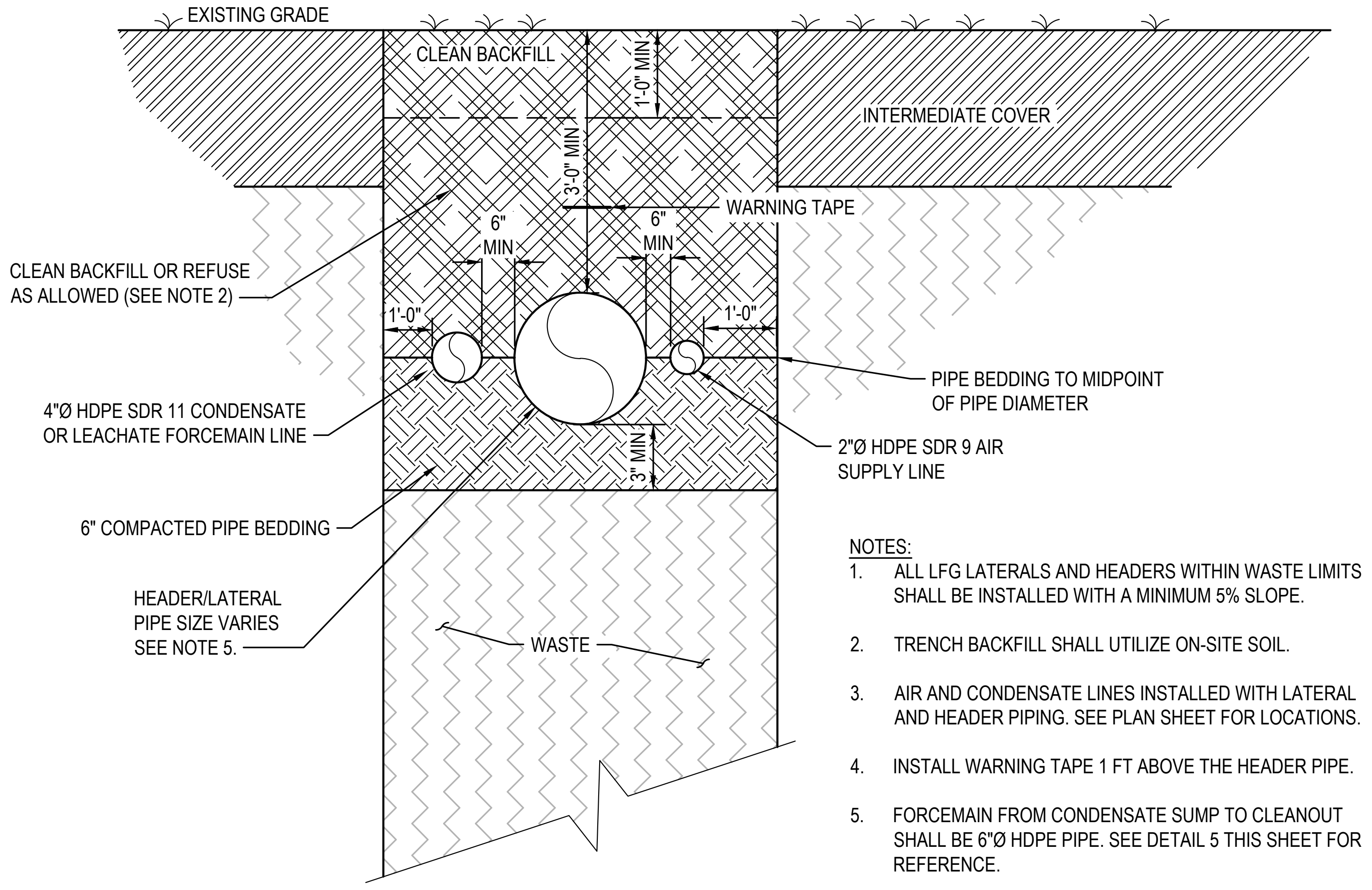
NOTES:

1. ORIENTATION OF HEADER LINES ENTERING CONDENSATE SUMP VARIES. SEE PLAN SHEET AND ADJUST FOR FIELD CONDITIONS.
2. LABEL ALL CONDENSATE SUMPS WITH IDENTIFICATION NUMBER WITH YELLOW OR WHITE PAINT AND STENCILS OR ADHESIVE LABEL AT 2" MINIMUM HEIGHT AND LOCATED IMMEDIATELY BELOW HIGH VISIBILITY TAPE.
3. EXISTING GRADE TO BE SLOPED FOR POSITIVE DRAINAGE IN A 1'Ø SURROUNDING SURFACE EXPRESSION.
4. STUBOUT FOR FUTURE CONNECTION SHALL HAVE A BLIND FLANGE AND PROTECTIVE COVER

CONDENSATE SUMP (TYPICAL)

5
01C-02

NOT TO SCALE



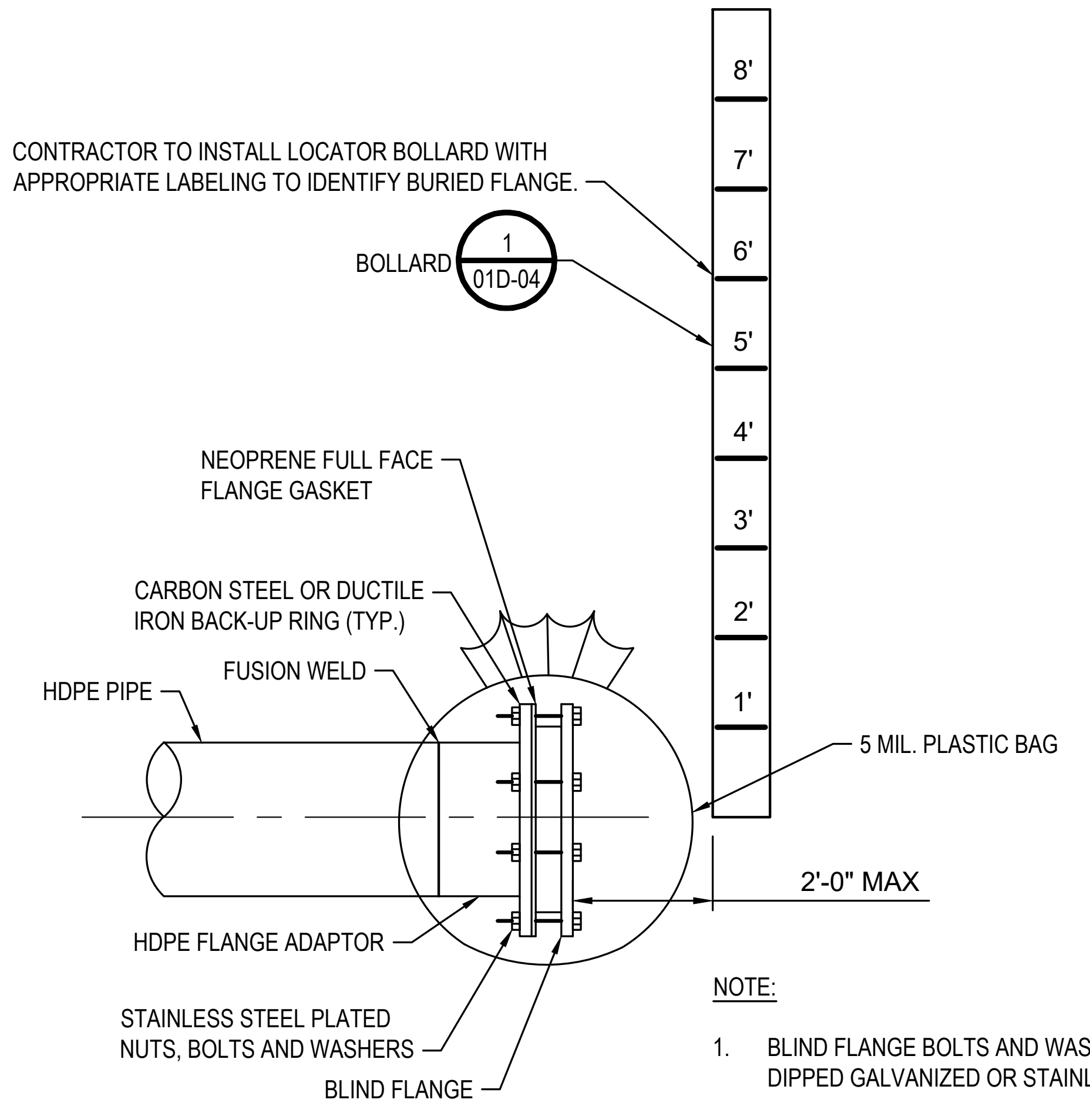
NOTES:

1. ALL LFG LATERALS AND HEADERS WITHIN WASTE LIMITS SHALL BE INSTALLED WITH A MINIMUM 5% SLOPE.
2. TRENCH BACKFILL SHALL UTILIZE ON-SITE SOIL.
3. AIR AND CONDENSATE LINES INSTALLED WITH LATERAL AND HEADER PIPING. SEE PLAN SHEET FOR LOCATIONS.
4. INSTALL WARNING TAPE 1 FT ABOVE THE HEADER PIPE.
5. FORCEMAIN FROM CONDENSATE SUMP TO CLEANOUT SHALL BE 6"Ø HDPE PIPE. SEE DETAIL 5 THIS SHEET FOR REFERENCE.

LANDFILL GAS PIPING IN WASTE TRENCH (TYP.)

3
01C-02

NOT TO SCALE



NOTE:

1. BLIND FLANGE BOLTS AND WASHERS MAY BE HOT DIPPED GALVANIZED OR STAINLESS STEEL.

BLIND FLANGE

4
01C-02

NOT TO SCALE

HDR Engineering, Inc. of the Carolinas

440 S. Church Street, Suite 1200
Charlotte, NC 28202-2075
704.338.6700

N.C.B.E.L.S. License Number: F-0116

A	07/2024	ISSUED FOR CONSTRUCTION
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	E. TUCKER, P.E.
DRAWN BY	J. GAUL
PROJECT NUMBER	10335518

ROWAN COUNTY

Rowan County Landfill

Rowan LFG 2024 Expansion

789 Campbell Road
Woodleaf, NC 27054

NORTH CAROLINA

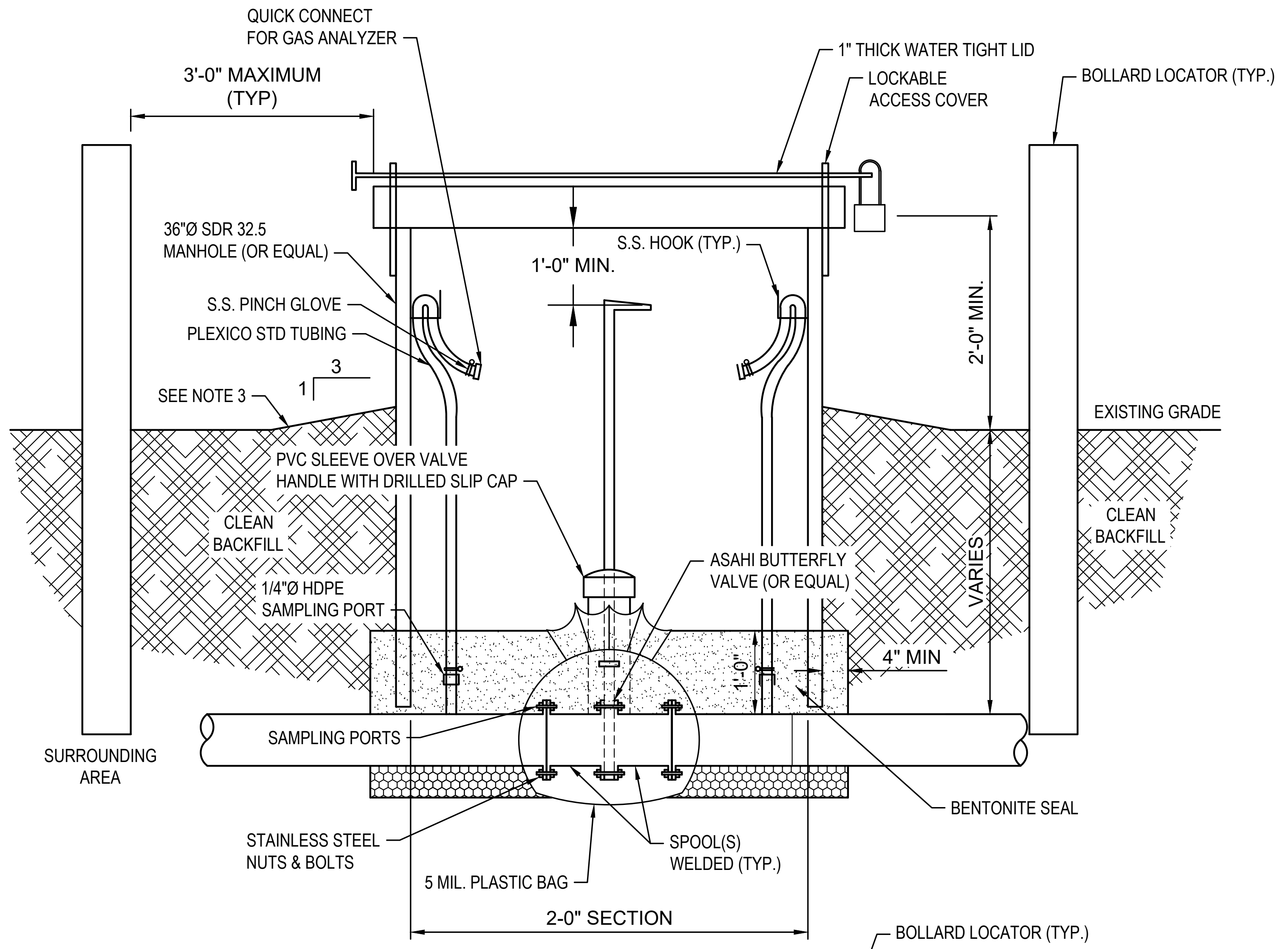
GAS COLLECTION SYSTEM DETAILS (2 OF 4)

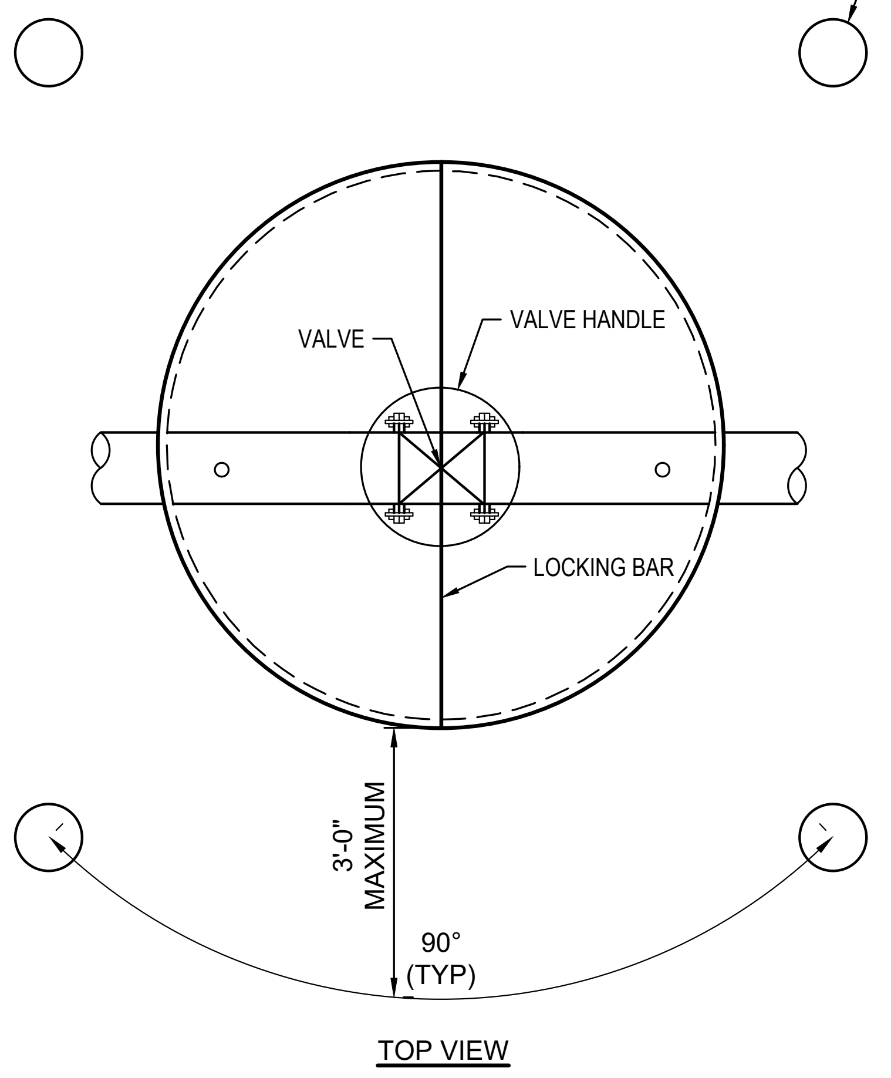
0 1" 2"

FILENAME 01D-02.DWG

SCALE AS SHOWN

SHEET 01D-02





TOP VIEW

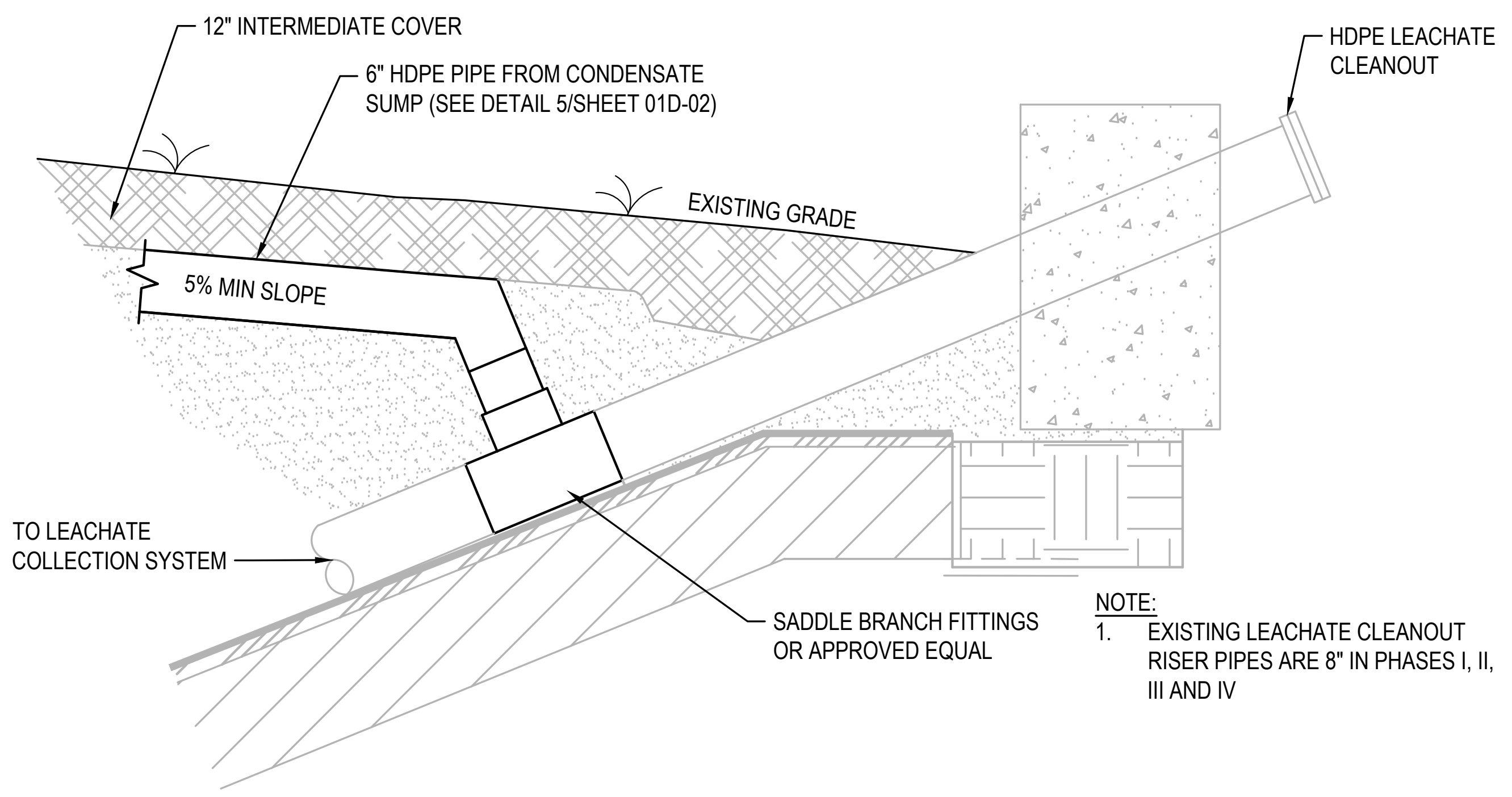
NOTES:

1. HOOK FOR SAMPLE PORT SHALL BE CONNECTED TO WALL OF VALVE PIT WITHIN REACH OF TOP OF VALVE PIT.
2. LABEL ALL VALVE PITS WITH IDENTIFICATION NUMBER WITH YELLOW OR WHITE PAINT AND STENCILS OR ADHESIVE LABEL AT 2" MINIMUM HEIGHT AND LOCATED IMMEDIATELY BELOW HIGH VISIBILITY TAPE.
3. EXISTING GRADE TO BE SLOPED FOR POSITIVE DRAINAGE IN A 1'Ø SURROUNDING SURFACE EXPRESSION.
4. BOLLARDS TO BE INSTALLED NO MORE THAN 3'-O" FROM THE OUTSIDE OF THE VALVE PIT. BOLLARDS TO BE INSTALLED ON FOUR SIDES OFFSET BY APPROXIMATELY 90 DEGREES.
5. THE BOLLARDS SHALL BE CONCRETE-FILLED STEEL PIPE BOLLARDS 6"ØX8' TALL. BOLLARDS SHALL BE PAINTED SAFETY YELLOW AND LABELED "LANDFILL GAS PIPE BURIED BELOW".I
6. BOLLARDS MAY BE SHARED WITH ACCESS POINT

1 / 01C-02

HEADER LINE ISOLATION VALVE

NOT TO SCALE



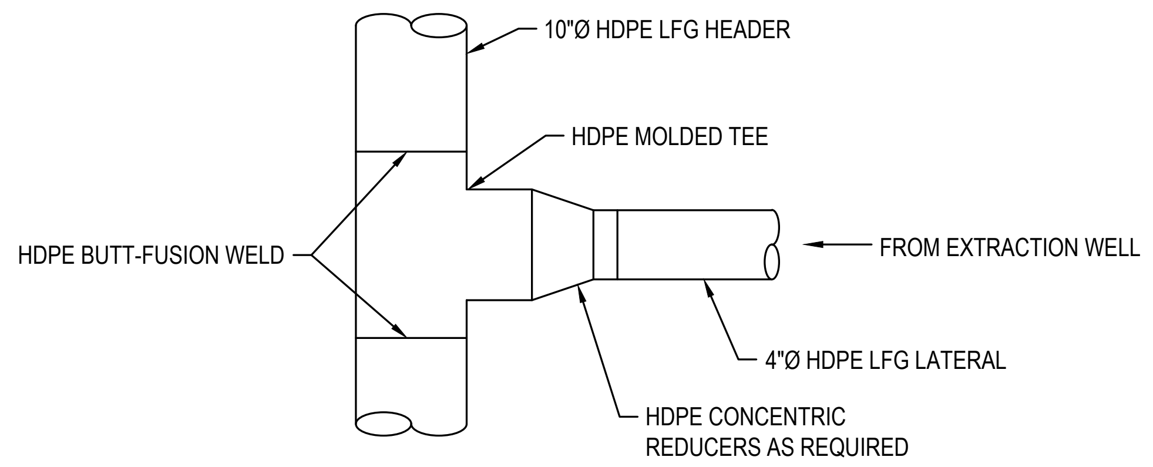
NOTE:

1. EXISTING LEACHATE CLEANOUT RISER PIPES ARE 8" IN PHASES I, II, III AND IV

2 / 01C-02

CONDENSATE LEACHATE CLEANOUT RISER CONNECT INSIDE WASTE LIMITS

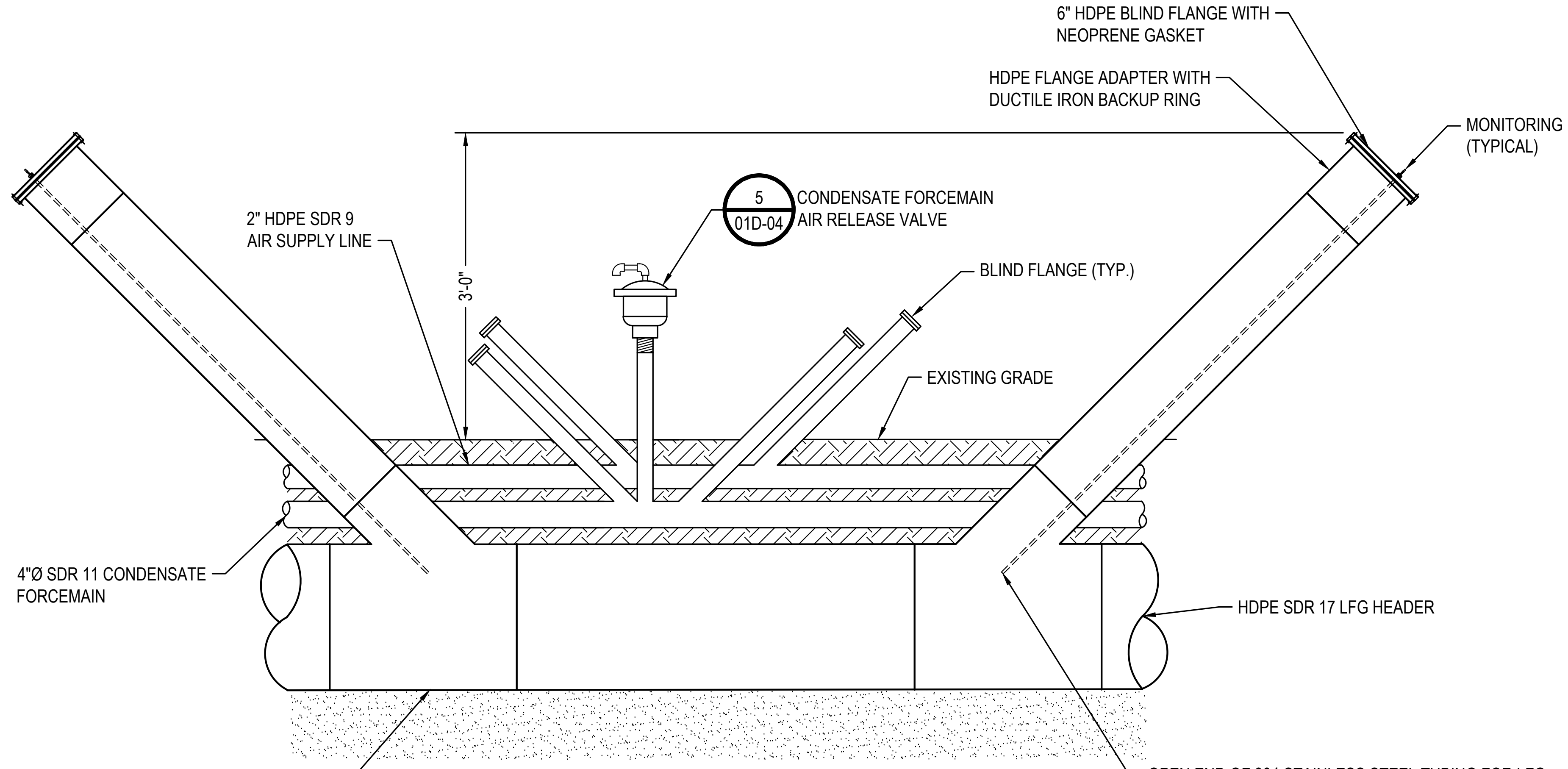
NOT TO SCALE



3 / 01C-02

LATERAL TIE-IN WITH TEE (TYP.)

NOT TO SCALE



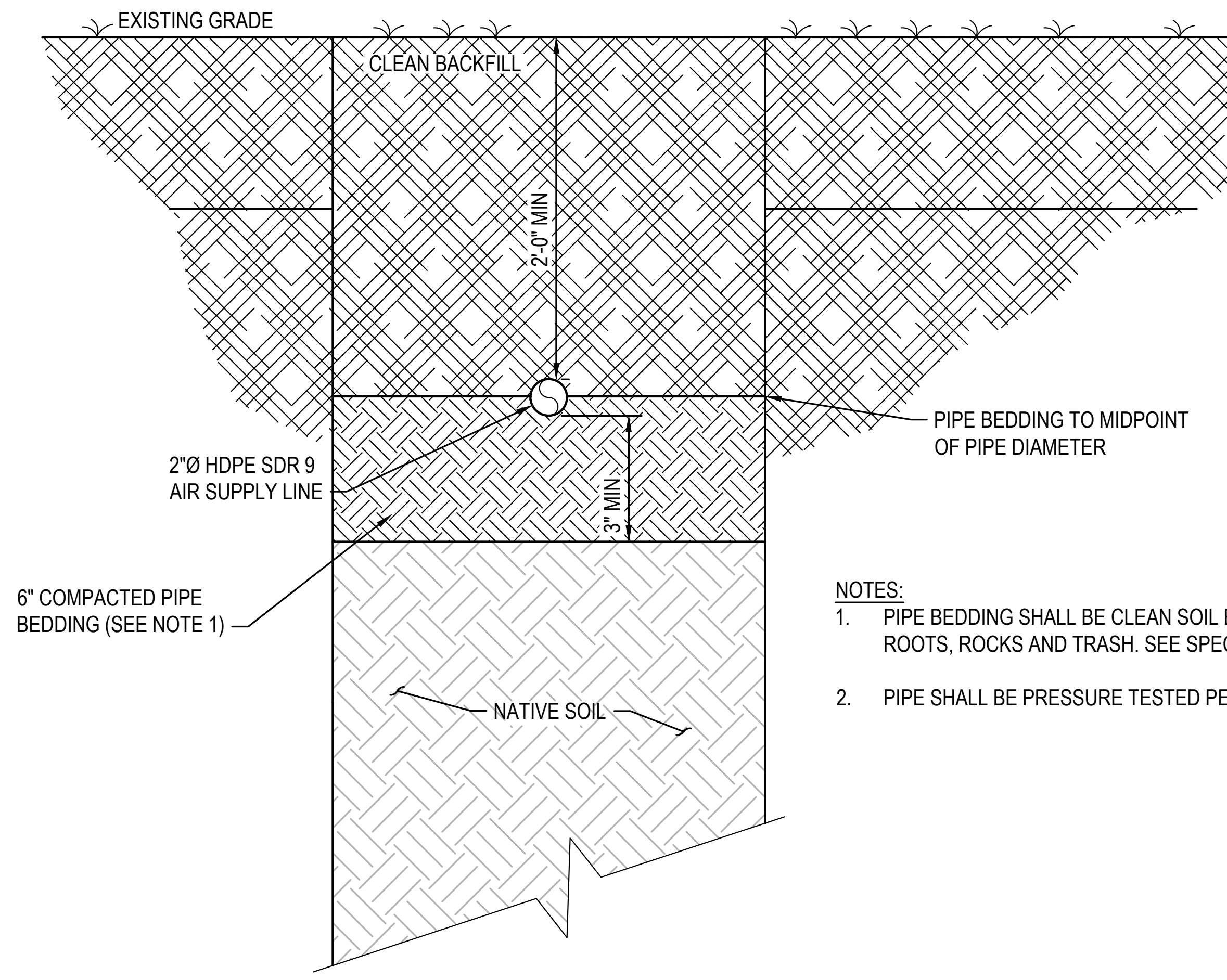
NOTE:

1. NOT ALL PIPE SYSTEMS SHOWN ARE PRESENT AT INDIVIDUAL LOCATIONS. SEE PLANS FOR PIPE SYSTEMS PRESENT AT EACH LOCATION.

4 / 01C-02

HIGH POINT ACCESS

NOT TO SCALE



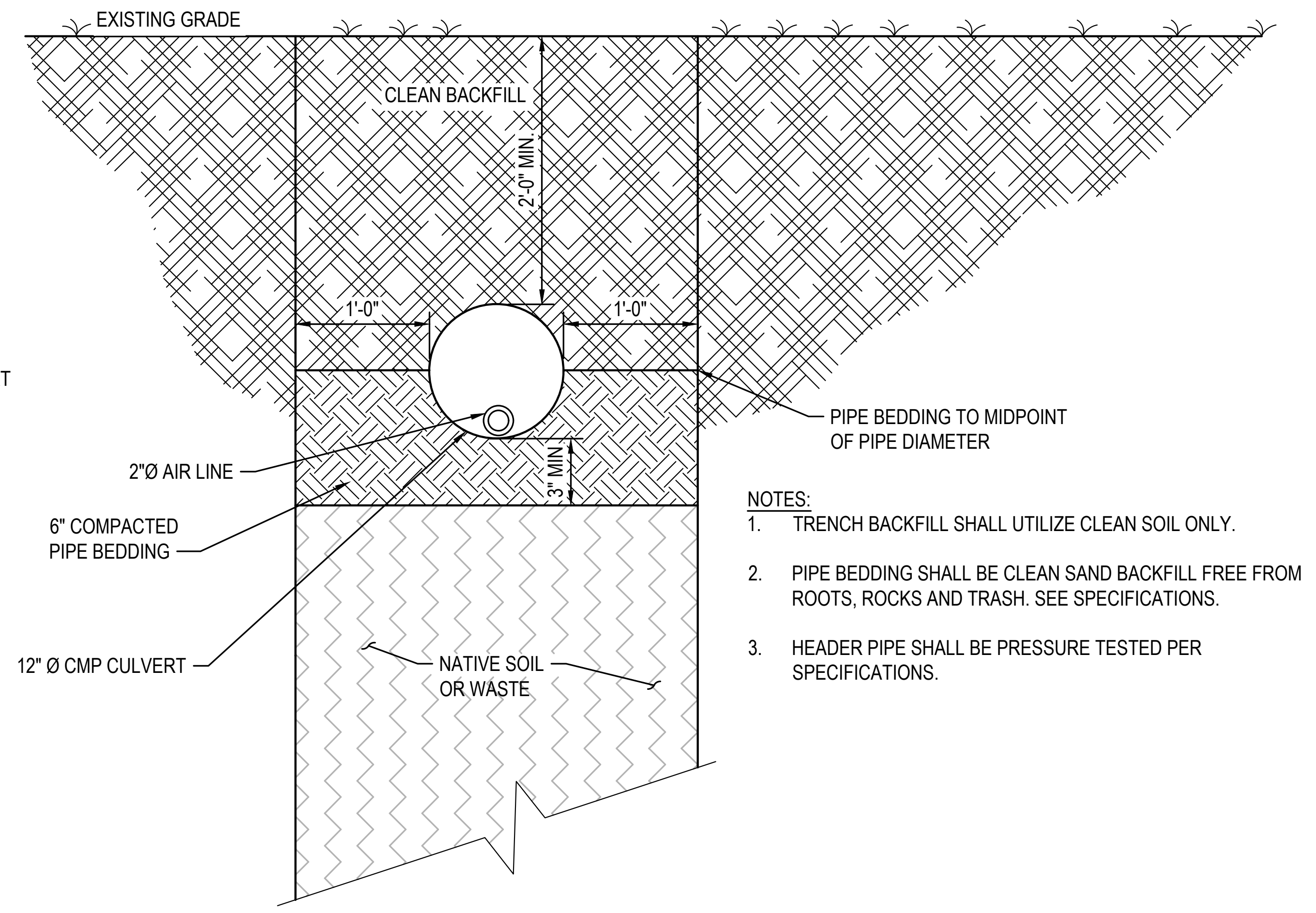
NOTES:

1. PIPE BEDDING SHALL BE CLEAN SOIL BACKFILL FREE FROM ROOTS, ROCKS AND TRASH. SEE SPECIFICATIONS.
2. PIPE SHALL BE PRESSURE TESTED PER SPECIFICATIONS.

5 / 01C-02

AIR LINE TRENCH OUTSIDE OF WASTE

NOT TO SCALE



NOTES:

1. TRENCH BACKFILL SHALL UTILIZE CLEAN SOIL ONLY.
2. PIPE BEDDING SHALL BE CLEAN SAND BACKFILL FREE FROM ROOTS, ROCKS AND TRASH. SEE SPECIFICATIONS.
3. HEADER PIPE SHALL BE PRESSURE TESTED PER SPECIFICATIONS.

6 / 01C-02

ROAD CROSSING TRENCH

NOT TO SCALE

HDR Engineering, Inc. of the Carolinas
440 S. Church Street, Suite 1200
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. License Number: F-0116

ISSUE	DATE	DESCRIPTION
A	07/2024	ISSUED FOR CONSTRUCTION

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PROJECT ENGINEER	E. TUCKER, P.E.
DRAWN BY	J. GAUL
PROJECT NUMBER	10335518

ROWAN COUNTY

Rowan County Landfill
Rowan LFG 2024 Expansion

789 Campbell Road
Woodleaf, NC 27054

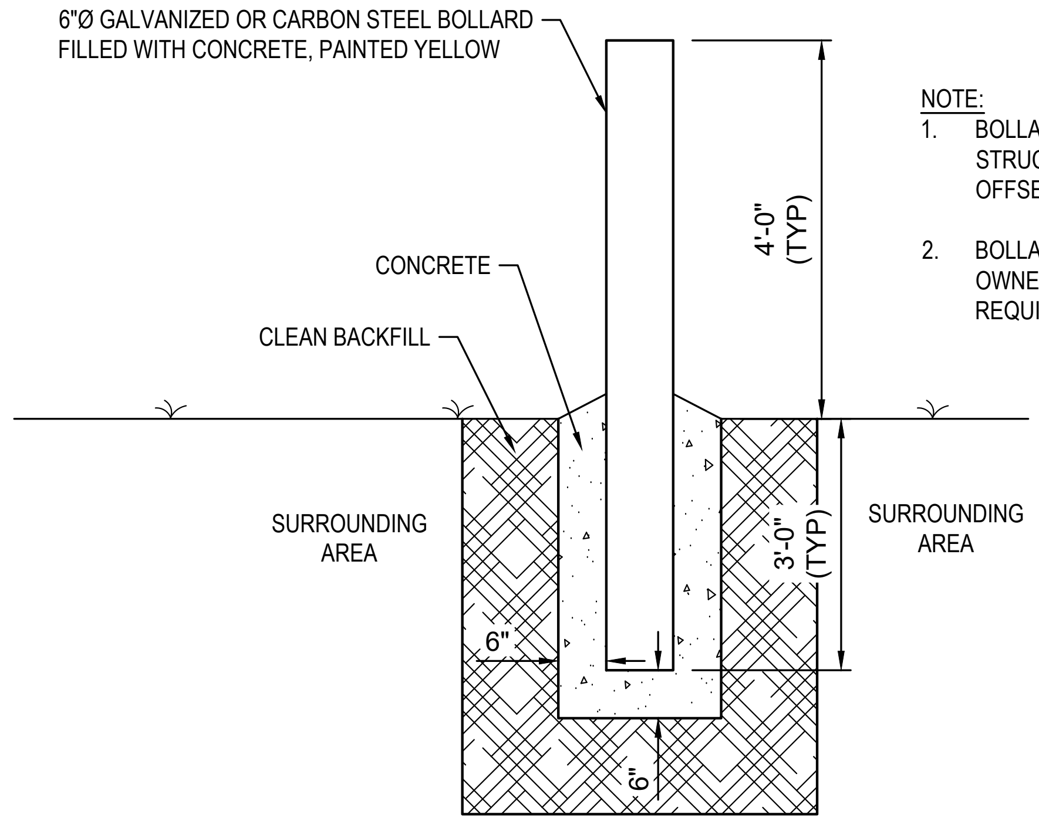
NORTH CAROLINA

GAS COLLECTION SYSTEM
DETAILS (3 OF 4)

0 1" 2"

FILENAME: 01D-03.DWG
SCALE: AS SHOWN

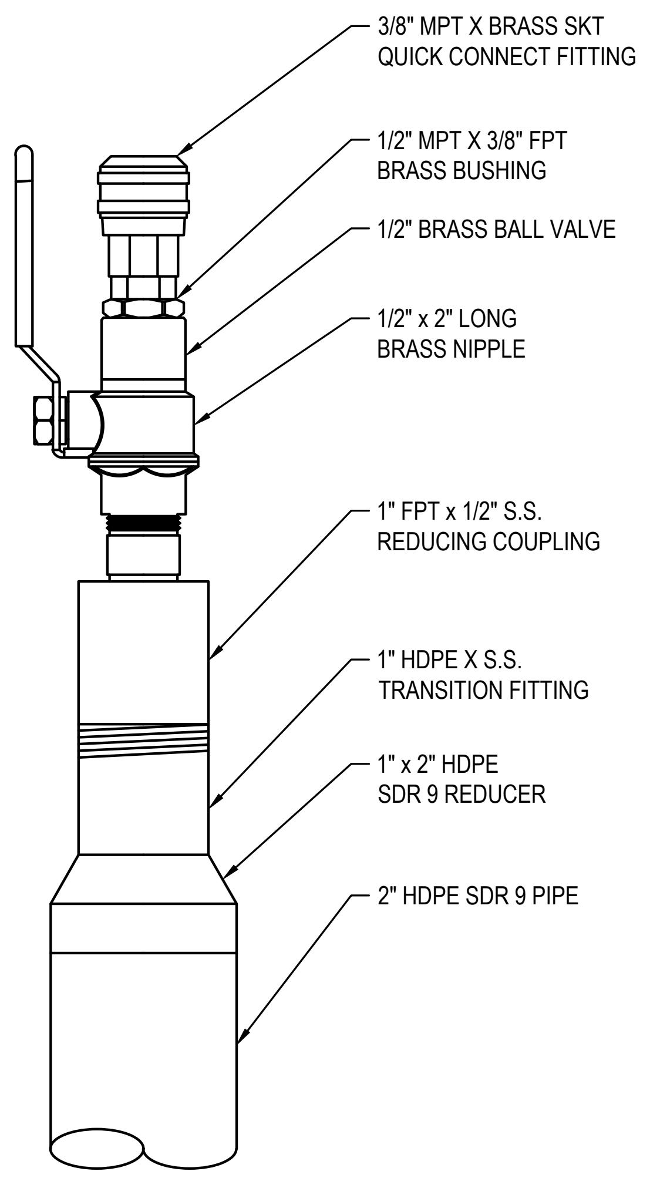
SHEET
01D-03



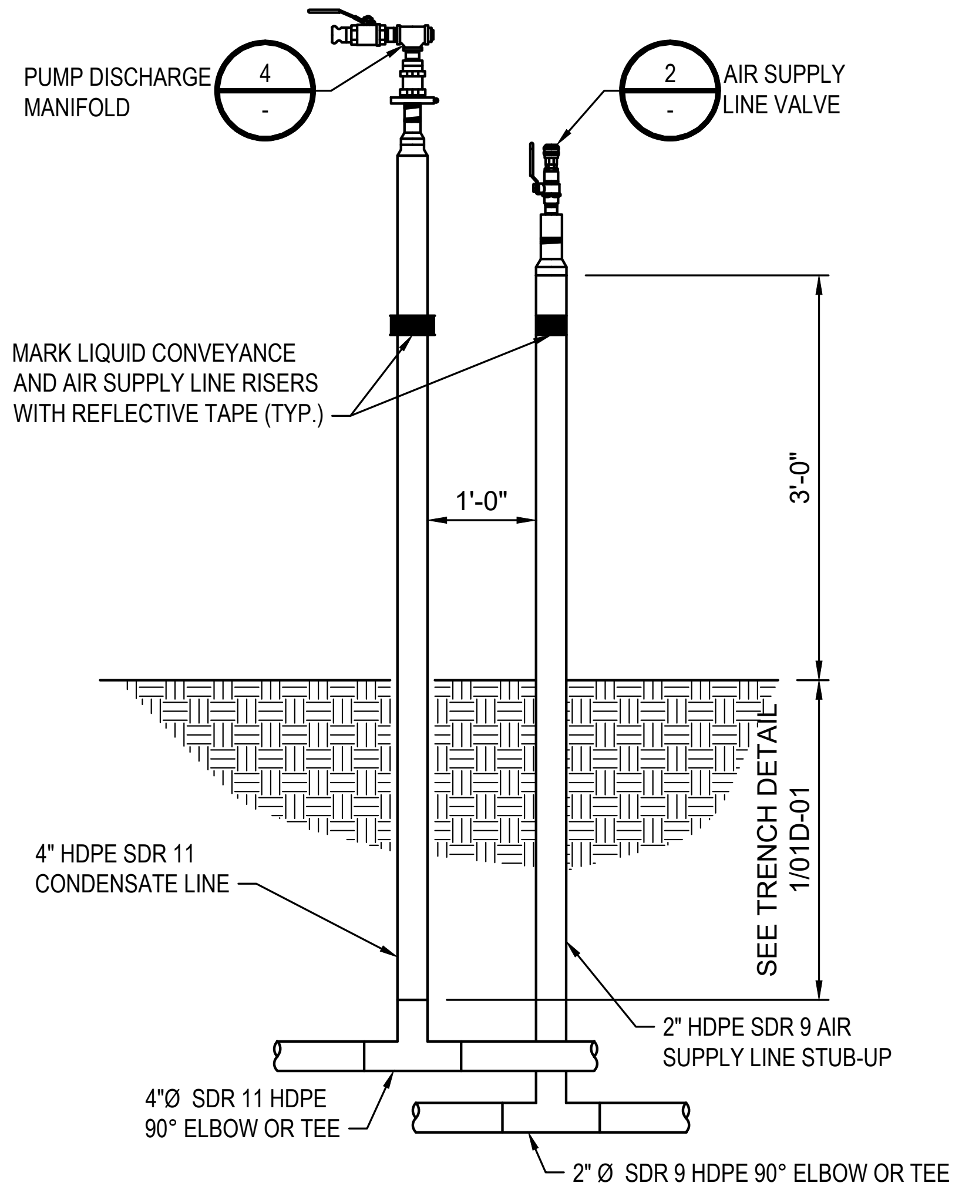
NOTE:

1. BOLLARDS TO BE INSTALLED NO MORE THAN 3'-0" FROM STRUCTURES. BOLLARDS TO BE INSTALLED ON FOUR SIDES OFFSET BY APPROXIMATELY 90 DEGREES.
2. BOLLARDS CAN BE GROUPED TO PROTECT VALVE GROUPS AT OWNER'S DISCRETION AND APPROVAL. MINIMUM 4 BOLLARDS REQUIRED.

1 / 01D-01 **BOLLARD**
NOT TO SCALE



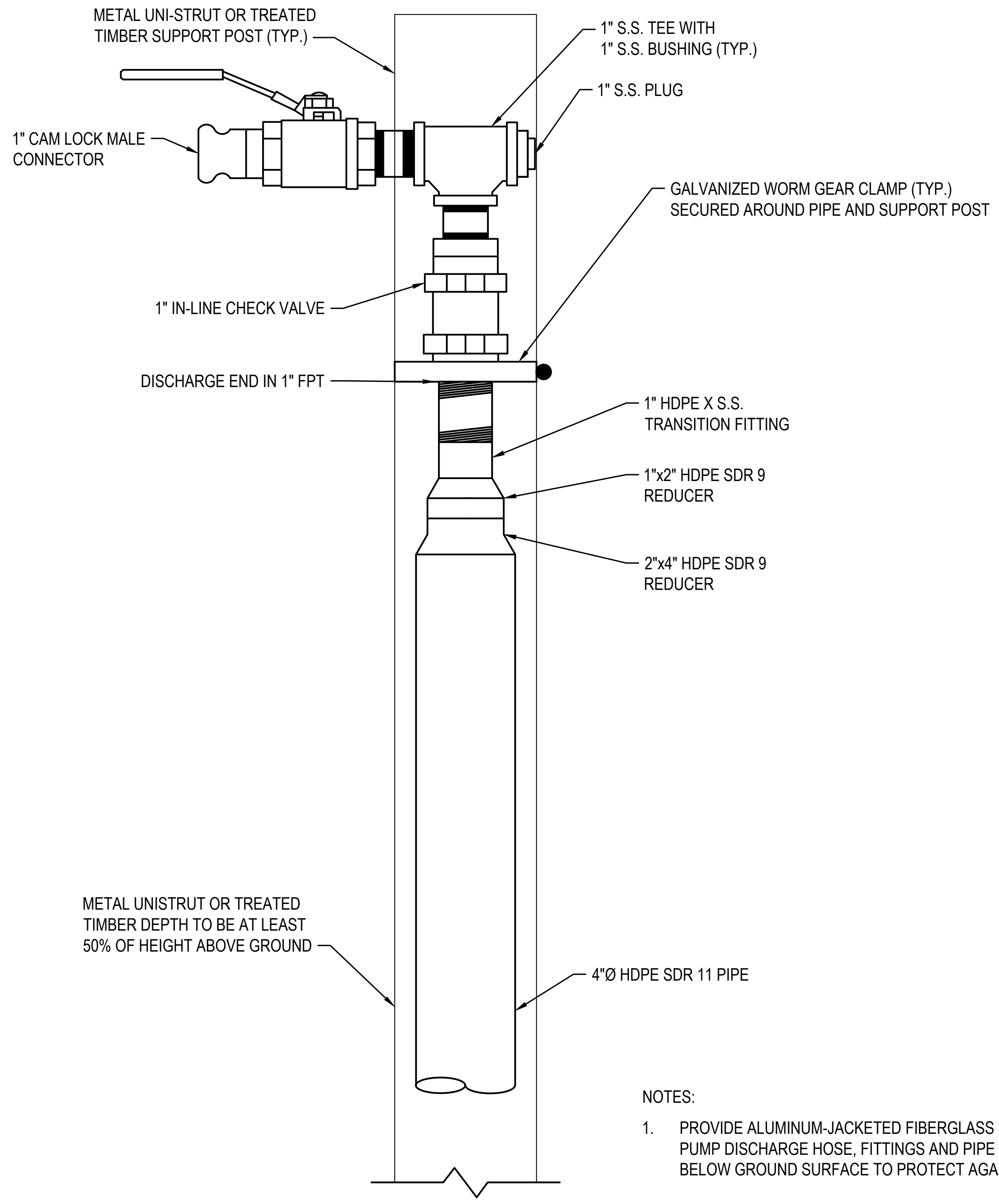
2 / 01D-04 **AIR SUPPLY LINE VALVE**
NOT TO SCALE



NOTE:

1. ALL AIR SUPPLY PIPE AND FITTINGS SHALL BE BUTT WELDED.
2. STUB UPS WILL BE LOCATED AT ALL NEW LFG WELLS.

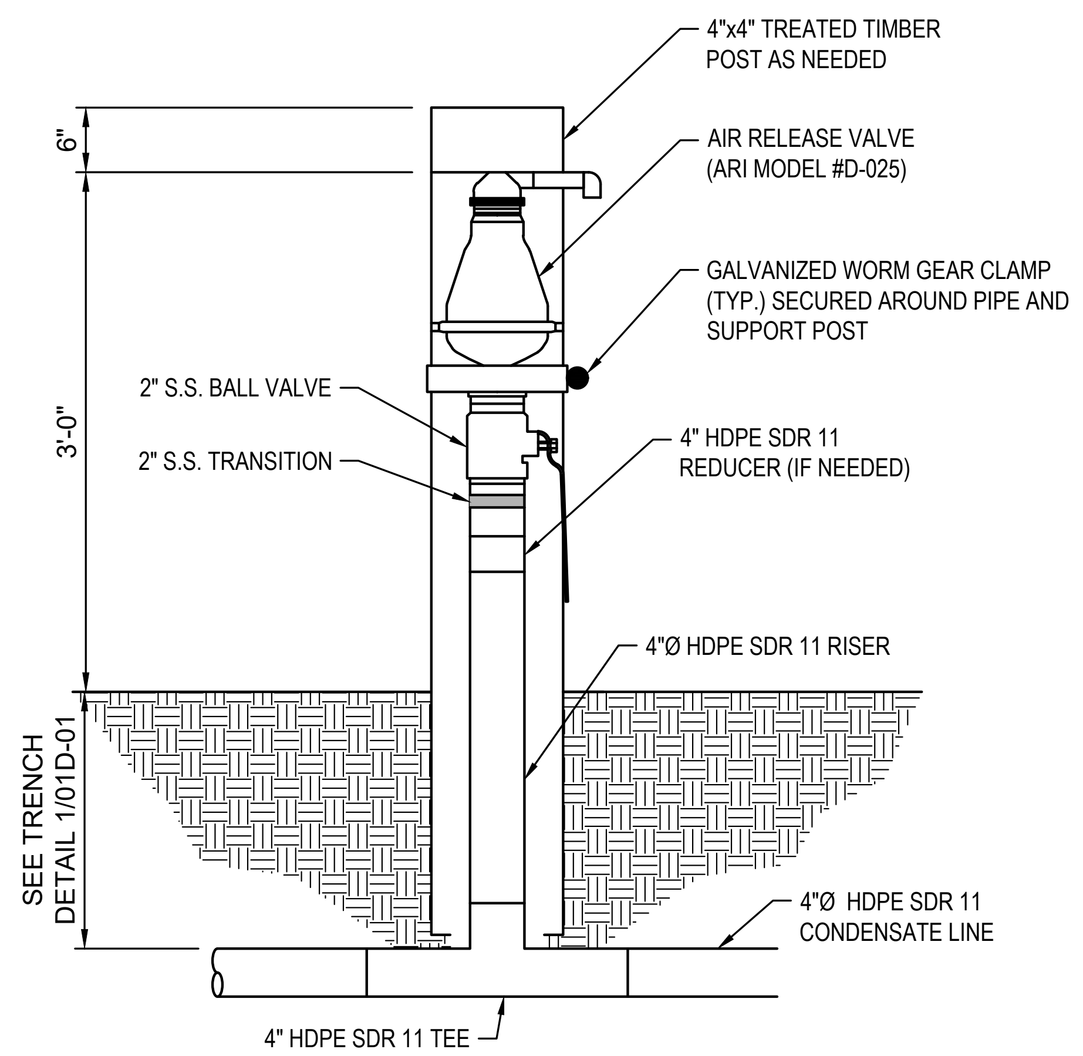
3 / 01C-02 **NEW AIR/FORCE MAIN STUB UP**
NOT TO SCALE



NOTES:

1. PROVIDE ALUMINUM-JACKETED FIBERGLASS INSULATION WRAP FOR ALL PUMP DISCHARGE HOSE, FITTINGS AND PIPE TO A MINIMUM OF 2 FEET BELOW GROUND SURFACE TO PROTECT AGAINST FREEZING.

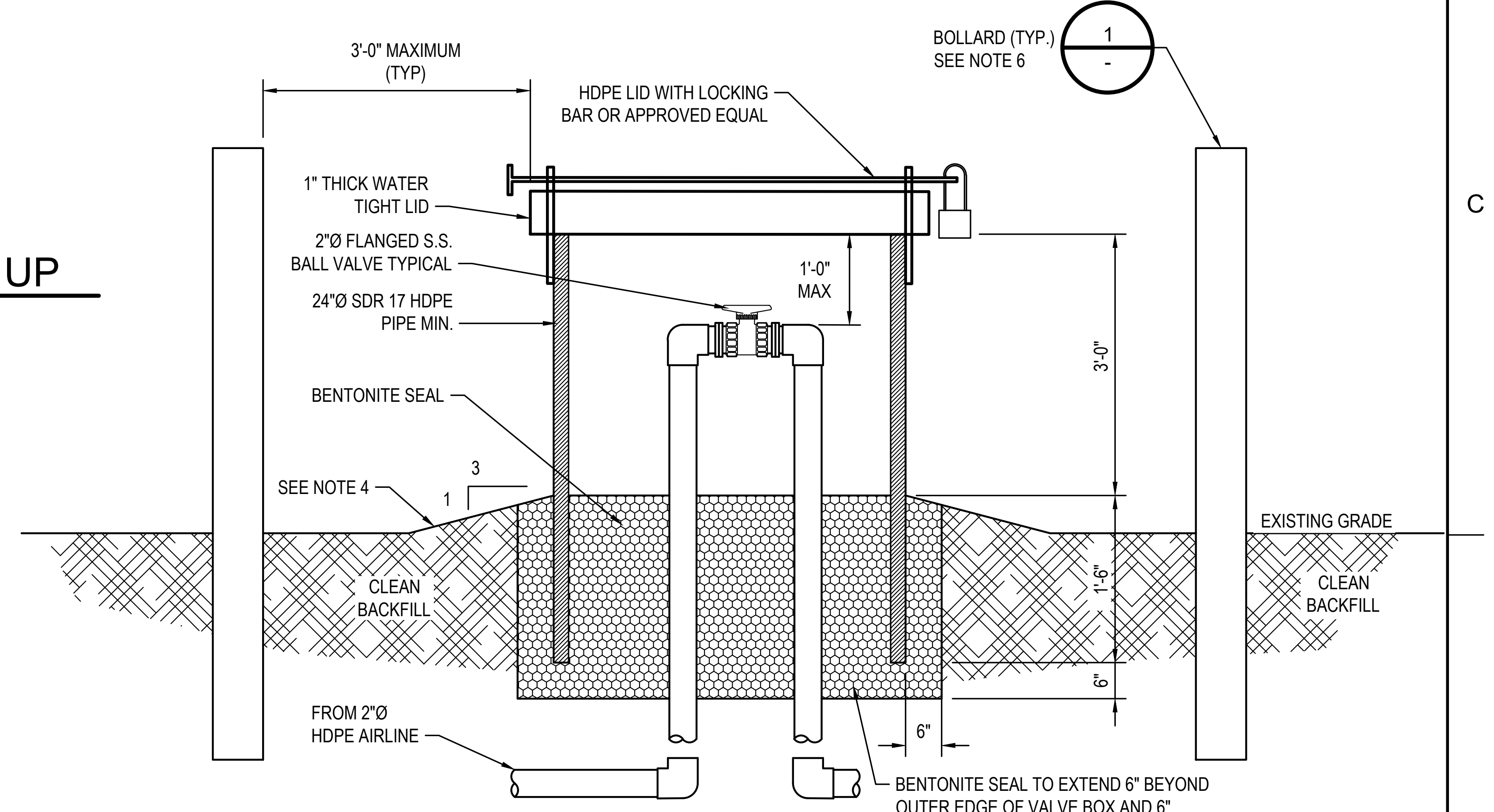
4 / 01D-04 **PUMP DISCHARGE MANIFOLD**
NOT TO SCALE

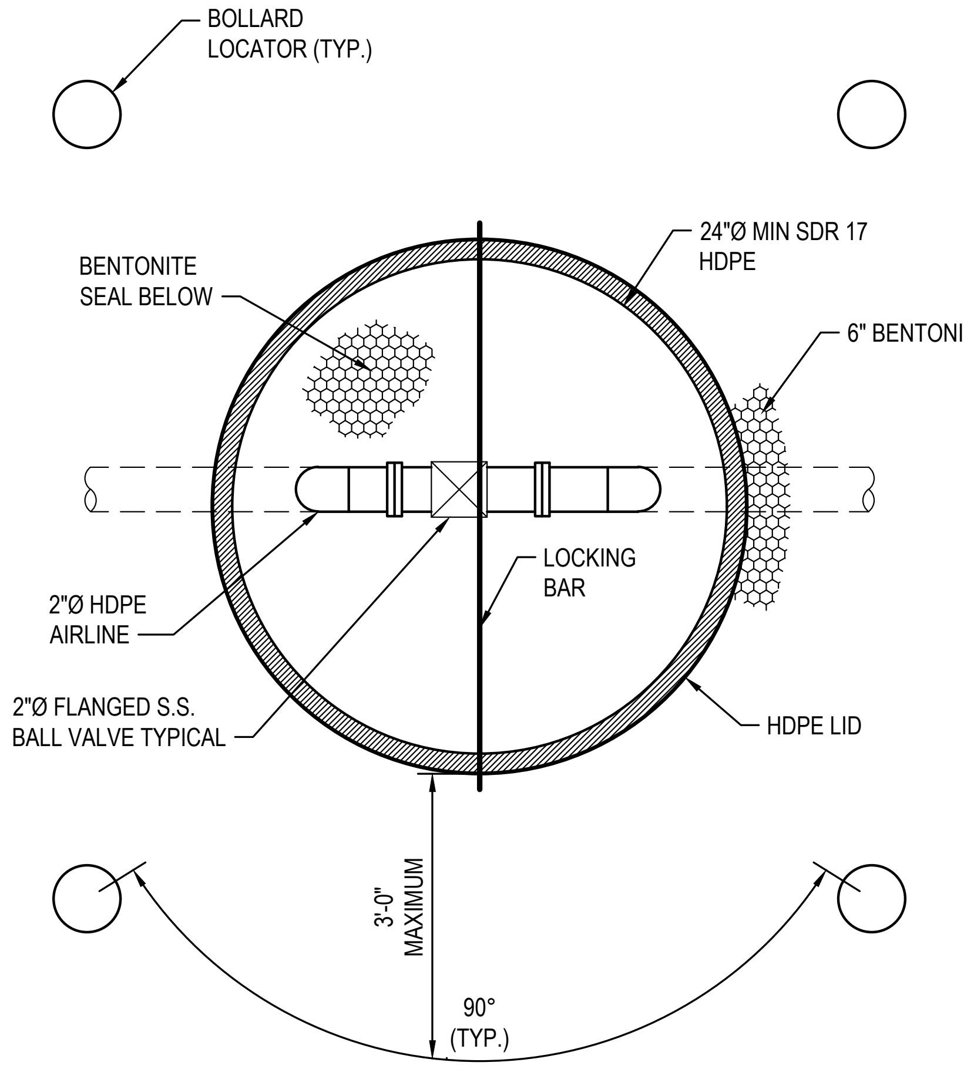


NOTE:

1. AIR RELEASE VALVE WILL BE LOCATED AT ALL HIGH POINTS

5 / 01C-02 **FORCEMAIN AIR RELEASE VALVE**
NOT TO SCALE





TOP VIEW

NOTES:

1. ALL FITTINGS SHALL BE HDPE SDR 9 UNLESS OTHERWISE NOTED.
2. VALVE BOX AND COVER SHALL BE 2'-0"Ø, WITH LID AND LOCKING DEVICE.
3. LABEL ALL VALVE PITS WITH IDENTIFICATION NUMBER WITH YELLOW OR WHITE PAINT AND STENCILS OR ADHESIVE LABEL AT 2" MINIMUM HEIGHT AND LOCATED IMMEDIATELY BELOW HIGH VISIBILITY TAPE.
4. EXISTING GRADE TO BE SLOPED FOR POSITIVE DRAINAGE IN A 1'Ø SURROUNDING SURFACE EXPRESSION.
5. BOLLARDS TO BE INSTALLED NO MORE THAN 3'-O" FROM THE OUTSIDE OF THE VALVE PIT. BOLLARDS TO BE INSTALLED ON FOUR SIDES OFFSET BY APPROXIMATELY 90 DEGREES.
6. BOLLARDS FOR VALVE GROUP CAN BE MINIMIZED/ COMBINED AROUND THE GROUP - MINIMUM 4 BOLLARDS REQUIRED.

6 / 01C-02 **AIR LINE VALVE PIT**
NOT TO SCALE

HDR Engineering, Inc. of the Carolinas
440 S. Church Street, Suite 1200
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. License Number: F-0116

ISSUE	DATE	DESCRIPTION
A	07/2024	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	M. PLUMMER, P.E.
PROJECT ENGINEER	E. TUCKER, P.E.
DRAWN BY	J. GAUL
PROJECT NUMBER	10335518

ROWAN COUNTY

Rowan County Landfill
Rowan LFG 2024 Expansion

789 Campbell Road
Woodleaf, NC 27054

NORTH CAROLINA

GAS COLLECTION SYSTEM DETAILS (4 OF 4)

0 1" 2"

FILENAME 01D-04.DWG
SCALE AS SHOWN

SHEET
01D-04

ATTACHMENT C
Excerpt from Parnel Blower/Flare Manual
(System Description)

PARNEL

BIOGAS Inc.

TULSA OKLAHOMA

Operating Instructions

DOT Energy Solutions, Inc.

Rowan County Landfill
789 Campbell Road
Woodleaf, NC 27054

One 1500scfm Landfill Gas Flare System
Parnel Biogas Job No. 16-166

June 30, 2017

5868 S. 129TH E. AVE. TULSA, OKLA. 74134
PH. 918-294-3868 FAX 918-294-9897

PARNEL
BIOGAS Inc.
TULSA OKLAHOMA

5868 S. 129TH E. AVE. TULSA, OKLA. 74134
PH. 918-294-3868 FAX 918-294-9897

TABLE OF CONTENTS:
JOB: 16-166 Rowan County Landfill

Section 1

System Description

PARNEL
BIOGAS Inc.
TULSA OKLAHOMA

16-166: Rowan County Landfill – 1500scfm Utility Flare

Process Specifications:

Landfill Gas Flow rate (max Flare)	1500 scfm
Landfill Gas Flow rate Flare (min Flare)	150 scfm
Flare exit velocity (not to exceed)	60.0 ft/sec
Landfill Gas Composition:	
Methane	30% - 55%
CO2, N2, O2, VOC's, H2O	Remainder
Heat Release (max)	54.6 MMBtu/hr
Inlet Pressure to flare	10" WC (approx)
Blower motor Horsepower	20 hp @ -40"wc
Site Elevation	791 msl approx.
Design wind load per ASCE 7-93	110mph
Noise level at 3ft.	< 85dba
Design ambient air temperature	-30F to 110F
Electrical Area Classification	Non-hazardous

Expected Flow/Emissions at 2000scfm, 50% methane:

N2	73.5 % vol.
O2	13.6 % vol.
CO2	6.0 % vol.
H2O	6.9 % vol.
NO2	0.068 lbs/MMBTU (per published EPA 60.18 section 13.5 Industrial Flares)
CO	0.31 lbs/MMBTU (per published EPA 60.18 section 13.5 Industrial Flares)

Destruction efficiency at design flow with landfill gas methane content of 40% to 60%---98% overall destruction of total hydrocarbons.

Guaranteed to meet E.P.A. emission standards for landfill gas utility type flares. Designed in accordance of EPA established criteria for open flares 40 CFR 60.18

THIS INFORMATION IS PROPRIETARY TO PARNEL BIOGAS INC.

Section 2

Operating Instructions

START UP: JOB: 16-166 Rowan County

All controls to the flares and inputs to be monitored are accessed through the MMI on the system control panel door. The following is the theory of how the system will function.

Normal flare auto startup

Select blower 1 and/or blower 2 from the Blower screen by placing them in auto position on the HMI. The flow block valve FV-301 must also be placed in the auto position. Move to the flare screen and place the system in “Auto” mode. The Flare propane pilot, SV-104 will be energized open for pilot ignition. After pilot is detected on TE-101 the landfill gas blower(s) selected will be energized to reach vacuum Setpoint set on the HMI (PIC-300). Block valve FV-301 located at the KO pot, will be energized open allowing flow to the flare.

The blower (s) will be controlled by the vacuum controller PIC-300. This unit has a selectable set point from the MMI screen.

If required the flare can be ran in manual for testing by selecting the manual functions on the MMI screen.

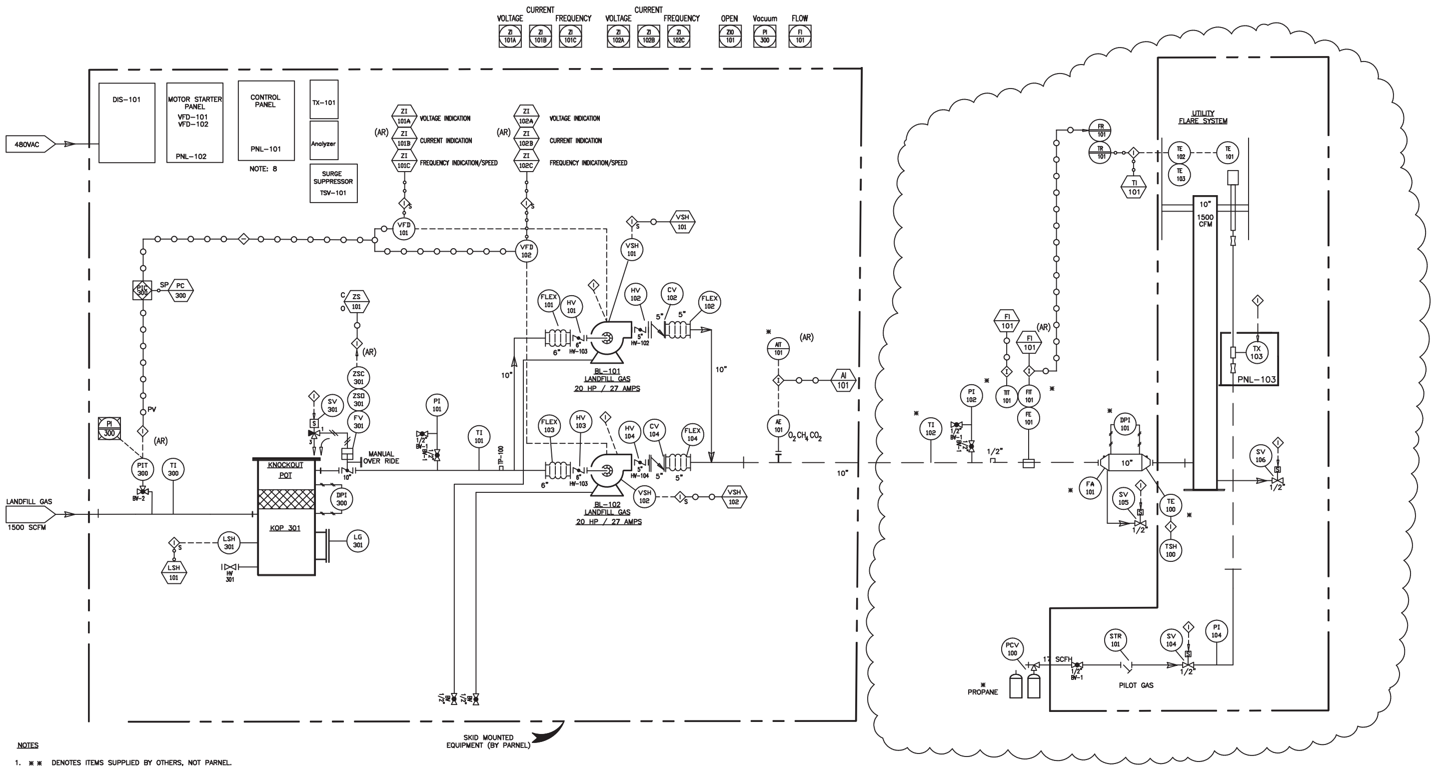
The recorder on the unit is activated by pushing the Start Recording button on the interactive screen. Once that is done the unit is recording the parameters that set in the recorder. In order to pull the SD card to load the information onto a laptop tap the upper left of the screen followed by a tap the lower right of the screen in quick succession. This will pull up a banner across the bottom of the screen with an SSD card icon on it. Select remove SD card yes. The card can now be removed from the recorder for down load. Once the down load is complete reinstall the card in the recorder and ensure the unit is set to record.

Section 3

Mechanical Drawings and Electrical Drawings

PROPRIETARY MATERIAL
The information contained within is the
property of Parnel Biogas Inc and shall not
be copied or used in any manner or disclosed
to others except as expressly authorized.

ZONE	LTR	DESCRIPTION	DATE	APPROVED



NOTES

1. ⁎⁎ DENOTES ITEMS SUPPLIED BY OTHERS, NOT PARNEL.
2. ⁎ DENOTES ITEMS TO BE SHIPPED LOOSE. INSTALLED BY OTHERS.
3. ALL PIPING MUST CONFORM TO ANST B313.
4. ---------- ELECTRICAL SIGNAL
5. — — — — FIELD PIPING
6. —o—o—o—o— INTER LINK
7. TRACE, INSULATION & LAGGING
8. Control Panels to be Nema 4X Non-Classified.

START-UP PANEL FACE MOUNTED INSTRUMENT
HMI DISPLAY
PLC FUNCTION
LOCAL CONTROL ROOM PLC PANEL
LOCALLY MOUNTED INSTRUMENT
CUSTOMER CONTROL SYSTEM
START-UP PANEL INDICATOR LIGHT
◇ PLC INTERLOCK SIGNAL
(AR) RECORDER

R4, MADE SKID AND FLARE SEPERATE.

NEXT ASSEMBLY | USED ON
APPLICATION

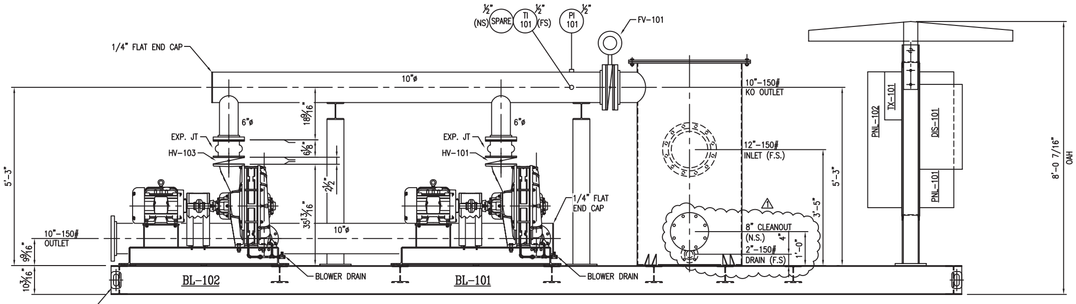
CUSTOMER Rowan County Landfill
PO NO.
LOCATION Woodleaf NC
USER Rowan County Landfill
LANDFILL
DRAWN KDG
DATE 11/16/16
DESIGN CP
DATE 10/24/16

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

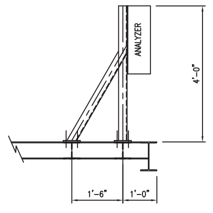
TITLE
PIPING & INSTRUMENT
DIAGRAM
UTILITY FLARE

SIZE D
DWG NO. 16-166-100
4
SCALE NONE
REL DATE
SHEET 1 OF 1

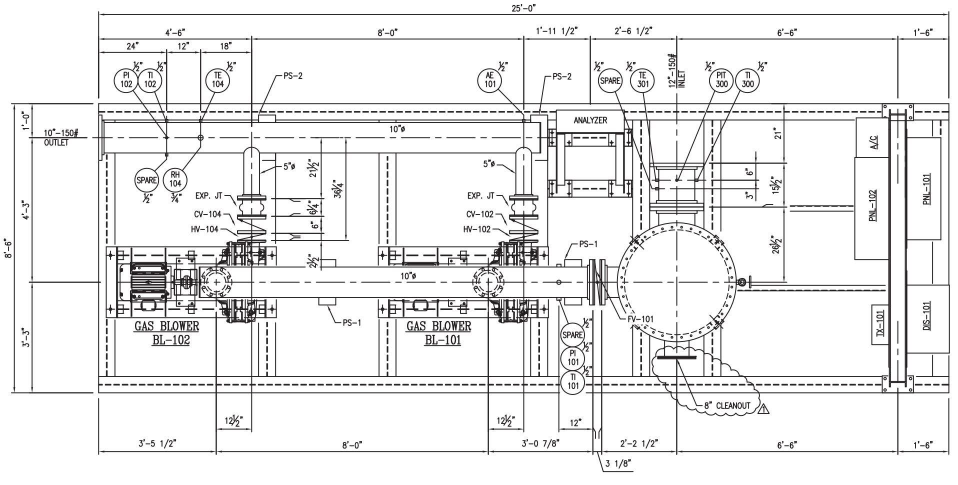
PROPRIETARY MATERIAL
The information contained within is the property of Parnel Biogas Inc and shall not be copied or used in any manner or disclosed to others except as expressly authorized.



FRONT ELEVATION



ANALYZER DETAIL



PLAN VIEW

NOTES:
1. 304SS SCH. 10 UNLESS OTHERWISE NOTED

REV	DESCRIPTION	DATE	DR.	APP.
1	ADDED 8" CLEANOUT	5/9/17	AR	BC
0	ISSUED FOR CONSTRUCTION	2/7/17	AR	BC

CUSTOMER
DOT ENERGY SOLUTIONS
PO NO.
LOCATION
WOODLEAF, NC
USER
ROWAN COUNTY
LANDFILL
DRAWN AR
DATE 1/17
DESIGN JP
DATE 1/17

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
GENERAL ARRANGEMENT
SKID AND PIPING DETAILS
10" FLARE SYSTEM

SIZE D
DWG NO. 16-166-301
1
SCALE NONE
REL DATE
SHEET 1 OF 1

PROPRIETARY MATERIAL
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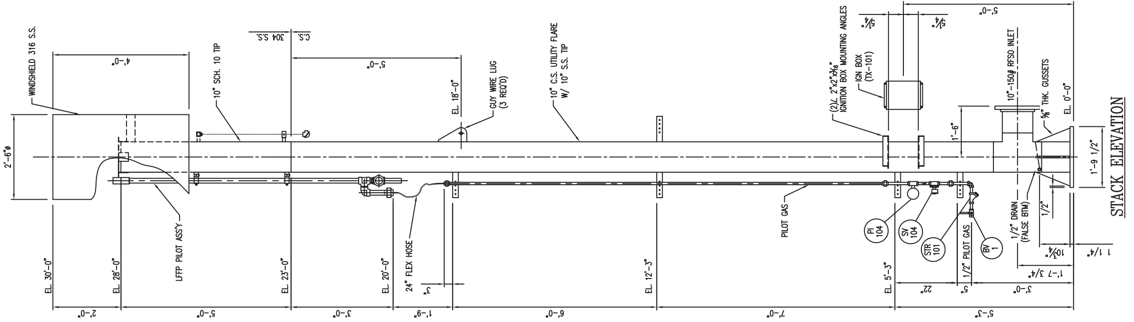
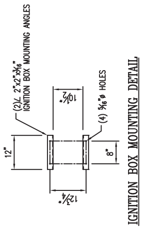


STACK ELEVATION

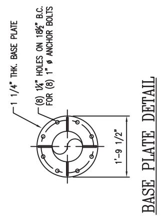
FOUNDATION LOADINGS

VERTICAL LOAD = 2.4 KIPS
SHEAR = 1.8 KIPS
MOMENT = 35.0 FT-KIPS

BASED ON 200°F TEMP
AND 110 MPH WIND LOAD
W/ 1/16" CORROSION ALLOWANCE.



IGNITION BOX MOUNTING DETAIL



BASE PLATE DETAIL

GENERAL NOTES:

1) STRUCTURAL STEEL = A36.
2) WELDING PER AWS/ FAB. PER AISC.
3) ALL TAG No'S. TO BE PREFIXED BY PARNEL W.O. No.
4) PIPING PER PARNEL SPEC. (CONFORMS TO B31.3)
5) STACK & PIPING FINISH - EXT. C.S. ~ SANDBLAST PER
SSPC-SP6 AND GALVANIZE.
6) ALL BOLT HOLES TO STRADDLE CENTER LINES UNLESS OTHERWISE NOTED

REV	DESCRIPTION	DATE	DR.	APP.
0	ISSUED FOR CONSTRUCTION	2/7/17	AR	BC

CUSTOMER
DOT ENERGY SOLUTIONS
PO NO.
LOCATION
WOODLEAF, NC
USER
ROWAN COUNTY
LANDFILL
DRAWN AR DATE 1/17
DESIGN JP DATE 1/17

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
GENERAL ARRANGEMENT
10" x 40' TALL
FLARE STACK

SIZE D
DWG NO. 16-166-302
0
SCALE NONE
REL DATE
SHEET 1 OF 1

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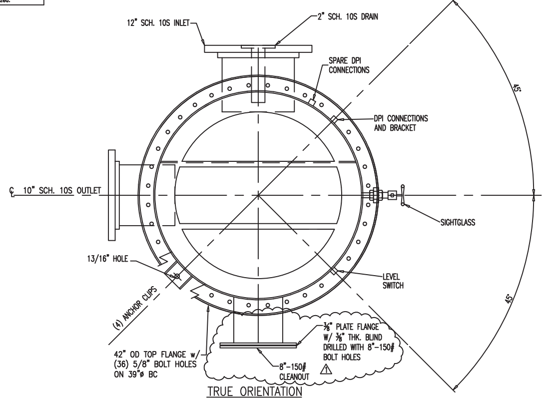
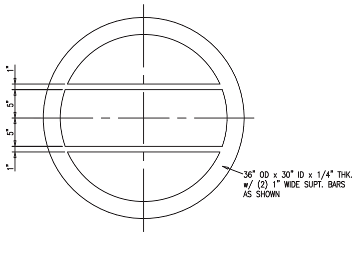
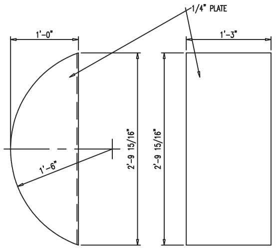


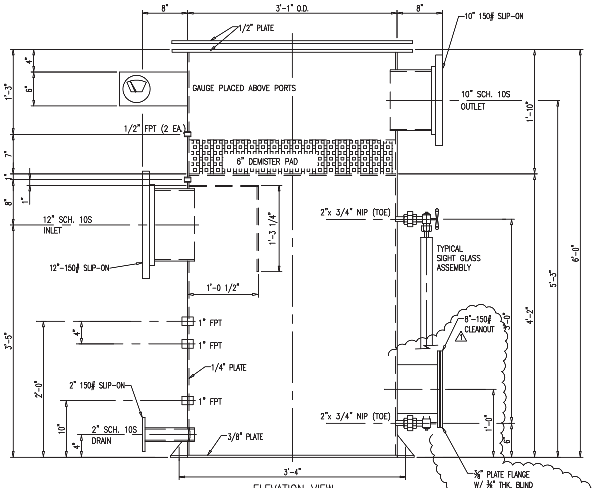
TRUE ORIENTATION
SHOWN WITHOUT LID



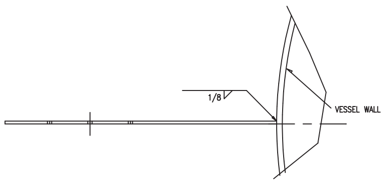
DEMISTER SUPPORT DETAIL
SHOWN WITHOUT LID

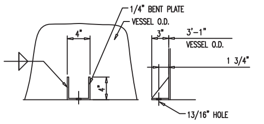


BAFFLE PLATE DETAIL
TWO PIECES AS SHOWN

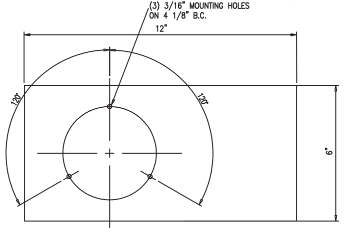


ELEVATION VIEW
ITEMS ROTATED FOR CLARITY





ANCHOR CLIP DETAIL
FOUR REQ'D AS SHOWN (LOCATE AT 45°)



MAGNEHELIC DPI MOUNTING PLATE
12 GA. PLATE

NOTES

1. ALL MATERIAL TO BE 304SS.
2. ALL NOZZLES TO HAVE 1" MIN. PROJECTION INSIDE.

REV	DESCRIPTION	DATE	DR.	APP.
1	ADDED 8" CLEANOUT	5/9/17	AR	BC
0	ISSUED FOR CONSTRUCTION	2/7/17	AR	BC

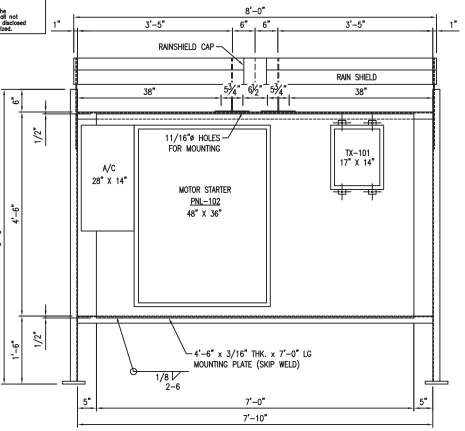
CUSTOMER
DOT ENERGY SOLUTIONS
PO NO.
LOCATION
WOODLEAF, NC
USER
ROWAN COUNTY
LANDFILL
DRAWN AR
DATE 1/17
DESIGN JP
DATE 1/17

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

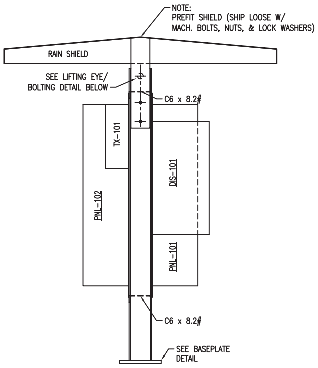
TITLE
KNOCKOUT POT DETAIL
37" O.D. x 6'-0" TALL
12" INLET x 10" OUTLET

SIZE D
DWG NO. 16-166-340
1
SCALE NONE
REL DATE
SHEET 1 OF 1

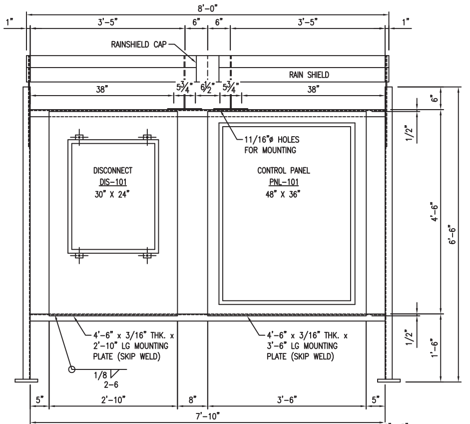
PROPRIETARY MATERIAL
The information contained within is the property of Parnel Biogas Inc and shall not be copied or used in any manner or disclosed to others except as expressly authorized.



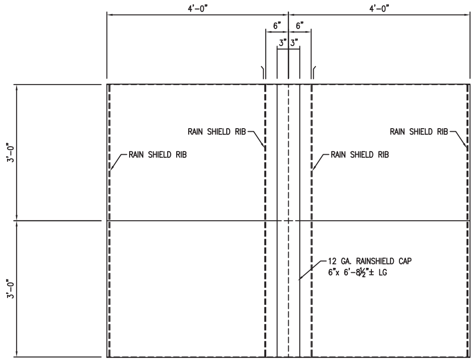
FRONT ELEVATION



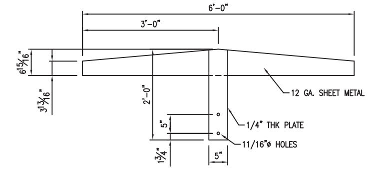
END ELEVATION



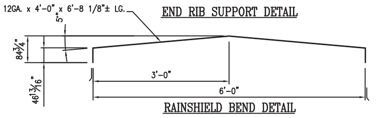
BACK ELEVATION



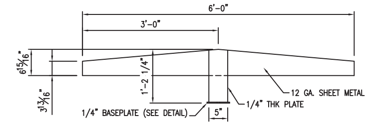
RAIN SHIELD DETAILS



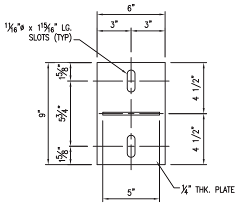
END RIB SUPPORT DETAIL



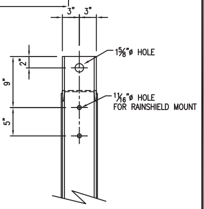
RAINSHIELD BEND DETAIL



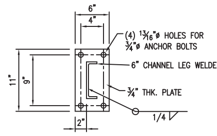
MIDDLE RIB SUPPORT DETAIL



MIDDLE RIB MOUNTING BASEPLATE



LIFTING EYE/BOLTING DETAIL



CONTROL RACK BASE PLATE
(2 REQ'D)

NOTES:
1. SHIP RAINSHIELD W/ NUTS, BOLTS, AND WASHERS LOOSE.
2. FINISH – EXTERNAL CARBON STEEL:
SANDBLAST PER SSPC-SP-6 AND HOT DIP GALVANIZE
3. PIPING PER PARNEL SPEC. B-1
4. ALL WELDS TO BE ³⁄₁₆" MIN. CONT. SEAL WELDS PER AWS D1.1, UNLESS NOTED OTHERWISE
5. ALL BUTTWELDS TO BE FULL PENETRATION
6. ALL VA's & PANELS TO HAVE MANUFACTURER'S STANDARD FINISH
7. RACK PIPING TO BE SOAP BUBBLE TESTED.
8. USE SCREWED FITTINGS ON RACK PIPING.
9. STRUCTURAL STEEL TO BE A-36 UNLESS NOTED OTHERWISE.
10. FABRICATION PER A.I.S.C.

REFERENCE DWG. 16-166-301_____BLOWER SKID ARRANGEMENT

REV	DESCRIPTION	DATE	DR.	APP.
0	ISSUED FOR CONSTRUCTION	2/7/17	AR	BC

CUSTOMER
DOT ENERGY SOLUTIONS
PO NO.
LOCATION
WOODLEAF, NC
USER
ROWAN COUNTY
LANDFILL
DRAWN AR DATE 1/17
DESIGN JP DATE 1/17

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
CONTROL RACK
ARRANGEMENT

SIZE D
DWG NO. 16-166-350
0
SCALE NONE
REL DATE
SHEET 1 OF 1

PROPRIETARY MATERIAL
The information contained within is the
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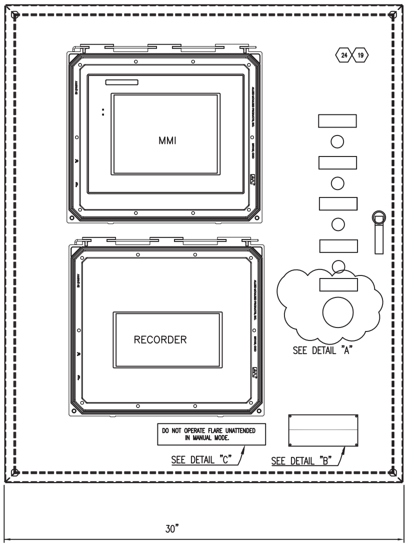
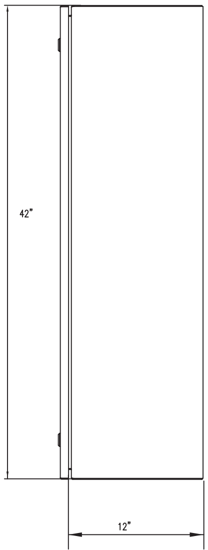
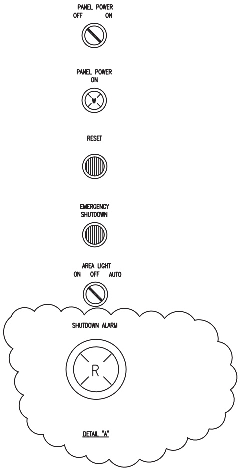
to others except as expressly authorized.



FRONT VIEW



END VIEW



DETAIL "A"

Parnel Biogas Inc

JOB NUMBER	16-166
DESCRIPTION	PNL-101
SHIP DATE	3/8/17

DETAIL "B"

WARNING
DO NOT OPERATE FLARE UNATTENDED
IN MANUAL MODE.

DETAIL "C"

c UL us LISTED
ENCLOSED INDUSTRIAL CONTROL PANEL
No. CL 44XXXX

TO BE MOUNTED INSIDE PANEL PER 508A

1. PANEL IS NEMA 4X, NON-CLASSIFIED.
2. ALL TAGS TO BE WHITE WITH BLACK LETTERS.

REV	DESCRIPTION	DATE	DR.	APP.
2	ALARM BECON ADDED PER CUSTOMER REQUEST	4/25/17	KDG	CP
0				

CUSTOMER
DOT ENERGY
PO NO.
n/a
LOCATION
WOODLEAF, NC
USER
ROWAN COUNTY
LANDFILL

DRAWN CP	DATE 12/6/16
DESIGN CP	DATE 12/6/16

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
PNL-101
LADDER LOGIC

SIZE D	DWG NO. 16-166-700	2
SCALE	REL DATE	SHEET 1 OF 1

PROPRIETARY MATERIAL
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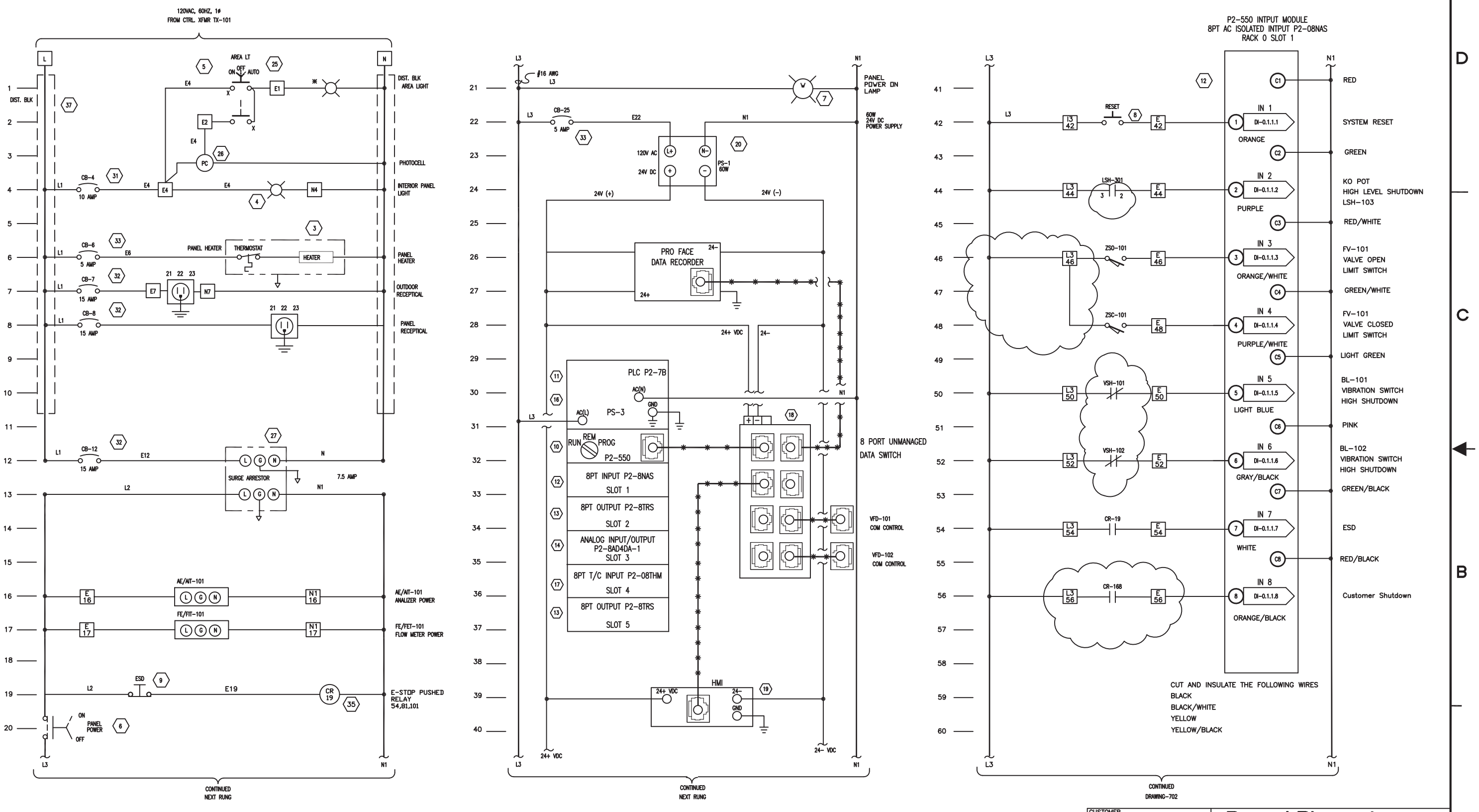

CUT AND INSULATE THE FOLLOWING WIRES
BLACK
BLACK/WHITE
YELLOW
YELLOW/BLACK

LEGEND:

□ — PNL-101 TERMINAL

▽ — PNL-102 TERMINAL

—— WIRING BY PARNEL

- - - - FIELD WIRING BY PARNEL

* * DENOTES ITEMS SUPPLIED BY OTHERS, NOT PARNEL.

NOTES:

R2, ASBUILT

REV	DESCRIPTION	DATE	DR.	APP.

CUSTOMER
DOT ENERGY

PO NO.
n/a

LOCATION
WOODLEAF, NC

USER
ROWAN LANDFILL

DRAWN CP
DATE 12/16/16

DESIGN CP
DATE 12/16/16

Parnel Biogas Inc

5868 S 129TH E. AVE
Tulsa, OK 74134

UTILITY FLARES
ENCLOSED FLARES

CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
PNL-101
LADDER LOGIC

SIZE D
DWG NO. 16-166-701
2

SCALE
REL DATE
SHEET 1 OF 1

PROPRIETARY MATERIAL
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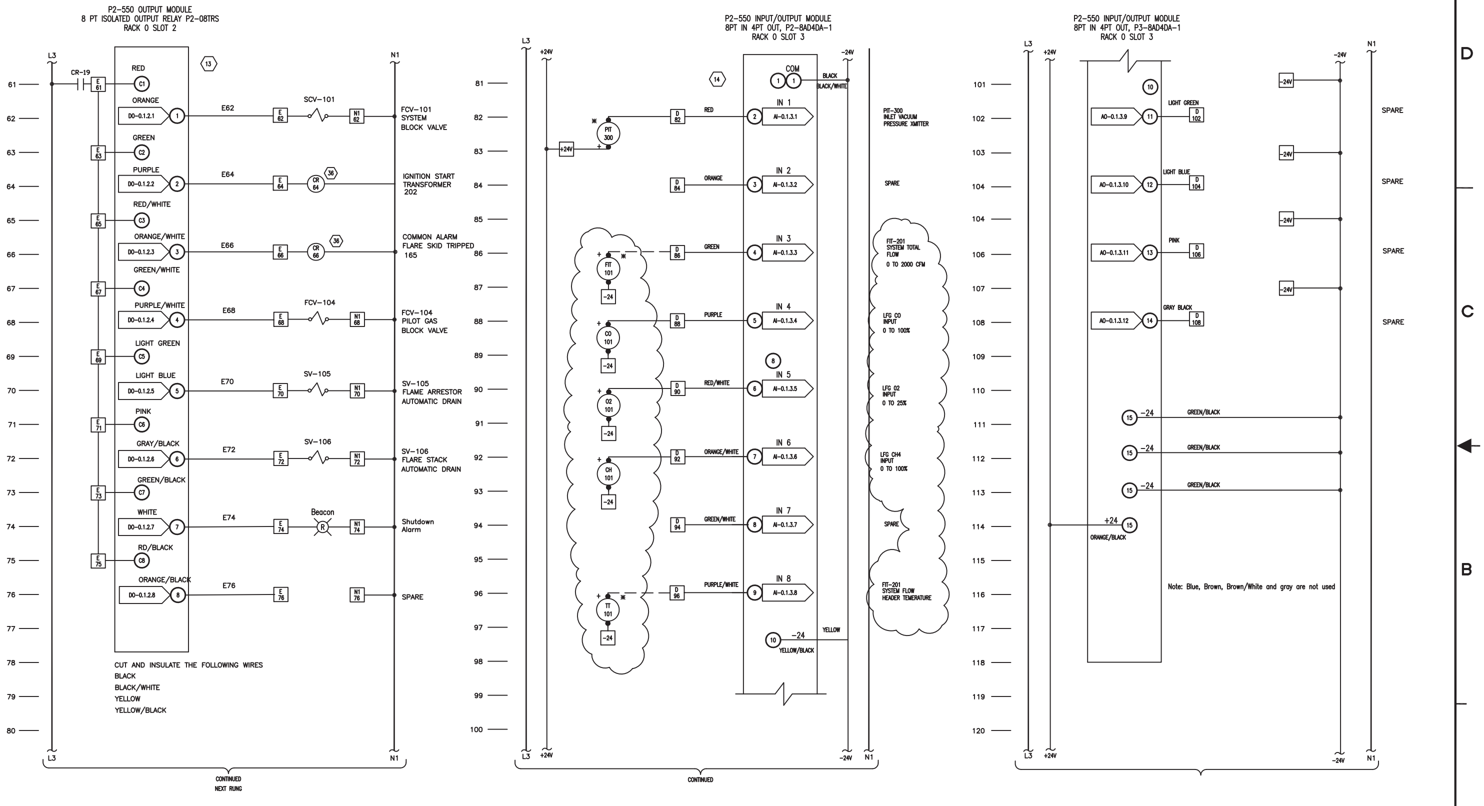

LEGEND:

☐ — PNL-101 TERMINAL

▽ — PNL-102 TERMINAL

—— WIRING BY PARNEL

- - - - FIELD WIRING BY PARNEL

✱ ✱ DENOTES ITEMS SUPPLIED BY OTHERS, NOT PARNEL.

NOTES:

R2, AS BUILT.

REV	DESCRIPTION	DATE	DR.	APP.

CUSTOMER
DOT ENERGY
PO NO.
n/a
LOCATION
WOODLEAF, NC
USER
ROWAN LANDFILL
DRAWN CP
DATE 12/16/16
DESIGN CP
DATE 12/16/16

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
PNL-101
LADDER LOGIC

SIZE D
DWG NO. 16-166-702
2
SCALE
REL DATE
SHEET 1 OF 1

PROPRIETARY MATERIAL
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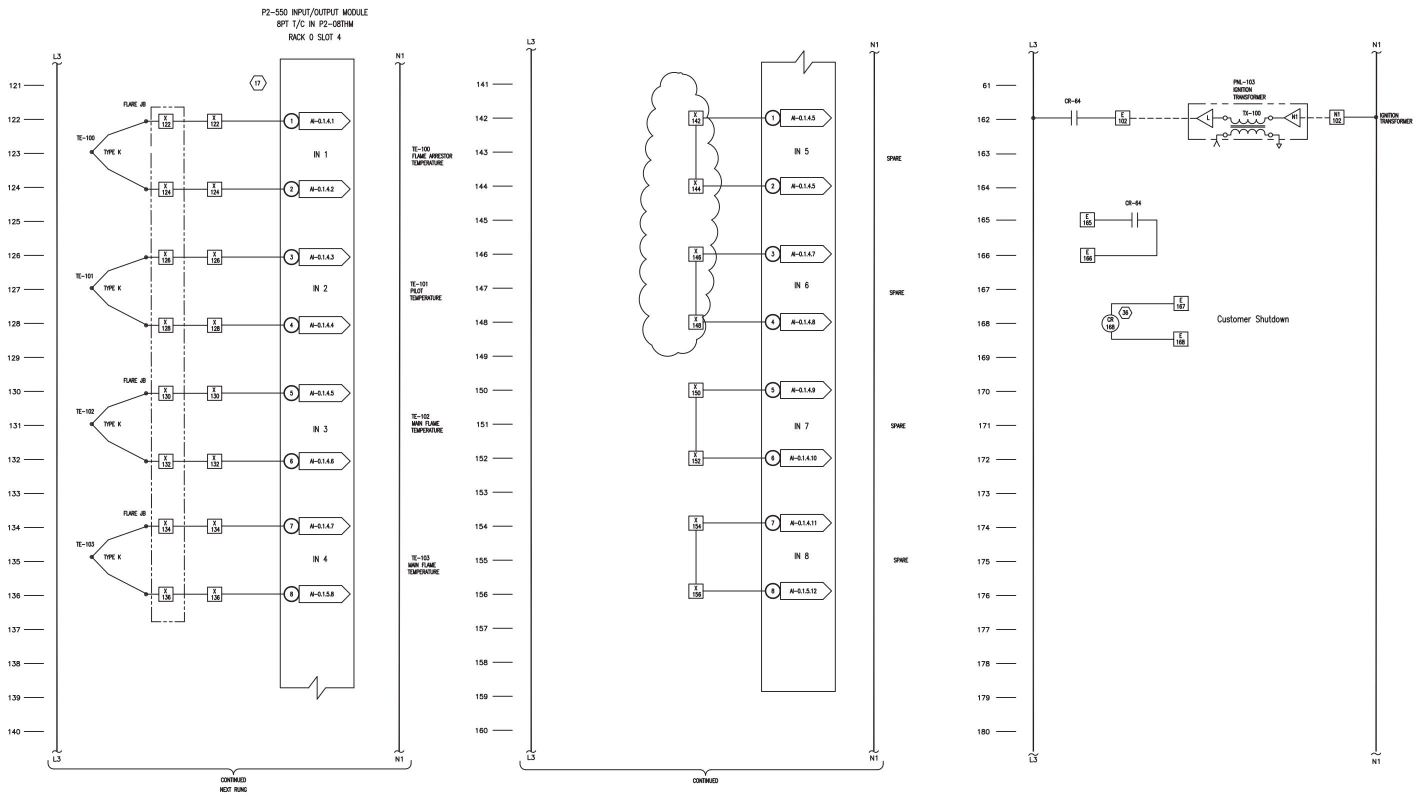

LEGEND:

□ — PNL.-101 TERMINAL

▽ — PNL.-102 TERMINAL

——— WIRING BY PARNEL

– – – – FIELD WIRING BY PARNEL

✱ ✱ DENOTES ITEMS SUPPLIED BY OTHERS, NOT PARNEL.

NOTES:

R2, AS BUILT

REV	DESCRIPTION	DATE	DR.	APP.

CUSTOMER
DOT ENERGY
PO NO.
n/a
LOCATION
WOODLEAF, NC
USER
ROWAN LANDFILL
DRAWN CP
DATE 12/16/16
DESIGN CP
DATE 12/16/16

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
PNL-101
LADDER LOGIC

SIZE D
DWG NO. 16-166-703
2
SCALE
REL DATE
SHEET 1 OF 1

PROPRIETARY MATERIAL
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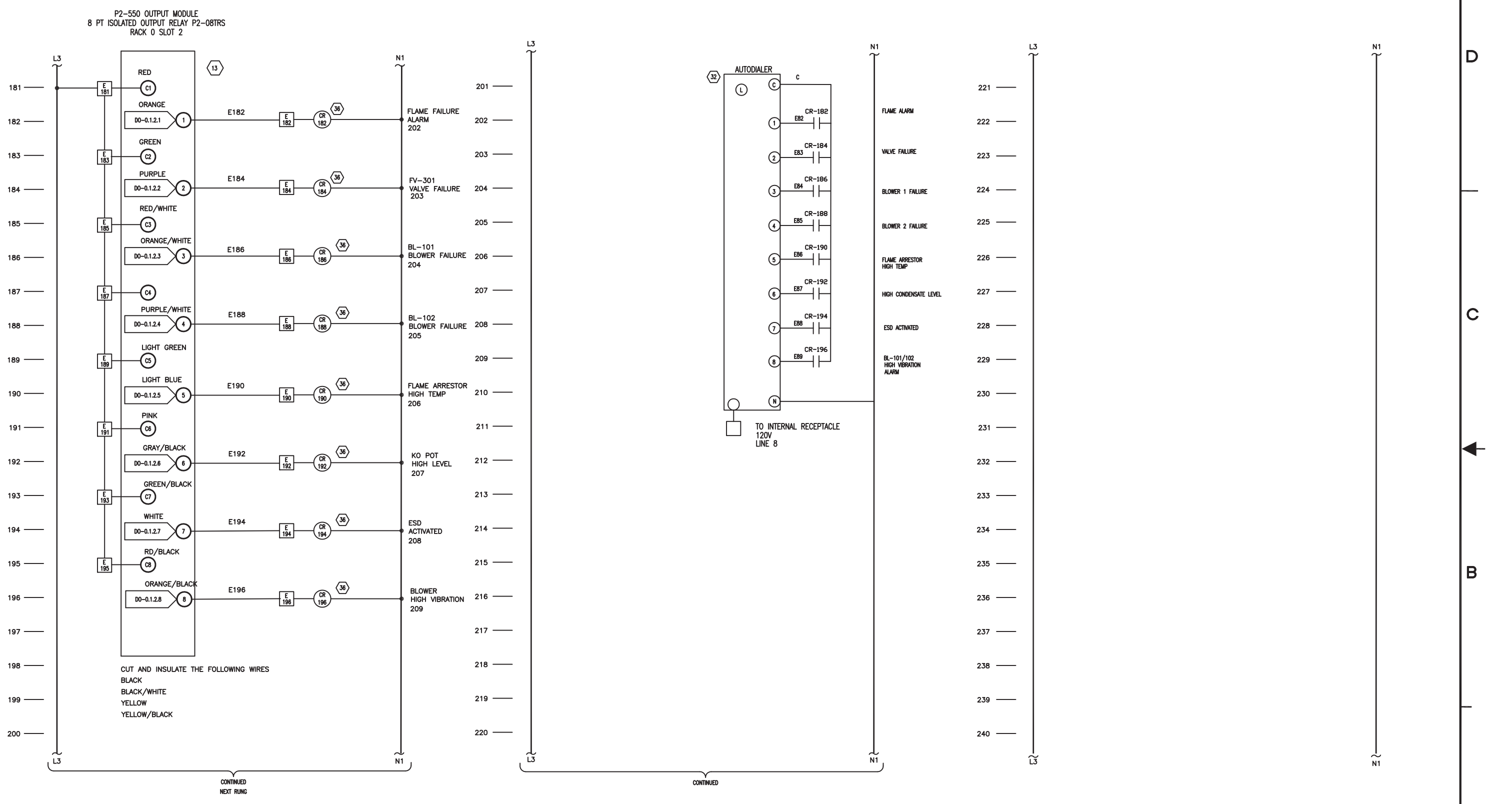

LEGEND:

□ — PNL-101 TERMINAL

▽ — PNL-102 TERMINAL

——— WIRING BY PARNEL

– – – – FIELD WIRING BY PARNEL

✱✱ DENOTES ITEMS SUPPLIED BY OTHERS, NOT PARNEL.

NOTES:

REV	DESCRIPTION	DATE	DR.	APP.

CUSTOMER
DOT ENERGY
PO NO.
n/a
LOCATION
WOODLEAF, NC
USER
ROWAN LANDFILL
DRAWN CP DATE 12/16/16
DESIGN CP DATE 12/16/16

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
PNL-101
LADDER LOGIC

SIZE D
DWG NO. 16-166-704
0
SCALE
REL DATE
SHEET 1 OF 1

PROPRIETARY MATERIAL
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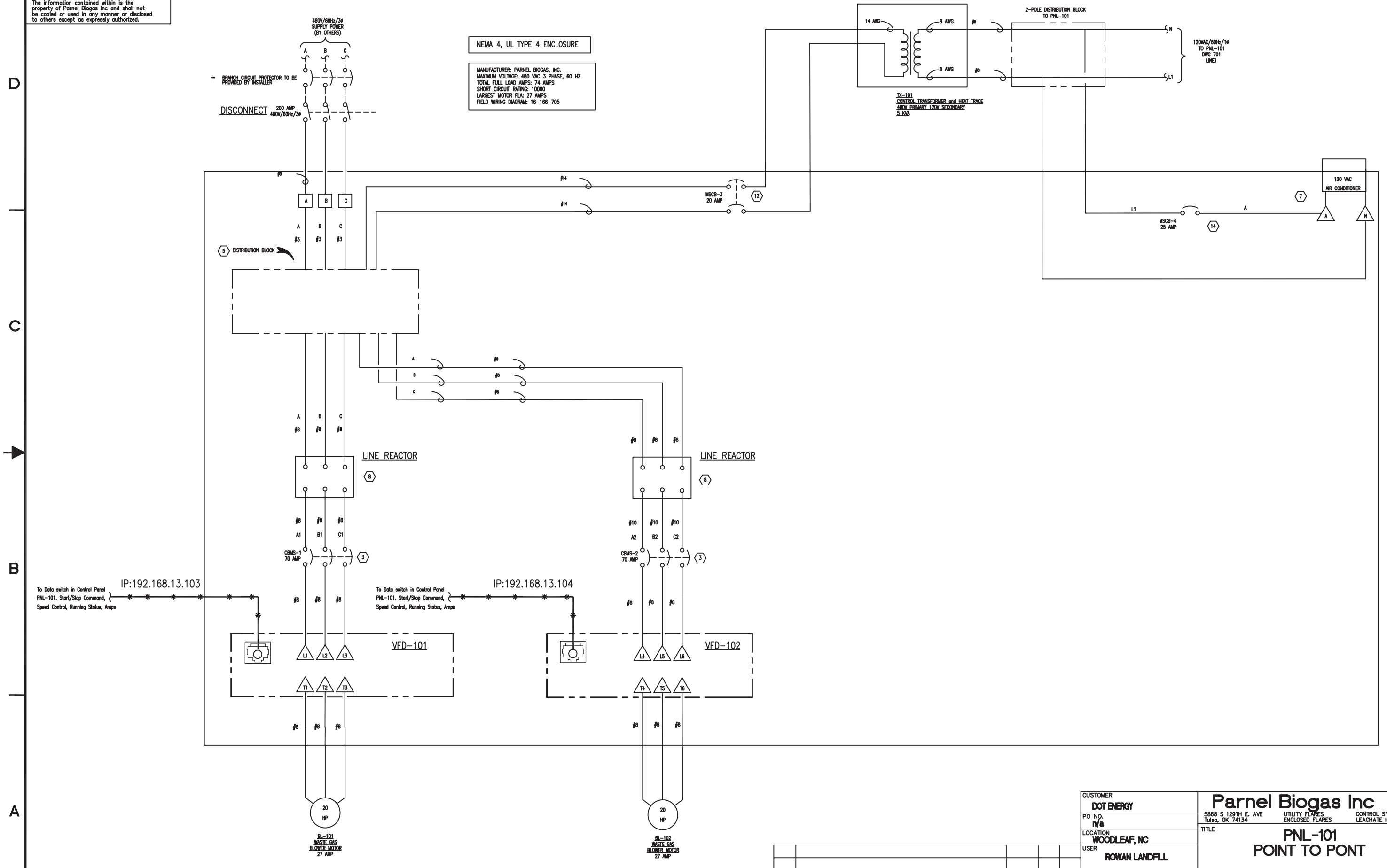

NEMA 4, UL TYPE 4 ENCLOSURE

MANUFACTURER: PARNEL BIOGAS, INC.
MAXIMUM VOLTAGE: 480 VAC 3 PHASE, 60 HZ
TOTAL FULL LOAD AMPS: 74 AMPS
SHORT CIRCUIT RATING: 10000
LARGEST MOTOR FLA: 27 AMPS
FIELD WIRING DIAGRAM: 16-166-705

NOTE; PANELS ARE UL 508A

REV	DESCRIPTION	DATE	DR.	APP.

CUSTOMER
DOT ENERGY
PO NO.
n/a
LOCATION
WOODLEAF, NC
USER
ROWAN LANDFILL
DRAWN CP
DATE 12/16/16
DESIGN CP
DATE 12/16/16

Parnel Biogas Inc
5868 S 129TH E. AVE
Tulsa, OK 74134
UTILITY FLARES
ENCLOSED FLARES
CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
PNL-101
POINT TO PONT

SIZE D
DWG NO. 16-166-705
1
SCALE
REL DATE
SHEET 1 OF 1

PROPRIETARY MATERIAL
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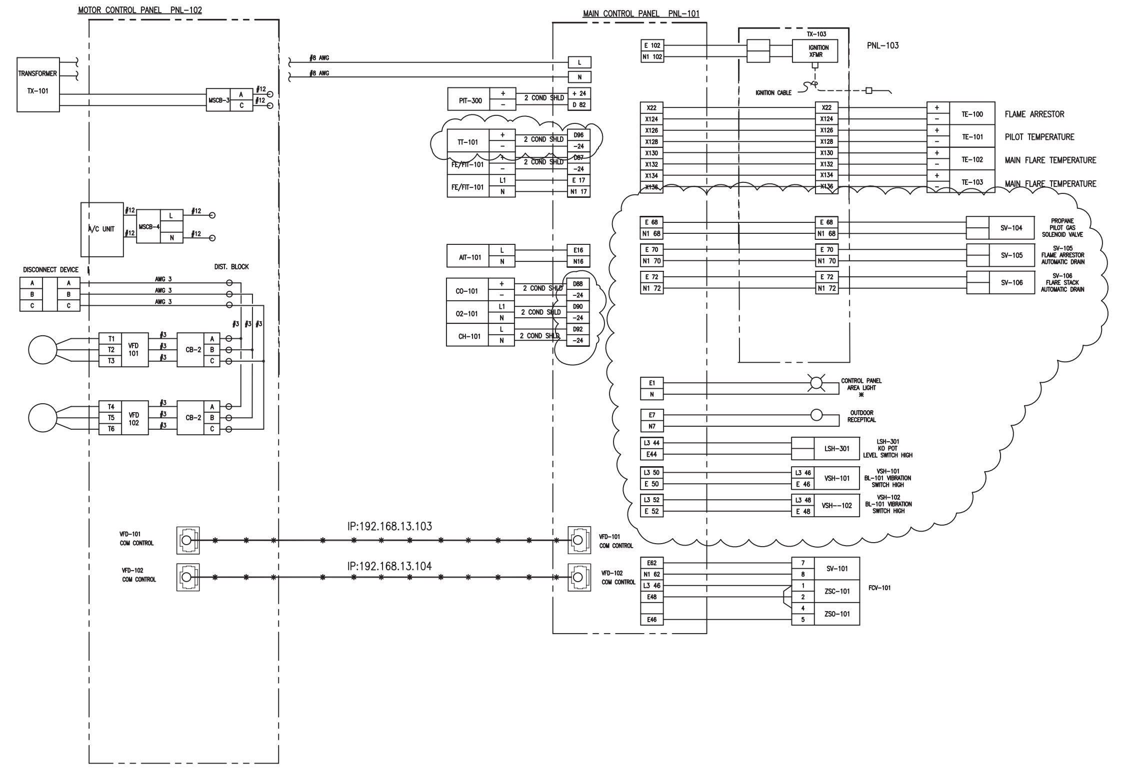


AC DRIVE	200 lb-in
POWER BLOCK	120 lb-in

LEGEND:

□ — PNL.-101 TERMINAL

▽ — PNL.-102 TERMINAL

——— WIRING BY PARNEL

- - - - FIELD WIRING BY PARNEL

⁎⁎ DENOTES ITEMS SUPPLIED BY OTHERS, NOT PARNEL.

NOTES:

REV	DESCRIPTION	DATE	DR.	APP.
0				

CUSTOMER
DOT ENERGY

PO NO.
n/a

LOCATION
WOODLEAF, NC

USER
ROWAN
LANDFILL

DRAWN CP DATE 12/16/16

DESIGN CP DATE 12/16/16

Parnel Biogas Inc

5868 S 129TH E. AVE
Tulsa, OK 74134

UTILITY FLARES
ENCLOSED FLARES

CONTROL SYSTEMS
LEACHATE INJECTION

TITLE
PNL-101
POINT TO PONT

SIZE D
DWG NO. 16-166-706
1

SCALE
REL DATE
SHEET 1 OF 1

ATTACHMENT D

EPA LandGEM LFG Generation Model

LandGEM
Landfill Gas Emissions Model
Version 3.1BETA
NOT FOR REGULATORY USE
U.S. Environmental Protection Agency
Office of Research and Development
Center for Environmental Solutions
and Emergency Response (CESER)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina
December 2023

Summary Report

Landfill Name or Identifier: ROWAN COUNTY LANDFILL

Date: Friday, August 9, 2024

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where,

Q_{CH4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *($year^{-1}$)*
L_0 = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the i^{th} year *(Mg)*
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1989**	
Landfill Closure Year (with 80-year limit)	**2051**	
Actual Closure Year (without limit)	***2051***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity	**8,203,309**	*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.057**	*year* $^{-1}$
Potential Methane Generation Capacity, L_0	**110**	m^3/*Mg*
NMOC Concentration	**600**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1989	10,087	11,096	0	0
1990	10,087	11,096	10,087	11,096
1991	10,087	11,096	20,174	22,191
1992	10,087	11,096	30,261	33,287
1993	49,123	54,035	40,348	44,383
1994	91,873	101,060	89,471	98,418
1995	85,613	94,174	181,344	199,478
1996	67,593	74,352	266,957	293,653
1997	62,324	68,556	334,550	368,005
1998	61,495	67,645	396,874	436,561
1999	65,555	72,111	458,369	504,206
2000	68,122	74,934	523,924	576,316
2001	62,868	69,155	592,046	651,251
2002	64,628	71,091	654,914	720,405
2003	69,180	76,098	719,542	791,496
2004	70,166	77,183	788,722	867,594
2005	78,957	86,853	858,888	944,777
2006	87,629	96,392	937,845	1,031,630
2007	82,186	90,405	1,025,474	1,128,021
2008	101,286	111,415	1,107,660	1,218,426
2009	122,594	134,853	1,208,946	1,329,841
2010	120,391	132,430	1,331,540	1,464,694
2011	113,683	125,052	1,451,931	1,597,124
2012	106,835	117,518	1,565,614	1,722,176
2013	109,257	120,182	1,672,449	1,839,694
2014	111,028	122,131	1,781,706	1,959,876
2015	118,967	130,863	1,892,734	2,082,007
2016	130,693	143,762	2,011,701	2,212,871
2017	127,530	140,283	2,142,394	2,356,633
2018	128,249	141,074	2,269,924	2,496,916
2019	130,839	143,923	2,398,173	2,637,990
2020	155,017	170,519	2,529,012	2,781,913
2021	163,623	179,985	2,684,029	2,952,432
2022	181,036	199,139	2,847,652	3,132,417
2023	190,189	209,207	3,028,687	3,331,556
2024	193,041	212,345	3,218,876	3,540,763
2025	195,937	215,531	3,411,917	3,753,109
2026	198,876	218,764	3,607,854	3,968,640
2027	201,859	222,045	3,806,730	4,187,403
2028	204,887	225,376	4,008,589	4,409,448

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2029	207,960	228,756	4,213,476	4,634,824
2030	211,080	232,188	4,421,437	4,863,580
2031	214,246	235,671	4,632,516	5,095,768
2032	217,460	239,206	4,846,762	5,331,439
2033	220,722	242,794	5,064,222	5,570,644
2034	224,032	246,436	5,284,944	5,813,438
2035	227,393	250,132	5,508,976	6,059,874
2036	230,804	253,884	5,736,369	6,310,006
2037	234,266	257,692	5,967,173	6,563,890
2038	237,780	261,558	6,201,438	6,821,582
2039	241,346	265,481	6,439,218	7,083,140
2040	244,967	269,463	6,680,565	7,348,621
2041	248,641	273,505	6,925,531	7,618,084
2042	252,371	277,608	7,174,172	7,891,590
2043	256,156	281,772	7,426,543	8,169,198
2044	259,999	285,999	7,682,700	8,450,970
2045	263,899	290,289	7,942,698	8,736,968
2046	267,857	294,643	8,206,597	9,027,257
2047	271,875	299,063	8,474,454	9,321,900
2048	275,953	303,548	8,746,329	9,620,962
2049	280,092	308,102	9,022,282	9,924,511
2050	284,294	312,723	9,302,375	10,232,612
2051	225,825	248,408	9,586,669	10,545,335
2052	0	0	9,812,494	10,793,743
2053	0	0	9,812,494	10,793,743
2054	0	0	9,812,494	10,793,743
2055	0	0	9,812,494	10,793,743
2056	0	0	9,812,494	10,793,743
2057	0	0	9,812,494	10,793,743
2058	0	0	9,812,494	10,793,743
2059	0	0	9,812,494	10,793,743
2060	0	0	9,812,494	10,793,743
2061	0	0	9,812,494	10,793,743
2062	0	0	9,812,494	10,793,743
2063	0	0	9,812,494	10,793,743
2064	0	0	9,812,494	10,793,743
2065	0	0	9,812,494	10,793,743
2066	0	0	9,812,494	10,793,743
2067	0	0	9,812,494	10,793,743
2068	0	0	9,812,494	10,793,743

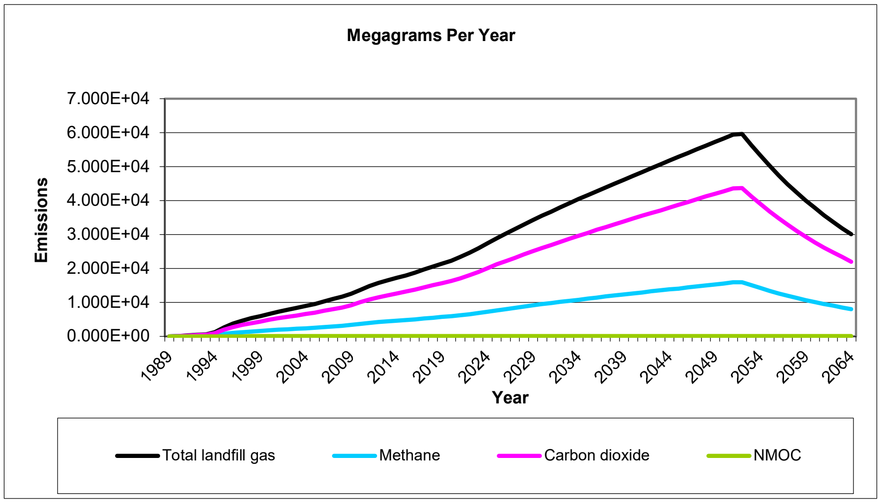
Pollutant Parameters

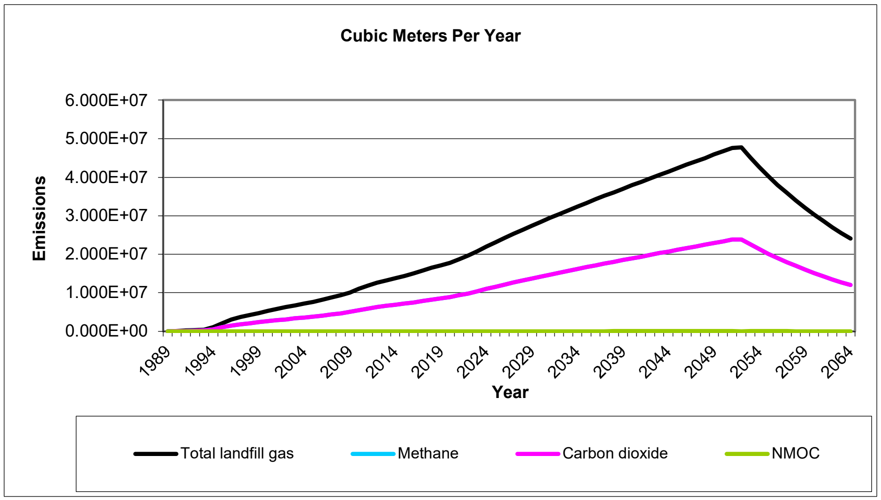
	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		30.03		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

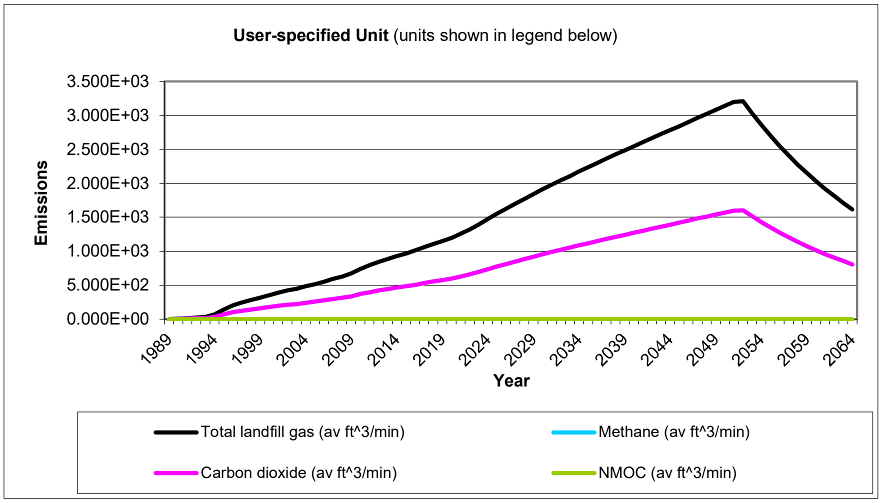
Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			***User-specified Pollutant Parameters:***	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
Emissions
7.000E+04
6.000E+04
5.000E+04
4.000E+04
3.000E+04
2.000E+04
1.000E+04
0.000E+00
1989
1994
1999
2004
2009
2014
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
Emissions
6.000E+07
5.000E+07
4.000E+07
3.000E+07
2.000E+07
1.000E+07
0.000E+00
1989
1994
1999
2004
2009
2014
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
3.500E+03
3.000E+03
2.500E+03
2.000E+03
1.500E+03
1.000E+03
5.000E+02
0.000E+00
1989
1994
1999
2004
2009
2014
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1989	0	0	0	0	0	0
1990	1.540E+02	1.233E+05	8.285E+00	4.113E+01	6.165E+04	4.142E+00
1991	2.994E+02	2.398E+05	1.611E+01	7.998E+01	1.199E+05	8.055E+00
1992	4.368E+02	3.498E+05	2.350E+01	1.167E+02	1.749E+05	1.175E+01
1993	5.666E+02	4.537E+05	3.049E+01	1.513E+02	2.269E+05	1.524E+01
1994	1.285E+03	1.029E+06	6.914E+01	3.433E+02	5.145E+05	3.457E+01
1995	2.616E+03	2.095E+06	1.408E+02	6.989E+02	1.048E+06	7.039E+01
1996	3.778E+03	3.026E+06	2.033E+02	1.009E+03	1.513E+06	1.016E+02
1997	4.601E+03	3.684E+06	2.475E+02	1.229E+03	1.842E+06	1.238E+02
1998	5.297E+03	4.242E+06	2.850E+02	1.415E+03	2.121E+06	1.425E+02
1999	5.943E+03	4.759E+06	3.197E+02	1.587E+03	2.379E+06	1.599E+02
2000	6.614E+03	5.296E+06	3.559E+02	1.767E+03	2.648E+06	1.779E+02
2001	7.288E+03	5.836E+06	3.921E+02	1.947E+03	2.918E+06	1.960E+02
2002	7.844E+03	6.281E+06	4.220E+02	2.095E+03	3.140E+06	2.110E+02
2003	8.396E+03	6.723E+06	4.517E+02	2.243E+03	3.361E+06	2.259E+02
2004	8.987E+03	7.196E+06	4.835E+02	2.400E+03	3.598E+06	2.417E+02
2005	9.560E+03	7.655E+06	5.143E+02	2.554E+03	3.827E+06	2.572E+02
2006	1.024E+04	8.196E+06	5.507E+02	2.734E+03	4.098E+06	2.753E+02
2007	1.101E+04	8.813E+06	5.922E+02	2.940E+03	4.407E+06	2.961E+02
2008	1.165E+04	9.329E+06	6.268E+02	3.112E+03	4.665E+06	3.134E+02
2009	1.255E+04	1.005E+07	6.753E+02	3.353E+03	5.025E+06	3.377E+02
2010	1.373E+04	1.099E+07	7.386E+02	3.667E+03	5.496E+06	3.693E+02
2011	1.480E+04	1.186E+07	7.965E+02	3.955E+03	5.928E+06	3.983E+02
2012	1.572E+04	1.259E+07	8.458E+02	4.199E+03	6.294E+06	4.229E+02
2013	1.648E+04	1.320E+07	8.867E+02	4.402E+03	6.598E+06	4.433E+02
2014	1.723E+04	1.380E+07	9.273E+02	4.604E+03	6.900E+06	4.636E+02
2015	1.797E+04	1.439E+07	9.671E+02	4.801E+03	7.197E+06	4.835E+02
2016	1.879E+04	1.505E+07	1.011E+03	5.020E+03	7.525E+06	5.056E+02
2017	1.975E+04	1.581E+07	1.063E+03	5.275E+03	7.907E+06	5.313E+02
2018	2.060E+04	1.650E+07	1.108E+03	5.503E+03	8.248E+06	5.542E+02
2019	2.142E+04	1.715E+07	1.152E+03	5.721E+03	8.575E+06	5.762E+02
2020	2.223E+04	1.780E+07	1.196E+03	5.937E+03	8.900E+06	5.980E+02
2021	2.336E+04	1.871E+07	1.257E+03	6.241E+03	9.354E+06	6.285E+02
2022	2.457E+04	1.967E+07	1.322E+03	6.562E+03	9.836E+06	6.609E+02
2023	2.597E+04	2.079E+07	1.397E+03	6.937E+03	1.040E+07	6.986E+02
2024	2.743E+04	2.197E+07	1.476E+03	7.328E+03	1.098E+07	7.380E+02
2025	2.886E+04	2.311E+07	1.553E+03	7.709E+03	1.156E+07	7.764E+02
2026	3.025E+04	2.422E+07	1.628E+03	8.081E+03	1.211E+07	8.138E+02
2027	3.161E+04	2.531E+07	1.701E+03	8.444E+03	1.266E+07	8.504E+02
2028	3.294E+04	2.638E+07	1.772E+03	8.799E+03	1.319E+07	8.862E+02
2029	3.425E+04	2.742E+07	1.842E+03	9.147E+03	1.371E+07	9.212E+02
2030	3.552E+04	2.844E+07	1.911E+03	9.488E+03	1.422E+07	9.556E+02
2031	3.678E+04	2.945E+07	1.979E+03	9.823E+03	1.472E+07	9.893E+02
2032	3.801E+04	3.044E+07	2.045E+03	1.015E+04	1.522E+07	1.023E+03
2033	3.922E+04	3.141E+07	2.110E+03	1.048E+04	1.570E+07	1.055E+03
2034	4.042E+04	3.237E+07	2.175E+03	1.080E+04	1.618E+07	1.087E+03
2035	4.160E+04	3.331E+07	2.238E+03	1.111E+04	1.666E+07	1.119E+03
2036	4.277E+04	3.425E+07	2.301E+03	1.142E+04	1.712E+07	1.150E+03
2037	4.392E+04	3.517E+07	2.363E+03	1.173E+04	1.758E+07	1.182E+03
2038	4.506E+04	3.608E+07	2.425E+03	1.204E+04	1.804E+07	1.212E+03

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2039	4.620E+04	3.699E+07	2.485E+03	1.234E+04	1.850E+07	1.243E+03
2040	4.732E+04	3.789E+07	2.546E+03	1.264E+04	1.895E+07	1.273E+03
2041	4.844E+04	3.879E+07	2.606E+03	1.294E+04	1.939E+07	1.303E+03
2042	4.955E+04	3.968E+07	2.666E+03	1.324E+04	1.984E+07	1.333E+03
2043	5.066E+04	4.056E+07	2.726E+03	1.353E+04	2.028E+07	1.363E+03
2044	5.176E+04	4.145E+07	2.785E+03	1.383E+04	2.072E+07	1.392E+03
2045	5.286E+04	4.233E+07	2.844E+03	1.412E+04	2.116E+07	1.422E+03
2046	5.396E+04	4.321E+07	2.903E+03	1.441E+04	2.161E+07	1.452E+03
2047	5.506E+04	4.409E+07	2.962E+03	1.471E+04	2.205E+07	1.481E+03
2048	5.616E+04	4.497E+07	3.022E+03	1.500E+04	2.249E+07	1.511E+03
2049	5.726E+04	4.585E+07	3.081E+03	1.530E+04	2.293E+07	1.540E+03
2050	5.837E+04	4.674E+07	3.140E+03	1.559E+04	2.337E+07	1.570E+03
2051	5.947E+04	4.762E+07	3.200E+03	1.589E+04	2.381E+07	1.600E+03
2052	5.962E+04	4.774E+07	3.208E+03	1.593E+04	2.387E+07	1.604E+03
2053	5.632E+04	4.510E+07	3.030E+03	1.504E+04	2.255E+07	1.515E+03
2054	5.320E+04	4.260E+07	2.862E+03	1.421E+04	2.130E+07	1.431E+03
2055	5.025E+04	4.024E+07	2.704E+03	1.342E+04	2.012E+07	1.352E+03
2056	4.747E+04	3.801E+07	2.554E+03	1.268E+04	1.901E+07	1.277E+03
2057	4.484E+04	3.590E+07	2.412E+03	1.198E+04	1.795E+07	1.206E+03
2058	4.235E+04	3.391E+07	2.279E+03	1.131E+04	1.696E+07	1.139E+03
2059	4.001E+04	3.204E+07	2.152E+03	1.069E+04	1.602E+07	1.076E+03
2060	3.779E+04	3.026E+07	2.033E+03	1.009E+04	1.513E+07	1.017E+03
2061	3.570E+04	2.858E+07	1.921E+03	9.535E+03	1.429E+07	9.603E+02
2062	3.372E+04	2.700E+07	1.814E+03	9.007E+03	1.350E+07	9.071E+02
2063	3.185E+04	2.550E+07	1.714E+03	8.508E+03	1.275E+07	8.568E+02
2064	3.009E+04	2.409E+07	1.619E+03	8.036E+03	1.205E+07	8.093E+02
2065	2.842E+04	2.276E+07	1.529E+03	7.591E+03	1.138E+07	7.645E+02
2066	2.684E+04	2.150E+07	1.444E+03	7.170E+03	1.075E+07	7.221E+02
2067	2.536E+04	2.030E+07	1.364E+03	6.773E+03	1.015E+07	6.821E+02
2068	2.395E+04	1.918E+07	1.289E+03	6.398E+03	9.590E+06	6.443E+02
2069	2.262E+04	1.812E+07	1.217E+03	6.043E+03	9.059E+06	6.086E+02
2070	2.137E+04	1.711E+07	1.150E+03	5.709E+03	8.557E+06	5.749E+02
2071	2.019E+04	1.617E+07	1.086E+03	5.392E+03	8.083E+06	5.431E+02
2072	1.907E+04	1.527E+07	1.026E+03	5.093E+03	7.635E+06	5.130E+02
2073	1.801E+04	1.442E+07	9.691E+02	4.811E+03	7.212E+06	4.846E+02
2074	1.701E+04	1.362E+07	9.154E+02	4.545E+03	6.812E+06	4.577E+02
2075	1.607E+04	1.287E+07	8.647E+02	4.293E+03	6.435E+06	4.323E+02
2076	1.518E+04	1.216E+07	8.168E+02	4.055E+03	6.078E+06	4.084E+02
2077	1.434E+04	1.148E+07	7.715E+02	3.830E+03	5.741E+06	3.858E+02
2078	1.355E+04	1.085E+07	7.288E+02	3.618E+03	5.423E+06	3.644E+02
2079	1.279E+04	1.025E+07	6.884E+02	3.418E+03	5.123E+06	3.442E+02
2080	1.209E+04	9.678E+06	6.503E+02	3.228E+03	4.839E+06	3.251E+02
2081	1.142E+04	9.142E+06	6.142E+02	3.049E+03	4.571E+06	3.071E+02
2082	1.078E+04	8.635E+06	5.802E+02	2.880E+03	4.318E+06	2.901E+02
2083	1.019E+04	8.157E+06	5.481E+02	2.721E+03	4.078E+06	2.740E+02
2084	9.622E+03	7.705E+06	5.177E+02	2.570E+03	3.852E+06	2.588E+02
2085	9.089E+03	7.278E+06	4.890E+02	2.428E+03	3.639E+06	2.445E+02
2086	8.585E+03	6.875E+06	4.619E+02	2.293E+03	3.437E+06	2.310E+02
2087	8.110E+03	6.494E+06	4.363E+02	2.166E+03	3.247E+06	2.182E+02
2088	7.660E+03	6.134E+06	4.121E+02	2.046E+03	3.067E+06	2.061E+02
2089	7.236E+03	5.794E+06	3.893E+02	1.933E+03	2.897E+06	1.947E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2090	6.835E+03	5.473E+06	3.677E+02	1.826E+03	2.737E+06	1.839E+02
2091	6.456E+03	5.170E+06	3.474E+02	1.725E+03	2.585E+06	1.737E+02
2092	6.099E+03	4.883E+06	3.281E+02	1.629E+03	2.442E+06	1.641E+02
2093	5.761E+03	4.613E+06	3.099E+02	1.539E+03	2.306E+06	1.550E+02
2094	5.441E+03	4.357E+06	2.928E+02	1.453E+03	2.179E+06	1.464E+02
2095	5.140E+03	4.116E+06	2.765E+02	1.373E+03	2.058E+06	1.383E+02
2096	4.855E+03	3.888E+06	2.612E+02	1.297E+03	1.944E+06	1.306E+02
2097	4.586E+03	3.672E+06	2.467E+02	1.225E+03	1.836E+06	1.234E+02
2098	4.332E+03	3.469E+06	2.331E+02	1.157E+03	1.734E+06	1.165E+02
2099	4.092E+03	3.277E+06	2.202E+02	1.093E+03	1.638E+06	1.101E+02
2100	3.865E+03	3.095E+06	2.080E+02	1.032E+03	1.548E+06	1.040E+02
2101	3.651E+03	2.924E+06	1.964E+02	9.753E+02	1.462E+06	9.822E+01
2102	3.449E+03	2.762E+06	1.856E+02	9.212E+02	1.381E+06	9.278E+01
2103	3.258E+03	2.609E+06	1.753E+02	8.702E+02	1.304E+06	8.764E+01
2104	3.077E+03	2.464E+06	1.656E+02	8.220E+02	1.232E+06	8.278E+01
2105	2.907E+03	2.328E+06	1.564E+02	7.764E+02	1.164E+06	7.820E+01
2106	2.746E+03	2.199E+06	1.477E+02	7.334E+02	1.099E+06	7.386E+01
2107	2.594E+03	2.077E+06	1.395E+02	6.928E+02	1.038E+06	6.977E+01
2108	2.450E+03	1.962E+06	1.318E+02	6.544E+02	9.809E+05	6.591E+01
2109	2.314E+03	1.853E+06	1.245E+02	6.181E+02	9.265E+05	6.225E+01
2110	2.186E+03	1.750E+06	1.176E+02	5.839E+02	8.752E+05	5.881E+01
2111	2.065E+03	1.653E+06	1.111E+02	5.515E+02	8.267E+05	5.555E+01
2112	1.950E+03	1.562E+06	1.049E+02	5.210E+02	7.809E+05	5.247E+01
2113	1.842E+03	1.475E+06	9.912E+01	4.921E+02	7.376E+05	4.956E+01
2114	1.740E+03	1.394E+06	9.363E+01	4.649E+02	6.968E+05	4.682E+01
2115	1.644E+03	1.316E+06	8.844E+01	4.391E+02	6.582E+05	4.422E+01
2116	1.553E+03	1.243E+06	8.354E+01	4.148E+02	6.217E+05	4.177E+01
2117	1.467E+03	1.175E+06	7.892E+01	3.918E+02	5.873E+05	3.946E+01
2118	1.385E+03	1.109E+06	7.454E+01	3.701E+02	5.547E+05	3.727E+01
2119	1.309E+03	1.048E+06	7.041E+01	3.496E+02	5.240E+05	3.521E+01
2120	1.236E+03	9.899E+05	6.651E+01	3.302E+02	4.950E+05	3.326E+01
2121	1.168E+03	9.351E+05	6.283E+01	3.119E+02	4.675E+05	3.141E+01
2122	1.103E+03	8.832E+05	5.935E+01	2.946E+02	4.416E+05	2.967E+01
2123	1.042E+03	8.343E+05	5.606E+01	2.783E+02	4.172E+05	2.803E+01
2124	9.842E+02	7.881E+05	5.295E+01	2.629E+02	3.940E+05	2.648E+01
2125	9.297E+02	7.444E+05	5.002E+01	2.483E+02	3.722E+05	2.501E+01
2126	8.781E+02	7.032E+05	4.725E+01	2.346E+02	3.516E+05	2.362E+01
2127	8.295E+02	6.642E+05	4.463E+01	2.216E+02	3.321E+05	2.231E+01
2128	7.835E+02	6.274E+05	4.216E+01	2.093E+02	3.137E+05	2.108E+01
2129	7.401E+02	5.927E+05	3.982E+01	1.977E+02	2.963E+05	1.991E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1989	0	0	0	0	0	0
1990	1.129E+02	6.165E+04	4.142E+00	2.652E-01	7.398E+01	4.971E-03
1991	2.195E+02	1.199E+05	8.055E+00	5.157E-01	1.439E+02	9.666E-03
1992	3.202E+02	1.749E+05	1.175E+01	7.523E-01	2.099E+02	1.410E-02
1993	4.153E+02	2.269E+05	1.524E+01	9.758E-01	2.722E+02	1.829E-02
1994	9.419E+02	5.145E+05	3.457E+01	2.213E+00	6.174E+02	4.149E-02
1995	1.918E+03	1.048E+06	7.039E+01	4.506E+00	1.257E+03	8.446E-02
1996	2.769E+03	1.513E+06	1.016E+02	6.507E+00	1.815E+03	1.220E-01
1997	3.372E+03	1.842E+06	1.238E+02	7.924E+00	2.211E+03	1.485E-01
1998	3.882E+03	2.121E+06	1.425E+02	9.123E+00	2.545E+03	1.710E-01
1999	4.355E+03	2.379E+06	1.599E+02	1.023E+01	2.855E+03	1.918E-01
2000	4.847E+03	2.648E+06	1.779E+02	1.139E+01	3.178E+03	2.135E-01
2001	5.341E+03	2.918E+06	1.960E+02	1.255E+01	3.501E+03	2.353E-01
2002	5.748E+03	3.140E+06	2.110E+02	1.351E+01	3.768E+03	2.532E-01
2003	6.153E+03	3.361E+06	2.259E+02	1.446E+01	4.034E+03	2.710E-01
2004	6.586E+03	3.598E+06	2.417E+02	1.548E+01	4.318E+03	2.901E-01
2005	7.006E+03	3.827E+06	2.572E+02	1.646E+01	4.593E+03	3.086E-01
2006	7.501E+03	4.098E+06	2.753E+02	1.763E+01	4.918E+03	3.304E-01
2007	8.066E+03	4.407E+06	2.961E+02	1.895E+01	5.288E+03	3.553E-01
2008	8.539E+03	4.665E+06	3.134E+02	2.006E+01	5.598E+03	3.761E-01
2009	9.199E+03	5.025E+06	3.377E+02	2.162E+01	6.030E+03	4.052E-01
2010	1.006E+04	5.496E+06	3.693E+02	2.364E+01	6.595E+03	4.431E-01
2011	1.085E+04	5.928E+06	3.983E+02	2.550E+01	7.113E+03	4.779E-01
2012	1.152E+04	6.294E+06	4.229E+02	2.707E+01	7.553E+03	5.075E-01
2013	1.208E+04	6.598E+06	4.433E+02	2.838E+01	7.918E+03	5.320E-01
2014	1.263E+04	6.900E+06	4.636E+02	2.968E+01	8.280E+03	5.564E-01
2015	1.317E+04	7.197E+06	4.835E+02	3.096E+01	8.636E+03	5.803E-01
2016	1.377E+04	7.525E+06	5.056E+02	3.237E+01	9.030E+03	6.067E-01
2017	1.447E+04	7.907E+06	5.313E+02	3.401E+01	9.488E+03	6.375E-01
2018	1.510E+04	8.248E+06	5.542E+02	3.548E+01	9.898E+03	6.650E-01
2019	1.570E+04	8.575E+06	5.762E+02	3.688E+01	1.029E+04	6.914E-01
2020	1.629E+04	8.900E+06	5.980E+02	3.828E+01	1.068E+04	7.176E-01
2021	1.712E+04	9.354E+06	6.285E+02	4.024E+01	1.122E+04	7.542E-01
2022	1.800E+04	9.836E+06	6.609E+02	4.231E+01	1.180E+04	7.930E-01
2023	1.903E+04	1.040E+07	6.986E+02	4.472E+01	1.248E+04	8.383E-01
2024	2.011E+04	1.098E+07	7.380E+02	4.725E+01	1.318E+04	8.856E-01
2025	2.115E+04	1.156E+07	7.764E+02	4.970E+01	1.387E+04	9.317E-01
2026	2.217E+04	1.211E+07	8.138E+02	5.210E+01	1.453E+04	9.766E-01
2027	2.317E+04	1.266E+07	8.504E+02	5.444E+01	1.519E+04	1.020E+00
2028	2.414E+04	1.319E+07	8.862E+02	5.673E+01	1.583E+04	1.063E+00
2029	2.510E+04	1.371E+07	9.212E+02	5.898E+01	1.645E+04	1.105E+00
2030	2.603E+04	1.422E+07	9.556E+02	6.118E+01	1.707E+04	1.147E+00
2031	2.695E+04	1.472E+07	9.893E+02	6.334E+01	1.767E+04	1.187E+00
2032	2.786E+04	1.522E+07	1.023E+03	6.546E+01	1.826E+04	1.227E+00
2033	2.875E+04	1.570E+07	1.055E+03	6.755E+01	1.884E+04	1.266E+00
2034	2.962E+04	1.618E+07	1.087E+03	6.961E+01	1.942E+04	1.305E+00
2035	3.049E+04	1.666E+07	1.119E+03	7.164E+01	1.999E+04	1.343E+00
2036	3.134E+04	1.712E+07	1.150E+03	7.365E+01	2.055E+04	1.381E+00
2037	3.219E+04	1.758E+07	1.182E+03	7.564E+01	2.110E+04	1.418E+00
2038	3.303E+04	1.804E+07	1.212E+03	7.761E+01	2.165E+04	1.455E+00

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2039	3.386E+04	1.850E+07	1.243E+03	7.956E+01	2.220E+04	1.491E+00
2040	3.468E+04	1.895E+07	1.273E+03	8.149E+01	2.274E+04	1.528E+00
2041	3.550E+04	1.939E+07	1.303E+03	8.342E+01	2.327E+04	1.564E+00
2042	3.632E+04	1.984E+07	1.333E+03	8.533E+01	2.381E+04	1.600E+00
2043	3.713E+04	2.028E+07	1.363E+03	8.724E+01	2.434E+04	1.635E+00
2044	3.794E+04	2.072E+07	1.392E+03	8.914E+01	2.487E+04	1.671E+00
2045	3.874E+04	2.116E+07	1.422E+03	9.104E+01	2.540E+04	1.706E+00
2046	3.955E+04	2.161E+07	1.452E+03	9.293E+01	2.593E+04	1.742E+00
2047	4.035E+04	2.205E+07	1.481E+03	9.483E+01	2.645E+04	1.777E+00
2048	4.116E+04	2.249E+07	1.511E+03	9.672E+01	2.698E+04	1.813E+00
2049	4.197E+04	2.293E+07	1.540E+03	9.861E+01	2.751E+04	1.849E+00
2050	4.278E+04	2.337E+07	1.570E+03	1.005E+02	2.804E+04	1.884E+00
2051	4.359E+04	2.381E+07	1.600E+03	1.024E+02	2.857E+04	1.920E+00
2052	4.370E+04	2.387E+07	1.604E+03	1.027E+02	2.865E+04	1.925E+00
2053	4.128E+04	2.255E+07	1.515E+03	9.699E+01	2.706E+04	1.818E+00
2054	3.899E+04	2.130E+07	1.431E+03	9.162E+01	2.556E+04	1.717E+00
2055	3.683E+04	2.012E+07	1.352E+03	8.654E+01	2.414E+04	1.622E+00
2056	3.479E+04	1.901E+07	1.277E+03	8.175E+01	2.281E+04	1.532E+00
2057	3.286E+04	1.795E+07	1.206E+03	7.722E+01	2.154E+04	1.447E+00
2058	3.104E+04	1.696E+07	1.139E+03	7.294E+01	2.035E+04	1.367E+00
2059	2.932E+04	1.602E+07	1.076E+03	6.890E+01	1.922E+04	1.291E+00
2060	2.770E+04	1.513E+07	1.017E+03	6.508E+01	1.816E+04	1.220E+00
2061	2.616E+04	1.429E+07	9.603E+02	6.148E+01	1.715E+04	1.152E+00
2062	2.471E+04	1.350E+07	9.071E+02	5.807E+01	1.620E+04	1.088E+00
2063	2.334E+04	1.275E+07	8.568E+02	5.485E+01	1.530E+04	1.028E+00
2064	2.205E+04	1.205E+07	8.093E+02	5.181E+01	1.445E+04	9.712E-01
2065	2.083E+04	1.138E+07	7.645E+02	4.894E+01	1.365E+04	9.174E-01
2066	1.967E+04	1.075E+07	7.221E+02	4.623E+01	1.290E+04	8.666E-01
2067	1.858E+04	1.015E+07	6.821E+02	4.367E+01	1.218E+04	8.186E-01
2068	1.755E+04	9.590E+06	6.443E+02	4.125E+01	1.151E+04	7.732E-01
2069	1.658E+04	9.059E+06	6.086E+02	3.896E+01	1.087E+04	7.304E-01
2070	1.566E+04	8.557E+06	5.749E+02	3.681E+01	1.027E+04	6.899E-01
2071	1.480E+04	8.083E+06	5.431E+02	3.477E+01	9.699E+03	6.517E-01
2072	1.398E+04	7.635E+06	5.130E+02	3.284E+01	9.162E+03	6.156E-01
2073	1.320E+04	7.212E+06	4.846E+02	3.102E+01	8.654E+03	5.815E-01
2074	1.247E+04	6.812E+06	4.577E+02	2.930E+01	8.175E+03	5.492E-01
2075	1.178E+04	6.435E+06	4.323E+02	2.768E+01	7.722E+03	5.188E-01
2076	1.113E+04	6.078E+06	4.084E+02	2.614E+01	7.294E+03	4.901E-01
2077	1.051E+04	5.741E+06	3.858E+02	2.470E+01	6.890E+03	4.629E-01
2078	9.927E+03	5.423E+06	3.644E+02	2.333E+01	6.508E+03	4.373E-01
2079	9.377E+03	5.123E+06	3.442E+02	2.204E+01	6.147E+03	4.130E-01
2080	8.858E+03	4.839E+06	3.251E+02	2.081E+01	5.807E+03	3.902E-01
2081	8.367E+03	4.571E+06	3.071E+02	1.966E+01	5.485E+03	3.685E-01
2082	7.903E+03	4.318E+06	2.901E+02	1.857E+01	5.181E+03	3.481E-01
2083	7.466E+03	4.078E+06	2.740E+02	1.754E+01	4.894E+03	3.288E-01
2084	7.052E+03	3.852E+06	2.588E+02	1.657E+01	4.623E+03	3.106E-01
2085	6.661E+03	3.639E+06	2.445E+02	1.565E+01	4.367E+03	2.934E-01
2086	6.292E+03	3.437E+06	2.310E+02	1.479E+01	4.125E+03	2.771E-01
2087	5.943E+03	3.247E+06	2.182E+02	1.397E+01	3.896E+03	2.618E-01
2088	5.614E+03	3.067E+06	2.061E+02	1.319E+01	3.680E+03	2.473E-01
2089	5.303E+03	2.897E+06	1.947E+02	1.246E+01	3.477E+03	2.336E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2090	5.009E+03	2.737E+06	1.839E+02	1.177E+01	3.284E+03	2.206E-01
2091	4.732E+03	2.585E+06	1.737E+02	1.112E+01	3.102E+03	2.084E-01
2092	4.470E+03	2.442E+06	1.641E+02	1.050E+01	2.930E+03	1.969E-01
2093	4.222E+03	2.306E+06	1.550E+02	9.921E+00	2.768E+03	1.860E-01
2094	3.988E+03	2.179E+06	1.464E+02	9.371E+00	2.614E+03	1.757E-01
2095	3.767E+03	2.058E+06	1.383E+02	8.852E+00	2.470E+03	1.659E-01
2096	3.558E+03	1.944E+06	1.306E+02	8.361E+00	2.333E+03	1.567E-01
2097	3.361E+03	1.836E+06	1.234E+02	7.898E+00	2.203E+03	1.480E-01
2098	3.175E+03	1.734E+06	1.165E+02	7.461E+00	2.081E+03	1.398E-01
2099	2.999E+03	1.638E+06	1.101E+02	7.047E+00	1.966E+03	1.321E-01
2100	2.833E+03	1.548E+06	1.040E+02	6.657E+00	1.857E+03	1.248E-01
2101	2.676E+03	1.462E+06	9.822E+01	6.288E+00	1.754E+03	1.179E-01
2102	2.528E+03	1.381E+06	9.278E+01	5.940E+00	1.657E+03	1.113E-01
2103	2.388E+03	1.304E+06	8.764E+01	5.610E+00	1.565E+03	1.052E-01
2104	2.255E+03	1.232E+06	8.278E+01	5.300E+00	1.478E+03	9.934E-02
2105	2.130E+03	1.164E+06	7.820E+01	5.006E+00	1.397E+03	9.384E-02
2106	2.012E+03	1.099E+06	7.386E+01	4.729E+00	1.319E+03	8.864E-02
2107	1.901E+03	1.038E+06	6.977E+01	4.467E+00	1.246E+03	8.373E-02
2108	1.796E+03	9.809E+05	6.591E+01	4.219E+00	1.177E+03	7.909E-02
2109	1.696E+03	9.265E+05	6.225E+01	3.985E+00	1.112E+03	7.471E-02
2110	1.602E+03	8.752E+05	5.881E+01	3.765E+00	1.050E+03	7.057E-02
2111	1.513E+03	8.267E+05	5.555E+01	3.556E+00	9.921E+02	6.666E-02
2112	1.429E+03	7.809E+05	5.247E+01	3.359E+00	9.371E+02	6.296E-02
2113	1.350E+03	7.376E+05	4.956E+01	3.173E+00	8.852E+02	5.947E-02
2114	1.275E+03	6.968E+05	4.682E+01	2.997E+00	8.361E+02	5.618E-02
2115	1.205E+03	6.582E+05	4.422E+01	2.831E+00	7.898E+02	5.307E-02
2116	1.138E+03	6.217E+05	4.177E+01	2.674E+00	7.460E+02	5.013E-02
2117	1.075E+03	5.873E+05	3.946E+01	2.526E+00	7.047E+02	4.735E-02
2118	1.015E+03	5.547E+05	3.727E+01	2.386E+00	6.657E+02	4.473E-02
2119	9.592E+02	5.240E+05	3.521E+01	2.254E+00	6.288E+02	4.225E-02
2120	9.060E+02	4.950E+05	3.326E+01	2.129E+00	5.939E+02	3.991E-02
2121	8.558E+02	4.675E+05	3.141E+01	2.011E+00	5.610E+02	3.770E-02
2122	8.084E+02	4.416E+05	2.967E+01	1.900E+00	5.299E+02	3.561E-02
2123	7.636E+02	4.172E+05	2.803E+01	1.794E+00	5.006E+02	3.363E-02
2124	7.213E+02	3.940E+05	2.648E+01	1.695E+00	4.729E+02	3.177E-02
2125	6.813E+02	3.722E+05	2.501E+01	1.601E+00	4.467E+02	3.001E-02
2126	6.436E+02	3.516E+05	2.362E+01	1.512E+00	4.219E+02	2.835E-02
2127	6.079E+02	3.321E+05	2.231E+01	1.429E+00	3.985E+02	2.678E-02
2128	5.742E+02	3.137E+05	2.108E+01	1.349E+00	3.764E+02	2.529E-02
2129	5.424E+02	2.963E+05	1.991E+01	1.275E+00	3.556E+02	2.389E-02

ATTACHMENT E

Wellfield Liquid Levels Technical Memorandum

Technical Memorandum

Date:	August 2024
Project:	Wellfield Liquid Levels Monitoring and Analysis
To:	Rowan County Landfill
From:	HDR Engineering, Inc.

1 Introduction and Purpose

The currently built out GCCS consists of 38 landfill LFG extraction wells (corresponding to an EW prefix in the well identifier) and 7 drip legs (corresponding to an LCO prefix in the monitoring point identifier), all of which undergo monthly emissions monitoring per regulatory standards. Wells and drip legs are checked for concentrations of methane, carbon dioxide, oxygen, and balance gases, as well as temperature and system pressure. The GCCS piping was designed such that liquid condensate developing in the header and lateral piping is drained by gravity to low points in the piping that are drained by the drip legs to the landfill leachate system.

The purpose of this Landfill gas (LFG) Collection and Control System (GCCS) Technical Memorandum is to examine historical data gathered on well LFG concentrations, liquid levels, and rainfall to diagnose issues of poor well performance. This memorandum examines the correlations between the percentage of available unsubmerged perforated pipe, water levels in the wells, and landfill LFG quality to determine what solutions are available to the County to remedy its well network.

2 Well Performance Monitoring and Measurement

Since 2022, several wells started showing elevated oxygen concentrations in excess of 5% as well as extremely low methane concentrations of 2% or less, indicating that the wells were having difficulty pulling LFG from the landfill, indicating a need for further study. Based on water level measurements performed in the wells conducted between July 2022 and August 2023, 71% (27) of the 38 measured LFG wells were observed with over 50% of their perforated length inundated with water, leading to the hypothesis that LFG quality and flow is deteriorating because they are not being adequately dewatered (to allow for collection of the generated LFG in the waste mass).

The 27 wells that were selected for evaluation in this technical memorandum have shown at least one elevated (>5%) oxygen concentration during any one monthly monitoring event between 2022 and 2023, and at least 50% inundation by liquids of the perforated well column. These 27 wells were EW-1 through EW-6, EW-8 through EW-14, EW-16 through EW-21, EW-23, EW-27, EW-29 through EW-31, and EW-34 through EW-36.

2.1 Monitoring Parameters

2.1.1 LFG Well Water Levels

During four water level monitoring events between 2022 and 2023, field personnel took LFG concentration readings as usual, but also used water level indicator tape to check the depth to water (DTW) in the wells.

2.1.2 Percentage of Available Perforated Pipe

A landfill gas (LFG) well is made up of a solid pipe extending from the ground surface into the waste, which connects to a perforated pipe situated further down within the waste mass. A vacuum is applied to the pipe to pull LFG through the waste mass into the perforated pipe up into the solid pipe and through the wellhead. If the perforated pipe becomes submerged in water, it can no longer effectively take up LFG from within the waste mass, resulting in higher oxygen concentrations and lower methane concentrations.

The DTW data gathered by field personnel was compared with the as-built well logs to assess the proportion of available perforated pipe and to evaluate whether submerged perforated sections affected well performance.

3 GCCS Well Analysis and Comparison

The following subsections provide comparison graphs of the monitored values, as well as commentary and discussion.

3.1 Percentage of Available Perforated Pipe 2022-2023

A line graph of each of the 27 underperforming evaluation wells showing the percent of available perforated pipe for each of the three observations between 2022 and 2023 is shown on the following page.

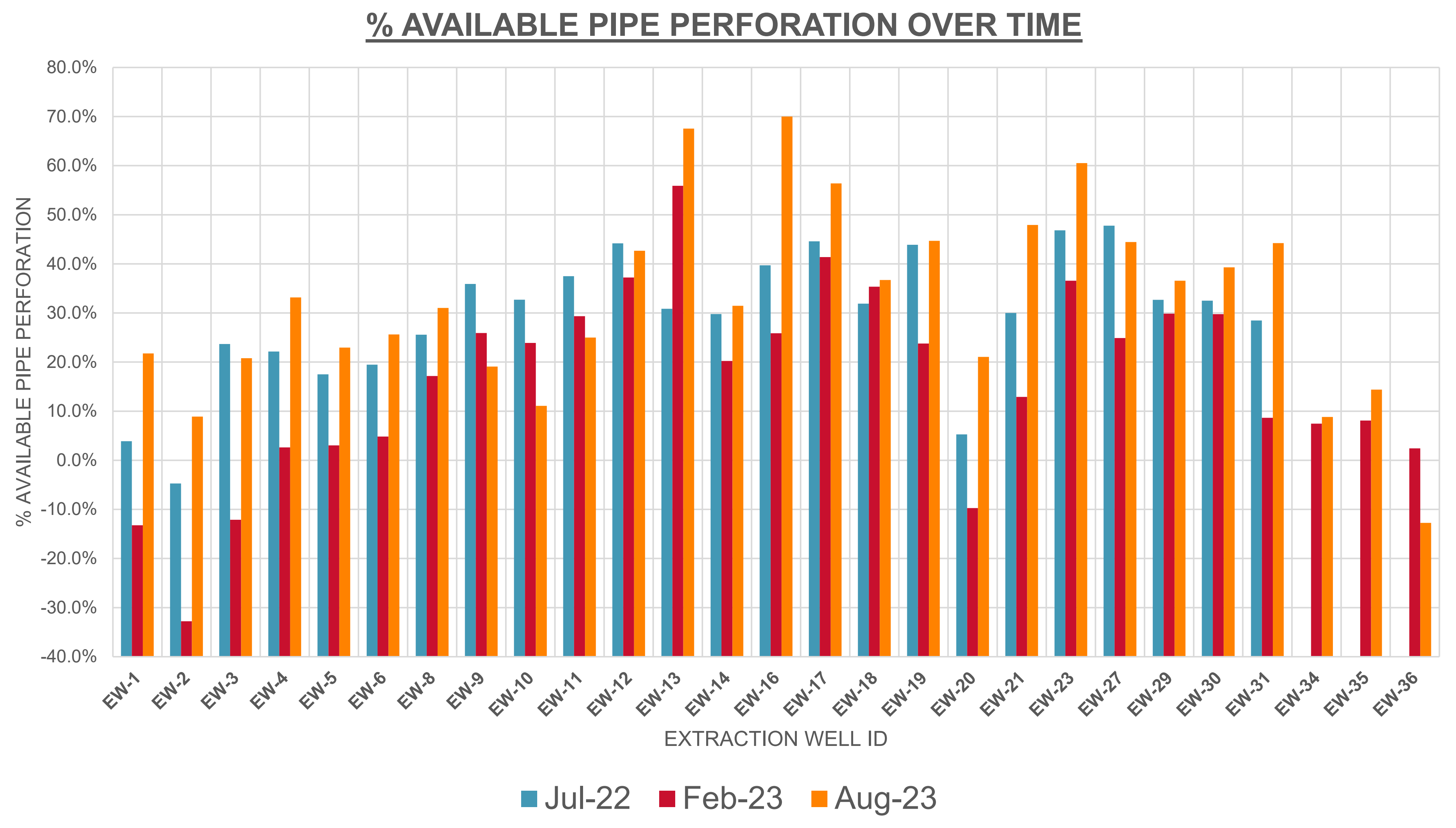


Figure 1: Percentage of Available Perforated Pipe Over Time

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It can be noted from the figure that almost all of the evaluation wells remained **below** 50% availability during the course of the investigation. It should be noted that when **negative** percentages are reported, not only is the entire length of the perforated pipe submerged, but a percentage of the **solid** pipe is submerged as well. That is, the measured water surface elevation in the well was still within the solid pipe, meaning the system is extremely inundated.

Table 1, below, provides the wells ranked from worst to best in terms of average percent of available perforation across the three monitoring events:

Table 1: Average Percent Available Perforation 2022-2023 from Lowest to Highest

Well	Average	Well	Average	Well	Average
EW-2	-9.54%	EW-4	19.32%	EW-30	33.85%
EW-36	-5.16%	EW-10	22.57%	EW-18	34.66%
EW-1	4.14%	EW-8	24.60%	EW-19	37.46%
EW-20	5.53%	EW-9	26.97%	EW-27	39.04%
EW-34	8.14%	EW-31	27.12%	EW-12	41.36%
EW-3	10.79%	EW-14	27.15%	EW-16	45.20%
EW-35	11.25%	EW-21	30.28%	EW-17	47.45%
EW-5	14.49%	EW-11	30.62%	EW-23	47.98%
EW-6	16.65%	EW-29	33.03%	EW-13	51.43%

3.5 Well Tuning, Flow and Efficacy

Well inundation is itself an issue, but to prioritize which wells need immediate attention, well tuning records from January 2022 to October 2023 were consulted to determine which wells' performance could not be improved by increases in vacuum. For the purposes of this analysis, a problem exists when well vacuum, measured in negative inches of H_2O, is continuously increased with no corresponding increases in LFG quality (i.e., consistently high oxygen and low methane). As a rule of thumb, a baseline indicator of bad LFG quality is O_2 concentrations above 5%.

These problem wells are detailed in **Table 2** below, with the lowest methane concentration, highest oxygen concentration, and highest vacuum during the 2022-2023 well tuning:

Table 2: Problem Extraction Wells with Poor LFG Quality and High Vacuum

Extraction Well ID	Lowest CH_4%	Highest O_2%	Highest Vacuum (inches H_2O)
EW-2	0.1	17.5	-14.25
EW-4	0.8	20	-14.93
EW-6	3.9	13.7	-6.16
EW-20	0.1	20.8	-14.37
EW-26	6.8	7.4	-2.3

In addition, when reviewing the tuning data for the remaining 33 wells which did not necessarily exhibit poor LFG quality while still being over 50% inundated, nearly every well showed high methane and low oxygen levels, indicating that the wells were performing properly. However, without the benefit of flow rate monitoring at the wellhead, it is not clear whether these measures of good LFG quality correspond to measures of good well performance that contributes LFG flow to the collection system.

Several seemingly high performing wells are under high vacuum (less than -10 inches H_2O), and without the benefit of flow rate monitoring, it cannot be substantially concluded that the wells are performing adequately given how watered in they are. It could be that the high LFG quality being observed represents a very small amount of total LFG.

3.3 Available Perforated Pipe Compared to LFG Quality

The following graphs show the percentage of available perforated pipe along with landfill LFG concentrations (methane, carbon dioxide, oxygen, and balance gases) for each of the evaluation wells for each of three monitoring events, July 2022, February 2023, and August 2023. An analysis of the data follows the graphs, identifying the wells with the highest levels of inundation and signifiers of low performance (low methane, oxygen>5%).

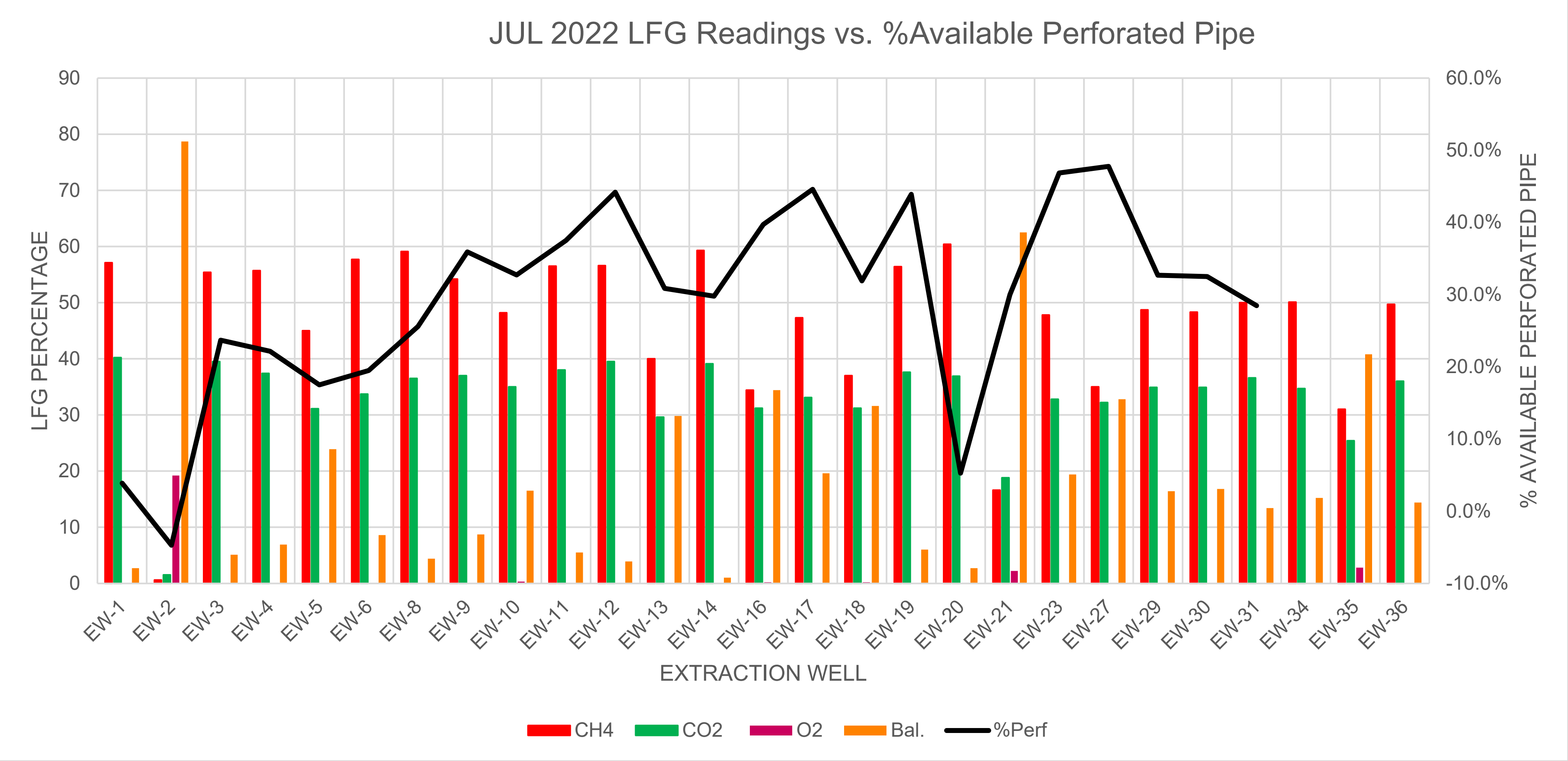

Figure 2: Percentage of Available Perforated Pipe and Landfill LFG Concentration, July 2022

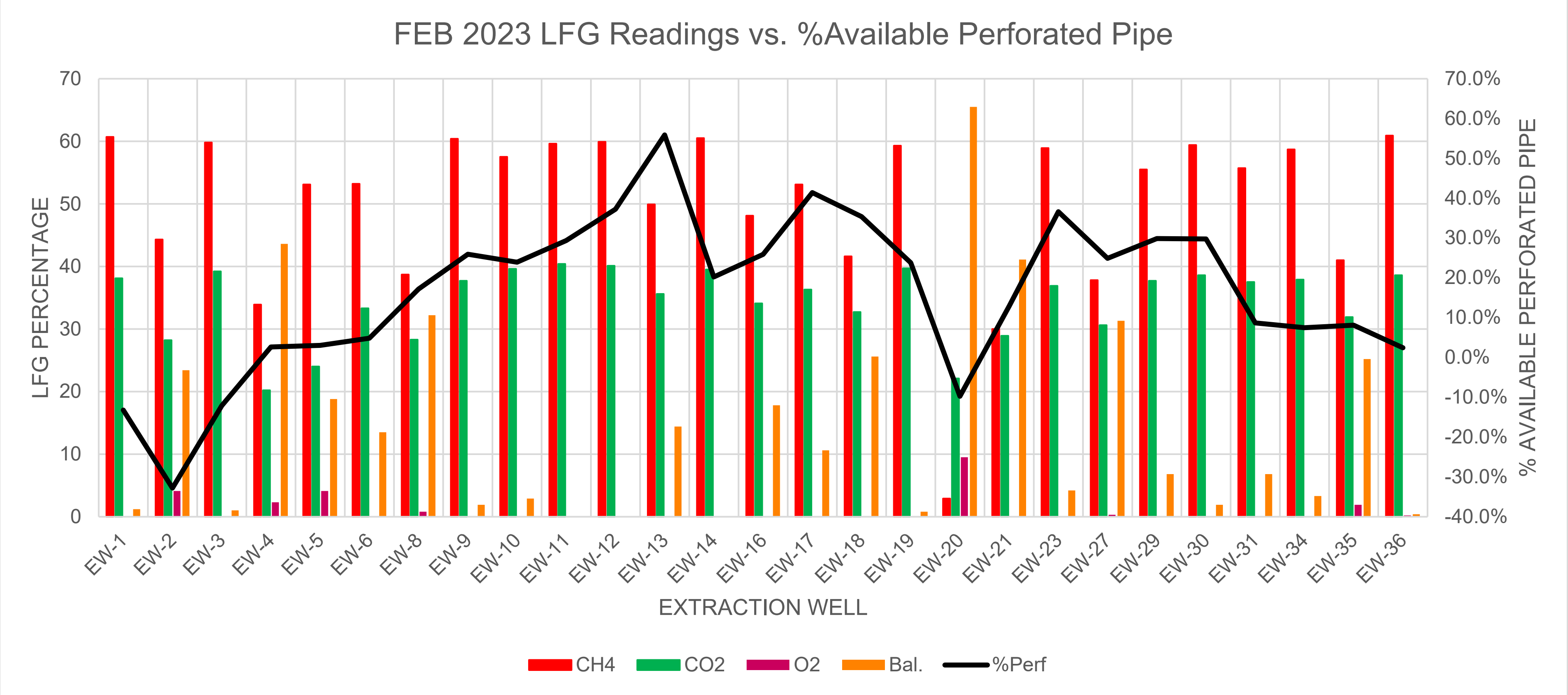

Figure 3: Percentage of Available Perforated Pipe and Landfill LFG Concentration, February 2023

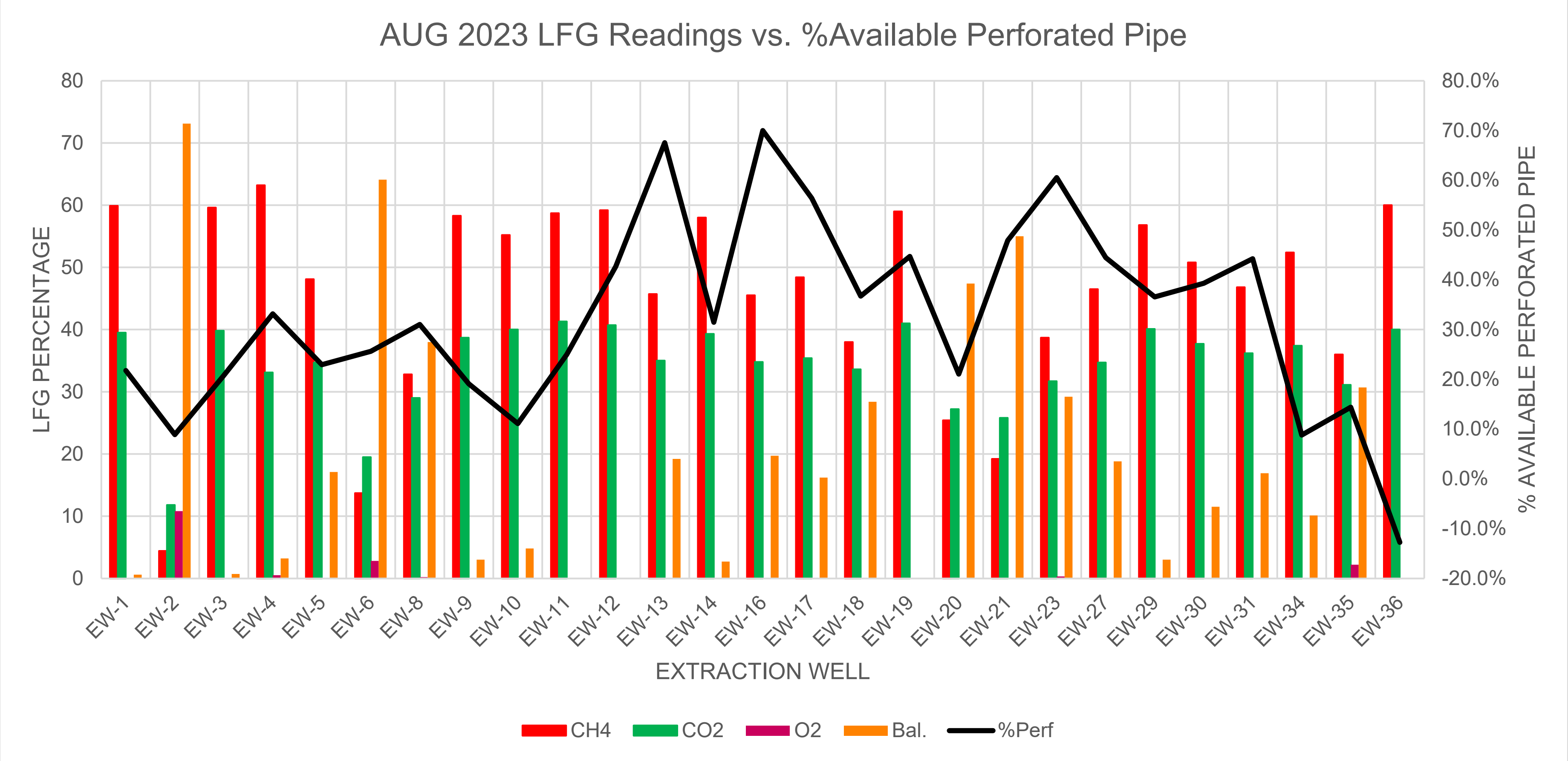

Figure 5: Percentage of Available Perforated Pipe and Landfill LFG Concentration, August 2023

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As indicated by the average available percentage of available perforation in **Table 1**, the worst five wells, as indicated by having an average over the three monitoring events of less than 10% available perforation, are EW-1, EW-2, EW-20, EW-34, and EW-36. However, when looking at well performance across the three graphs above, the wells do not all show underperformance, either consistently or sometimes at all. For instance, EW-1 showed higher than 50% methane in its LFG readings over all three events despite averaging only 4.1% available perforated pipe. EW-2 showed little to no methane and high oxygen concentrations (over 10%) for two of the events but was measured to be functioning well for one of the events. EW-20 also showed poor well performance for two of the three events, but again not all of them. EW-34 and EW-36 both had greater than 50% methane concentrations in the LFG for all three events despite their available pipe perforation being nearly completely submerged through all three events.

It is clear that a correlation cannot necessarily be drawn between poor well performance and available pipe perforation based on these worst-case scenarios, as a majority of the time, these most submerged wells still had LFG measurements with high methane and low oxygen, and seemed to be performing well based on just these data points. This should not be a conclusion that a submerged well will still perform, however. LFG monitoring at Rowan has simply consisted of LFG sampling and a determination of concentrations of methane, oxygen, carbon dioxide, and balance gases at the well head. What has not been measured is the quantity of LFG, or flow measurement. Conditions inside the LFG well can mimic a high functioning well based entirely on concentration, but it is the *flow* of quality LFG that actually defines how effectively a well is performing. A well that is more than 50% submerged--or in the case of the 5 worst wells discussed above, more than 90% submerged—does not have adequate available perforated pipe to take up landfill LFG in effective quantities, meaning the good LFG readings are reflective only of a small quantity of LFG trapped between the solid pipe and the well head that gives the appearance of good quality LFG, but cannot represent much in terms of the its *quantity*. The wells are likely still performing poorly because of how submerged they are, but this cannot be determined without combining flow measurements with LFG quality.

In order to fully understand the implications of the performance of these submerged wells, flow metering should be included in future monitoring.

4 Conclusion and Recommendations

This analysis shows that elevated liquid levels in the LFG wells are a problem for the GCCS at the site. All but 1 of the 27 monitored wells at the site averaged over 50% submerged for the monitoring events from 2022-2023, and a well whose perforated pipe length is greater than 50% submerged is generally categorized as underperforming regardless of LFG quality. Liquid levels in the wells is a high priority, but currently, a pumping infrastructure does not exist for the wells that could alleviate these issues. The following are recommended actions/practices based on the findings of this memorandum:

1. Monitor LFG flow rate during monthly monitoring. This can be done automatically with the GEM-5000 hand held unit but measuring the differential pressure across the orifice plate or Pitot tube within the wellhead. The wellheads and GEM unit are designed with this functionality, however, the well IDs in the GEM unit must be set up with the correct sizing to perform the calculations correctly and provide valid output.

2. Rowan County should prioritize the most inundated wells with the lowest performing wells for dewatering and create a moveable pump system around those. Combining the list of the 5 most submerged wells with the list of the 5 most underperforming wells, it is recommended that the following wells be prioritized for pumping down:
   - EW-1
   - EW-2
   - EW-4
   - EW-6
   - EW-20
   - EW-26
   - EW-34
   - EW-36

   Multiple options exist for dewatering these wells, but in the absence of an airline (for pumps) and forcemain system (for leachate), the most reasonable solution would be to purchase eight (8) vertical well pumps, connect them by hose to a tanker truck, and to manage the liquids in this truck as leachate.

3. With these 8 pumps in hand and the infrastructure to go over the ground with them, the County could begin to systematically dewater all of its LFG wells eight at a time until it decides to either:
   a. Expand its wellfield infrastructure by adding pumps, airlines, and liquid lines (tied into its leachate collection system) to all the existing wells and managing liquid levels in the wells effectively at all times in a closed system; or
   b. Continue to move pumps around from well to well to continue the process of umping each well down as they become inundated.

4. Regardless of the choice of dewatering, continued LFG monitoring should drive the well priorities list with at least quarterly depth to water monitoring to check the percent available perforated pipe and with the addition of flow metering to truly capture whether wells are performing efficiently.

ATTACHMENT F
Monthly Wellhead Readings

Attachment 1

2023 Monthly Wellhead Monitoring

Well	Date	CH4 Concentration	CO2 Concentration	O2 Concentration	Bal. Concentration	Temperature	Pressure
		%	%	%	%	F	(H20 ")
EW-1	1/20/2023	59.5	38.9	0	1.6	60	-14.44
	2/27/2023	60.7	38.1	0	1.2	66	-13.54
	3/30/2023	61.3	37.8	0.2	0.7	65	-13.77
	4/12/2023	62	36.9	0	1.1	76	-13.69
	5/16/2023	58.1	36.3	0.4	5.2	92	-12.57
	6/14/2023	59.7	38.7	0	1.6	88	-12.64
EW-2	1/20/2023	48.4	29.7	3.8	18.1	60	-1.03
	2/27/2023	44.3	28.2	4.1	23.4	70	-2.68
	3/30/2023	18.4	14.3	13.5	53.8	69	-0.06
	4/12/2023	23	19.7	9.6	47.8	78	-2.12
	5/16/2023	15.2	17.4	9.1	58.3	80	4.11
	5/22/2023	8.7	10.6	13.6	67.1	80	-0.46
	6/14/2023	11.4	17.3	8.8	62.6	82	-0.59
EW-3	1/20/2023	60.4	39.3	0.1	0.3	50	-12.6
	2/27/2023	59.8	39.2	0	1	68	-12.51
	3/30/2023	59.2	39.5	0.2	1.1	69	-12.85
	4/12/2023	60.9	39.1	0	0	70	-12.72
	5/16/2023	57.4	38.5	0.2	3.8	82	-11.64
	6/14/2023	59.1	39.5	0	1.4	80	-11.71
EW-4	1/20/2023	50.9	34.3	0	14.8	52	-9.6
	2/27/2023	33.9	20.2	2.3	43.6	70	-14.93
	3/30/2023	1.6	6.1	20	72.3	62	-14.11
	4/12/2023	0.8	4.5	19.5	75.1	76	-1.02
	5/16/2023	0.8	8.4	18	72.7	90	-13.15
	6/14/2023	2.2	3	18.4	76.4	88	-13.55
EW-5	1/20/2023	54.3	31.1	0.5	14	70	-14.66
	2/27/2023	53.1	24	4.1	18.8	74	-14.25
	3/30/2023	40.4	22.7	6.8	30.1	80	-14.13
	4/12/2023	46.3	25.9	5	22.8	78	-14.61
	5/16/2023	68.6	26.7	0.4	4.4	90	-4.3
	6/14/2023	45.2	33.6	0.3	20.9	80	-8.57

EW-6	1/20/2023	41.6	31.1	0	27.3	60	-0.18
	2/27/2023	53.2	33.3	0	13.5	70	-0.2
	3/30/2023	8.2	12.1	9.1	70.6	88	-0.91
	4/12/2023	10.8	13.6	8.5	67	82	-1.14
	5/16/2023	11.2	14.8	6.9	67	92	-0.78
	6/14/2023	9	13.3	7.9	69.8	96	-0.81
EW-7	1/20/2023	59.6	39.6	0	0.7	62	-8.87
	2/27/2023	59.4	38.9	0.1	1.6	68	-8.17
	3/30/2023	59.5	39.3	0.3	0.9	70	-8.85
	4/12/2023	59.3	38.7	0.1	1.8	70	-8.73
	5/16/2023	57.3	38.2	0.3	4.2	80	-7.3
	6/14/2023	58.3	39.6	0	2.1	80	-8.26
EW-8	1/20/2023	32	26.2	2.2	39.7	78	-5.07
	2/27/2023	38.7	28.3	0.8	32.2	88	-2.02
	3/30/2023	52.1	32.6	0.2	15	85	-0.33
	4/12/2023	54.5	33.4	0	12	76	-0.46
	5/16/2023	59.4	35.6	0.3	4.7	90	-0.49
	6/14/2023	26.7	25.5	1.6	46.2	100	-3.12
EW-9	1/20/2023	60.2	37.9	0	2	62	-8.28
	2/27/2023	60.4	37.7	0	1.9	70	-6.41
	3/30/2023	60.4	38.2	0.1	1.3	70	-5.94
	4/12/2023	60.2	37.7	0	2.1	76	-6.67
	5/16/2023	58.1	37.5	0.2	4.2	80	-5.14
	6/14/2023	58.4	38.6	0	3	80	-6.07
EW-10	1/20/2023	57.2	39.7	0	3	82	-6.57
	2/27/2023	57.5	39.6	0	2.9	90	-5.56
	3/30/2023	56.3	39.5	0.2	4.1	100	-5.94
	4/12/2023	56.8	39.3	0	3.9	100	-6.02
	5/16/2023	53.6	38.3	0.6	7.5	100	-4.45
	6/14/2023	54.7	39.7	0	5.5	100	-4.52
EW-11	1/20/2023	59.4	40.6	0	0	90	-9.51
	2/27/2023	59.6	40.4	0	0	114	-6.94
	3/30/2023	58.9	40.2	0.2	0.8	110	-8.57
	4/12/2023	59.1	40	0	0.8	115	-8.31
	5/16/2023	57.1	39.4	0.2	3.2	110	-6.72
	6/14/2023	58.5	41.1	0	0.4	110	-7.74

EW-12	1/20/2023	60	40	0	0	70	-7.78
	2/27/2023	59.9	40.1	0	0	68	-7.55
	3/30/2023	59.2	40.3	0.1	0.4	70	-8.55
	4/12/2023	60.1	39.9	0	0	70	-8.36
	5/16/2023	56.4	38.9	0.3	4.4	70	-7.29
	6/14/2023	59	40.5	0	0.5	76	-7.53
EW-13	1/20/2023	47.6	34.9	0.5	17	100	-6.19
	2/27/2023	49.9	35.6	0.1	14.4	98	-4.23
	3/30/2023	44.3	33.5	0.6	21.6	100	-4.76
	4/12/2023	47.9	34.7	0.2	17.2	108	-4.96
	5/16/2023	47.2	34.6	0.3	17.9	105	-3.54
	6/14/2023	45.5	34.6	0.2	19.7	98	-4.09
EW-14	1/20/2023	60.5	39.5	0	0	70	-7.17
	2/27/2023	60.5	39.5	0	0	92	-5.19
	3/30/2023	59.3	30	0.2	1.5	92	-6.84
	4/12/2023	59.6	38.9	0	1.6	84	-6.75
	5/16/2023	57.5	38.7	0.2	3.7	87	-5.94
	6/14/2023	58.9	40	0	1.2	90	-6.83
EW-15	1/20/2023	59.3	40.3	0	0.4	68	-12.05
	2/27/2023	59.5	40.2	0	0.5	80	-12.2
	3/30/2023	58.2	40	0.2	1.6	85	-12.36
	4/12/2023	58.9	40	0	1	80	-12.43
	5/16/2023	57.4	40	0.1	2.5	85	-11.2
	6/14/2023	57.7	40.6	0	1.7	90	-11.45
EW-16	1/20/2023	46.3	33.6	0.1	20.1	60	-9.34
	2/27/2023	48.1	34.1	0.1	17.8	78	-9.2
	3/30/2023	40.6	32	0.3	27.1	80	-8.82
	4/12/2023	45.3	33.1	0.1	21.5	78	-9.12
	5/16/2023	43.1	32.7	0.1	24	92	-8.08
	6/14/2023	35.3	31.2	0	33.4	88	-7.95
EW-17	1/20/2023	51.1	35.1	0	13.9	72	-6.78
	2/27/2023	53.1	36.3	0	10.6	78	-6.03
	3/30/2023	51.9	35.9	0.2	12	80	-5.94
	4/12/2023	51.9	35.7	0	17.4	80	-6.44
	5/16/2023	51.3	35.9	0.2	12.6	85	-5.68
	6/14/2023	49.5	35.9	0	14.5	84	-5.66

EW-18	1/20/2023	37.9	31.8	0	30.3	72	-6.78
	2/27/2023	41.6	32.7	0	25.6	115	-4.87
	3/30/2023	38.1	31.8	0.2	29.9	120	-5.11
	4/12/2023	44.8	33.9	0	21.3	117	-5.66
	5/16/2023	39.8	33.2	0.1	26.9	112	-4.38
	6/14/2023	36.6	31.6	0.1	31.8	96	-4.41
EW-19	1/20/2023	59.7	39.9	0	0.3	84	-6.09
	2/27/2023	59.3	39.7	0	0.8	84	-5.3
	3/30/2023	58.7	39.5	0.3	1.5	90	-4.98
	4/12/2023	58.8	39.6	0	1.6	90	-4.91
	5/16/2023	56.5	39.5	0.3	3.7	90	-3.67
	6/14/2023	58.1	40.6	0	1.3	98	-3.25
EW-20	1/20/2023	2	17.4	14	66.6	60	-0.52
	2/27/2023	2.9	22.1	9.5	65.5	62	-0.9
	3/30/2023	2.5	20.3	10.7	66.5	70	-0.31
	4/12/2023	1.3	11	15.8	71.8	90	-0.72
	5/16/2023	4.1	27.1	6	62.7	87	-13.3
	6/14/2023	21.3	23.9	6.4	48.6	80	-13.72
EW-21	1/20/2023	33.3	32.1	0	34.6	58	-1.06
	2/27/2023	30	28.9	0	41.1	68	-0.4
	3/30/2023	18.8	25.9	0.1	55.2	90	-0.34
	4/12/2023	25.4	27.2	0	47.4	64	-0.64
	5/16/2023	27.5	27.8	0.1	44.6	87	-0.3
	6/14/2023	16.3	23.8	0	59.9	86	-0.42
EW-22	1/20/2023	45.8	34.1	0.1	20	78	-5.63
	2/27/2023	40.8	32.4	0.1	26.7	80	-5.41
	3/30/2023	48.3	34.7	0.2	16.9	80	-4.59
	4/12/2023	48.5	34.7	0.1	16.7	78	-5.14
	5/16/2023	44.2	33.4	0.1	22.2	82	-4.29
	6/14/2023	45.5	34.1	0	20.4	86	-4.28
EW-23	1/20/2023	53.6	36.1	0	10.4	84	-2.41
	2/27/2023	58.9	36.9	0	4.2	82	-0.43
	3/30/2023	52.3	35.4	0.2	12.1	90	-1.39
	4/12/2023	53.9	35.4	0	10.7	89	-1.73
	5/16/2023	52.2	35.9	0.1	11.8	92	-1.34
	6/14/2023	50.3	35.7	0	14.2	92	-1.86

Attachment 1

EW-24	1/20/2023	40.1	31.8	0	28	64	-0.29
	2/27/2023	46.5	33.6	0	19.8	70	-0.15
	3/30/2023	20.6	23.5	2	53.9	78	-0.65
	4/12/2023	22.5	24.3	2.2	51.1	84	-0.88
	5/16/2023	25.1	26.4	0.6	47.9	95	-1.9
	6/14/2023	21.4	25	1	52.6	98	-0.88
EW-25	1/20/2023	26	26.6	0	47.3	68	-0.19
	2/27/2023	28.1	26.8	0	45	68	-0.01
	3/30/2023	12.1	20.3	1.6	66.9	80	-0.29
	4/12/2023	13.5	21.6	0.5	64.3	78	-0.51
	5/16/2023	14.5	22.1	0.4	63	82	-0.38
	6/14/2023	17.9	22.8	0.1	62.2	88	-0.47
EW-26	1/20/2023	10.7	17	5.7	66.6	80	-0.04
	2/27/2023	9.5	16	5	69.4	83	-0.19
	3/30/2023	9.1	15.4	5.7	69.8	80	-0.07
	4/12/2023	9.7	16.6	5	68.7	80	-0.88
	5/16/2023	10.1	16.8	4.3	68.7	90	-0.08
	6/14/2023	11.7	17.1	4.1	67	92	-0.17
EW-27	1/20/2023	37.8	31	0.4	30.8	70	-7.88
	2/27/2023	37.8	30.6	0.3	31.3	70	-7.93
	3/30/2023	36.6	30.5	0.5	32.4	79	-8.32
	4/12/2023	39.8	31.5	0.1	28.6	76	-7.97
	5/16/2023	38.4	30.9	0.3	30.4	77	-7.44
	6/14/2023	39.9	32.1	0.1	27.9	78	-7.96
EW-28	1/20/2023	59.3	38.9	0.1	1.6	60	-0.72
	2/27/2023	58.5	38.4	0	3.1	68	-0.78
	3/30/2023	54.4	38.2	0.3	7.2	70	-1.05
	4/12/2023	55.6	37.4	0.1	7	76	-1.15
	5/16/2023	50.8	36.8	0.4	12	79	-1.04
	6/14/2023	54.2	38.4	0.2	7.2	86	-0.89
EW-29	1/20/2023	53.6	37.4	0	9	60	-7.5
	2/27/2023	55.5	37.7	0	6.8	70	-6.41
	3/30/2023	53.3	37.7	0.2	8.9	80	-7.1
	4/12/2023	54.1	37.6	0	8.3	80	-7.03
	5/16/2023	52.3	37.5	0.2	10	80	-5.73
	6/14/2023	50.4	37.9	0	11.6	82	-6.46

EW-30	1/20/2023	56.7	38.1	0.1	5	60	-7.09
	2/27/2023	59.4	38.6	0	1.9	82	-6.1
	3/30/2023	57.8	38.5	0.2	3.6	70	-7.21
	4/12/2023	60	38.5	0	1.5	76	-7.19
	5/16/2023	55.6	37.8	0.2	6.4	80	-5.47
	6/14/2023	54	38	0	6	82	-5.9
EW-31	1/20/2023	51.3	36.6	0	12.1	60	-11.78
	2/27/2023	55.7	37.5	0	6.8	70	-10.99
	3/30/2023	52.6	36.9	0.2	10.2	80	-11.37
	4/12/2023	53.7	36.9	0	9.4	80	-11.48
	5/16/2023	51.5	37	0.2	11.3	70	-10.2
	6/14/2023	48.7	36.8	0	14.5	80	-10.17
EW-32	1/20/2023	58.4	38.6	0	3	70	-5.93
	2/27/2023	60.3	39.2	0	0.5	68	-4.4
	3/30/2023	57.6	38.8	0.2	3.5	78	-5.54
	4/12/2023	58.9	38.9	0	2.1	78	-5.65
	5/16/2023	57.2	38.9	0.1	3.8	80	-3.94
	6/14/2023	55.6	39.1	0	5.3	88	-3.87
EW-33	1/20/2023	30.8	21.5	8.5	39.2	58	-7.69
	2/27/2023	61.7	38.1	0	0.2	62	-4.61
	3/30/2023	60.8	38	0.2	1.1	70	-5.47
	4/12/2023	60.7	37.5	0	1.8	76	-5.1
	5/16/2023	56.4	36.4	0.5	6.7	80	-2.67
	6/14/2023	59.7	38.5	0	1.9	80	-4.87
EW-34	1/20/2023	59.5	38	0	2.5	64	-11.78
	2/27/2023	58.7	37.9	0	3.3	70	-11.06
	3/30/2023	57	38	0.2	4.8	79	-11.16
	4/12/2023	59.6	38.4	0	2	76	-11.37
	5/16/2023	55.8	37.7	0.1	6.2	80	-10.24
	6/14/2023	53.9	37.3	0	1.9	80	-10.53
EW-35	1/20/2023	41.6	33.5	2.2	22.7	68	-1.71
	2/27/2023	41	31.9	1.9	25.2	84	-1.65
	3/30/2023	38.5	31.2	2.6	27.6	82	-1.81
	4/12/2023	38.5	30.8	2.3	28.4	80	-1.9
	5/16/2023	36.8	29.9	2.5	30.9	90	-1.46
	6/14/2023	37.7	31.8	1.9	28.7	84	-1.49

EW-36	1/20/2023	61.5	38.5	0	0	62	-14.62
	2/27/2023	60.9	38.6	0.2	0.4	70	-14.44
	3/30/2023	59.8	38.5	0.3	1.4	75	-6.15
	4/12/2023	60.3	38.6	0	1.1	78	-10.21
	5/16/2023	59.4	38.3	0.2	2.2	82	-12.53
	6/14/2023	59.4	39.5	0	1.1	90	-6.39
EW-37	1/20/2023	62	38	0	0	70	-5.84
	2/27/2023	61.7	38.3	0	0	72	-4.41
	3/30/2023	61	38.1	0.1	0.8	82	-5.38
	4/12/2023	61.3	37.7	0	1	77	-5.03
	5/16/2023	60.5	37.7	0.2	1.6	80	-3.8
	6/14/2023	60.5	38.5	0	1.1	90	-4.4
EW-38	1/20/2023	60.9	39	0	0	60	-4.16
	2/27/2023	61	39	0	0	68	-1.63
	3/30/2023	60.2	39.2	0.2	0.4	72	-2.74
	4/12/2023	60.7	38.7	0	0.6	76	-2.02
	5/16/2023	58.7	38.2	0.2	2.9	82	-0.83
	6/14/2023	59.7	39.7	0	0.5	84	-1.43
LCO-1	1/20/2023	42.2	32.6	2.5	22.7	50	-13.83
	2/27/2023	44.8	33.5	1.2	20.6	50	-12.85
	3/30/2023	47.3	34.3	1.3	17	60	-13.44
	4/12/2023	55.4	36.6	0.6	7.4	57	-13.14
	5/16/2023	41.9	32.2	1.4	24.5	65	-7.33
	6/14/2023	30.1	25.5	5.3	39.1	62	-9.81
LCO-2	1/20/2023	0.2	0.2	20.9	78.7	44	-0.06
	2/27/2023	0.1	0.1	20.7	79	60	-0.31
	3/30/2023	0.1	0.3	21.1	78.4	79	-0.02
	4/12/2023	0.2	0.3	21	78.5	50	-0.35
	5/16/2023	0.1	0.4	20.3	79.2	90	-0.84
	6/14/2023	0.3	0.2	19.6	79.9	78	-3.27
LCO-3	1/20/2023	61.1	38.2	0	0.7	72	-8.34
	2/27/2023	61.4	38.6	0.1	0	66	-5.92
	3/30/2023	59.7	38.3	0.3	1.7	80	-7.47
	4/12/2023	60.9	38.2	0	0.8	78	-7.09
	5/16/2023	59	38	0.2	2.8	80	-5.77
	6/14/2023	59.8	38.8	0	1.3	80	-7.16

LCO-4	1/20/2023	5.6	5.6	17.6	71.1	78	-0.32
	2/27/2023	3.9	8.2	18.1	69.8	62	-5.48
	3/30/2023	2.4	9.1	17.3	71.3	84	-8
	4/12/2023	2.4	10.2	16.7	70.6	76	-0.21
	5/16/2023	1.8	9.7	16.6	71.8	89	-2.92
	6/14/2023	1	4.4	17.8	76.9	90	-0.12
LCO-5	1/20/2023	61.4	38.6	0.1	0	78	-1.53
	2/27/2023	61.2	38.8	0	0	76	-0.2
	3/30/2023	61.4	38.5	0.2	0	76	-1.53
	6/14/2023	61.8	38.2	0	0	78	-1.6
	5/16/2023	59.8	38	0.3	2	80	-1.1
	6/14/2023	61	39	0	0	80	-1.56
LCO-30	1/20/2023	38	28.7	5.5	27.9	50	-4.02
	2/27/2023	48.6	34.5	2.2	14.7	70	-1.49
	3/30/2023	40.3	30	5.2	24.6	74	-2.24
	4/12/2023	50.4	35.4	1.7	12.4	76	-1.65
	5/16/2023	56.5	38.2	0.3	5	75	-0.82
	6/14/2023	42.3	31.5	3.7	22.5	80	-1.1
LCO-34	1/20/2023	29.2	21.7	9.2	39.9	58	-3.18
	2/27/2023	35.3	24.8	7.6	32.4	56	-0.74
	3/30/2023	0.1	0	21.2	78.7	75	-0.78
	4/12/2023	0.2	0.2	20.7	78.7	80	-0.68
	5/16/2023	8.6	5.1	17.3	68.9	92	0.37
	5/22/2023	0	0	20.6	79.4	80	-0.67
	6/14/2023	18.1	13.7	12.7	55.5	92	-0.22

Notes:

1. Grey highlighted cells indicate monitoring occurred to check that exceedances were rectified rather than a monthly monitoring event.
2. Landfill cover is inspected for integrity during the monthly wellhead readings. Any necessary repairs are reported to Rowan County Landfill staff.

Attachment 1

2023 Monthly Wellhead Monitoring

Well	Date	CH4 Concentration %	CO2 Concentration %	O2 Concentration %	Bal. Concentration %	Temp F	Pressure (H20 ")
EW-1	7/12/2023	59.0	36.6	0.1	4.4	94	-12.70
	8/16/2023	59.9	39.5	0.0	0.6	86	-12.24
	9/5/2023	57.3	36.8	0.1	5.7	100	-12.25
	10/11/2023	55.5	44.5	0.0	0.0	74	-9.46
	11/28/2023	49.0	34.6	0.0	16.3	42	-8.80
	12/20/2023	50.4	33.6	0.0	16.0	70	-6.25
EW-2	7/13/2023	5.6	11.6	12.3	70.5	80	-0.80
	8/16/2023	4.4	11.8	10.8	73.1	88	-0.41
	9/5/2023	0.5	2.3	16.8	80.4	90	-0.90
	10/11/2023	1.1	4.5	17.5	76.9	72	-0.40
	11/28/2023	6.2	20.9	6.4	66.4	50	-0.80
	12/20/2023	52.5	28.3	2.7	16.5	52	-5.52
EW-3	7/12/2023	59.0	37.2	0.0	3.8	78	-12.12
	8/16/2023	59.6	39.8	0.0	0.7	84	-11.52
	9/5/2023	57.7	37.1	0.0	5.2	90	-11.04
	10/11/2023	55.3	44.7	0.0	0.0	70	-8.45
	11/28/2023	60.5	37.5	0.0	2.0	48	-7.81
	12/20/2023	60.0	35.6	0.0	4.4	60	-5.57
EW-4	7/13/2023	38.6	20.9	7.5	33.1	96	-12.00
	8/16/2023	63.2	33.1	0.5	3.2	86	-2.24
	9/5/2023	39.4	31.0	0.0	29.6	94	-6.07
	10/11/2023	42.5	35.4	0.0	22.1	80	-4.60
	11/28/2023	35.0	29.1	0.0	35.9	58	-3.87
	12/20/2023	36.8	28.6	0.0	34.6	60	-2.84
EW-5	7/12/2023	48.6	32.4	0.0	19.1	98	-7.46
	8/16/2023	48.1	34.7	0.1	17.1	90	-6.74
	9/5/2023	45.2	32.7	0.3	21.8	98	-6.32
	10/11/2023	49.3	38.1	0.0	12.6	78	-4.70
	11/28/2023	39.8	30.6	0.0	29.7	58	-4.13
	12/20/2023	43.6	29.3	0.0	27.1	52	-4.11

EW-6	7/13/2023	9.0	14.2	6.1	70.7	90	-0.21
	8/16/2023	13.7	19.5	2.8	64.1	92	-0.32
	9/5/2023	13.2	20.0	2.0	64.8	90	-0.61
	10/11/2023	17.7	23.5	1.1	57.8	84	-0.12
	11/28/2023	30.6	27.1	0.0	32.3	58	-0.10
	12/20/2023	16.4	21.2	1.9	60.4	58	-0.22
EW-7	7/12/2023	58.0	36.8	0.0	5.1	80	-8.46
	8/16/2023	57.4	38.6	0.0	4.0	78	-8.30
	9/5/2023	54.3	36.6	0.0	9.1	90	-8.16
	10/11/2023	56.4	43.6	0.0	0.0	78	-6.41
	11/28/2023	53.1	35.6	0.0	11.3	58	-5.92
	12/20/2023	55.8	35.0	0.0	9.3	60	-4.30
EW-8	7/12/2023	28.6	25.2	1.2	45.1	98	-2.36
	8/16/2023	32.8	29.0	0.2	38.0	98	-1.22
	9/5/2023	36.7	29.0	0.0	34.3	100	-1.11
	10/11/2023	46.2	36.2	0.0	17.6	80	-0.35
	11/28/2023	47.8	32.6	0.0	19.6	60	-0.10
	12/20/2023	56.0	33.6	0.0	10.4	62	-0.20
EW-9	7/12/2023	58.0	36.3	0.0	5.7	78	-6.50
	8/16/2023	58.3	38.7	0.0	3.0	80	-6.53
	9/5/2023	56.4	36.2	0.1	7.3	90	-6.27
	10/11/2023	57.3	42.7	0.0	0.0	80	-4.31
	11/28/2023	52.7	34.8	0.0	12.5	60	-5.92
	12/20/2023	54.4	34.0	0.0	11.6	60	-3.36
EW-10	7/12/2023	53.9	36.9	0.0	9.2	100	-4.39
	8/16/2023	55.2	40.0	0.0	4.8	96	-4.55
	9/5/2023	53.5	37.6	0.0	8.9	98	-4.49
	10/11/2023	55.4	44.6	0.0	0.0	98	-2.82
	11/28/2023	54.0	37.0	0.0	9.0	100	-2.01
	12/20/2023	55.6	36.3	0.0	8.0	90	-1.60
EW-11	7/12/2023	58.1	37.9	0.0	4.0	110	-8.21
	8/16/2023	58.7	41.3	0.0	0.0	118	-8.47
	9/5/2023	58.1	38.2	0.0	3.7	112	-8.30
	10/11/2023	54.7	45.4	0.0	0.0	118	-5.87
	11/28/2023	60.6	38.3	0.0	1.0	110	-6.02
	12/20/2023	60.1	36.9	0.0	3.1	110	-4.28

EW-12	7/12/2023	58.6	37.9	0.0	3.5	78	-7.74
	8/16/2023	59.2	40.7	0.0	0.0	80	-7.47
	9/5/2023	57.6	37.9	0.0	4.5	84	-7.39
	10/11/2023	54.3	45.7	0.0	0.0	78	-5.91
	11/28/2023	57.5	37.5	0.0	4.9	68	-5.48
	12/20/2023	58.8	36.3	0.0	4.8	72	-7.29
EW-13	7/12/2023	43.2	32.0	0.2	24.6	102	-3.76
	8/16/2023	45.7	35.0	0.0	19.2	94	-3.65
	9/5/2023	43.6	33.0	0.1	23.4	100	-3.59
	10/11/2023	50.6	39.5	0.0	9.9	100	-2.58
	11/28/2023	45.3	33.0	0.0	21.6	60	-2.40
	12/20/2023	43.7	31.7	0.0	24.6	90	-1.00
EW-14	7/12/2023	57.7	36.9	0.0	5.4	90	-7.20
	8/16/2023	58.0	39.3	0.0	2.7	96	-7.33
	9/5/2023	55.0	36.4	0.0	8.6	98	-7.58
	10/11/2023	57.5	42.5	0.0	0.0	84	-5.70
	11/28/2023	52.3	35.2	0.0	12.6	80	-5.39
	12/20/2023	54.4	34.7	0.0	10.8	82	-3.92
EW-15	7/12/2023	57.5	37.8	0.0	4.7	88	-11.26
	8/16/2023	58.9	41.1	0.0	0.0	96	-11.13
	9/5/2023	57.7	38.5	0.0	3.8	98	-11.02
	10/11/2023	54.4	45.6	0.0	0.0	82	-8.14
	11/28/2023	52.7	36.5	0.0	10.8	80	-7.25
	12/20/2023	57.5	36.0	0.0	6.5	70	-6.28
EW-16	7/13/2023	38.3	30.4	0.0	31.3	80	-4.22
	8/16/2023	45.5	34.8	0.0	19.7	80	-4.28
	9/5/2023	43.6	32.9	0.0	23.5	94	-4.05
	10/11/2023	47.8	38.8	0.0	13.3	80	-3.16
	11/28/2023	39.0	31.2	0.0	29.7	58	-2.63
	12/20/2023	39.1	30.1	0.0	30.8	60	-7.44
EW-17	7/12/2023	48.6	33.5	0.0	17.8	98	-5.03
	8/16/2023	48.4	35.4	0.0	16.2	100	-5.43
	9/5/2023	46.8	33.4	0.0	19.8	90	-5.23
	10/11/2023	50.4	39.3	0.0	0.3	82	-4.58
	11/28/2023	43.2	32.4	0.0	24.4	68	-3.90
	12/20/2023	45.3	31.6	0.0	23.0	80	-3.57

EW-18	7/13/2023	38.9	31.3	0.0	29.9	115	-2.28
	8/16/2023	38.0	33.6	0.0	28.4	118	-2.46
	9/5/2023	37.0	31.0	0.0	32.0	110	-2.53
	10/11/2023	39.7	36.2	0.0	24.1	115	-1.92
	11/28/2023	35.1	30.2	0.0	34.7	110	-1.59
	12/20/2023	34.4	29.2	0.0	36.4	110	-1.68
EW-19	7/12/2023	57.9	37.8	0.0	4.3	98	-2.98
	8/16/2023	59.0	41.0	0.0	0.0	100	-2.70
	9/5/2023	57.2	38.2	0.0	4.6	100	-2.83
	10/11/2023	55.8	44.3	0.0	0.0	96	-2.09
	11/28/2023	54.3	36.4	0.0	9.4	90	-1.93
	12/20/2023	56.5	35.5	0.0	8.0	88	-1.79
EW-20	7/13/2023	24.5	31.1	1.4	43.0	80	-0.98
	8/16/2023	24.5	31.0	2.1	42.4	82	-0.65
	9/5/2023	25.4	31.9	0.1	42.6	90	-0.84
	10/11/2023	59.2	40.8	0.0	0.0	64	-0.15
	11/28/2023	21.4	25.1	0.0	53.5	60	-0.26
	12/20/2023	17.5	22.2	0.0	60.3	68	-5.89
EW-21	7/13/2023	17.0	23.9	0.0	59.1	94	-0.10
	8/16/2023	19.2	25.8	0.0	55.0	84	-0.33
	9/5/2023	18.8	25.5	0.1	55.7	90	-0.49
	10/11/2023	22.9	29.2	0.0	47.9	66	-0.25
	11/28/2023	18.7	24.5	0.0	56.8	50	-0.25
	12/20/2023	22.1	24.0	0.0	53.9	46	-6.91
EW-22	7/12/2023	44.3	31.9	0.0	23.8	80	-3.50
	8/16/2023	46.9	35.2	0.0	17.9	80	-3.57
	9/5/2023	46.4	33.6	0.2	20.2	80	-3.37
	10/11/2023	49.8	39.3	0.0	10.9	80	-2.98
	11/28/2023	43.8	32.4	0.0	21.8	80	-2.50
	12/20/2023	43.5	31.5	0.0	25.1	70	-6.62
EW-23	7/12/2023	44.6	31.5	0.0	23.8	98	-2.38
	8/16/2023	38.7	31.7	0.3	29.2	100	-3.25
	9/5/2023	35.6	28.8	0.5	35.2	100	-3.70
	10/11/2023	38.4	32.6	0.4	28.6	100	-3.00
	11/28/2023	29.8	25.8	1.5	42.9	100	-3.14
	12/20/2023	30.7	25.5	1.3	42.5	100	-3.34

EW-24	7/13/2023	21.2	24.8	0.3	53.7	98	-0.40
	8/16/2023	23.0	26.6	0.4	50.1	100	-0.51
	9/5/2023	22.4	26.1	0.4	51.2	92	-0.62
	10/11/2023	27.0	30.3	0.0	42.7	90	-0.06
	11/28/2023	30.0	28.5	0.4	41.1	75	-1.70
	12/20/2023	9.2	17.7	3.5	69.6	90	-6.72
EW-25	7/13/2023	14.2	22.4	0.2	63.2	88	-0.42
	8/16/2023	16.9	23.7	0.4	59.0	86	-0.58
	9/5/2023	16.9	23.7	0.3	59.0	84	-0.67
	10/11/2023	9.7	16.5	4.7	69.1	78	-0.10
	11/28/2023	25.1	26.7	0.5	47.7	90	-0.80
	12/20/2023	4.3	14.9	3.8	77.0	100	-4.62
EW-26	7/13/2023	10.7	15.5	7.0	66.8	96	-0.18
	8/16/2023	8.2	14.1	7.4	70.2	80	-0.22
	9/5/2023	8.1	14.8	7.2	69.9	100	-0.42
	10/11/2023	19.5	27.0	0.0	53.4	78	-0.08
	11/28/2023	11.5	17.7	6.1	64.4	90	-0.39
	12/20/2023	2.7	10.5	10.4	76.4	90	-2.48
EW-27	7/13/2023	41.2	30.9	0.1	27.8	76	-4.72
	8/16/2023	46.5	34.7	0.0	18.8	78	-4.70
	9/5/2023	46.6	32.7	0.2	20.5	80	-4.73
	10/11/2023	51.0	39.4	0.0	9.6	78	-4.02
	11/28/2023	46.4	33.0	0.0	20.6	62	-5.05
	12/20/2023	40.5	31.1	0.0	28.5	64	-6.98
EW-28	7/12/2023	48.3	34.7	0.2	16.8	80	-0.92
	8/16/2023	42.6	33.5	1.2	22.7	86	-0.84
	9/5/2023	38.7	30.8	1.2	29.3	94	-1.15
	10/11/2023	44.9	36.3	0.9	17.8	78	-0.56
	11/28/2023	42.6	31.7	1.3	24.4	56	-0.32
	12/20/2023	55.7	34.7	0.0	9.6	64	-0.40
EW-29	7/12/2023	46.5	34.6	0.0	19.0	80	-6.49
	8/16/2023	56.8	40.1	0.0	3.0	90	-6.83
	9/5/2023	55.6	37.2	0.0	7.1	90	-6.85
	10/11/2023	56.1	43.9	0.0	0.0	78	-4.87
	11/28/2023	54.3	36.5	0.0	9.1	56	-4.76
	12/20/2023	55.3	35.5	0.0	9.2	60	-3.78

EW-30	7/12/2023	52.3	35.3	0.0	12.4	80	-6.23
	8/16/2023	50.8	37.7	0.0	11.5	82	-5.95
	9/5/2023	49.4	34.6	0.0	16.0	100	-5.79
	10/11/2023	57.2	41.2	0.0	1.5	80	-3.95
	11/28/2023	50.6	34.1	0.3	15.1	58	-3.74
	12/20/2023	53.6	34.0	0.0	12.3	62	-2.69
EW-31	7/12/2023	46.5	33.6	0.0	19.9	98	-9.92
	8/16/2023	46.8	36.2	0.0	16.9	96	-10.10
	9/5/2023	45.8	33.2	0.0	21.1	98	-8.67
	10/11/2023	51.3	39.3	0.0	9.3	80	-7.52
	11/28/2023	41.3	32.1	0.0	26.6	66	-2.27
	12/20/2023	46.0	32.4	0.0	21.7	88	-6.26
EW-32	7/12/2023	49.6	34.7	0.0	15.6	86	-13.66
	8/16/2023	46.6	36.5	0.0	17.0	90	-13.74
	9/5/2023	44.7	33.6	0.1	21.6	94	-13.71
	10/11/2023	53.4	40.1	0.1	6.4	80	-10.32
	11/28/2023	45.4	32.6	1.2	20.9	66	-10.74
	12/20/2023	48.4	32.5	0.6	18.5	64	-8.53
EW-33	7/12/2023	58.6	35.4	0.2	5.8	80	-5.53
	8/16/2023	61.1	38.9	0.0	0.0	90	-6.44
	9/5/2023	58.2	35.9	0.0	5.9	92	-6.29
	10/11/2023	57.0	43.0	0.0	0.0	78	-4.36
	11/28/2023	39.2	27.6	3.8	29.3	50	-1.90
	12/20/2023	43.3	28.7	2.5	25.6	60	-1.32
EW-34	7/12/2023	55.1	35.9	0.0	9.0	80	-10.53
	8/16/2023	52.4	37.4	0.1	10.1	94	-10.59
	9/5/2023	49.8	34.3	0.0	15.8	96	-10.33
	10/11/2023	55.9	40.1	0.0	4.1	80	-7.85
	11/28/2023	47.0	32.5	0.3	20.3	60	-7.56
	12/20/2023	56.5	34.0	0.0	9.6	58	-6.08
EW-35	7/12/2023	39.0	30.6	1.7	28.8	86	-1.28
	8/16/2023	36.0	31.1	2.2	30.7	90	-1.50
	9/5/2023	36.3	28.5	1.9	33.3	98	-1.60
	10/11/2023	37.4	31.8	1.8	29.0	80	-1.10
	11/28/2023	29.5	25.9	3.6	41.0	60	-1.07
	12/20/2023	31.4	26.7	2.1	39.8	60	-0.99

EW-36	7/12/2023	58.7	36.8	0.0	4.5	88	-4.42
	8/16/2023	60.0	40.0	0.0	0.0	102	-3.31
	9/5/2023	58.8	36.7	0.0	4.5	100	-3.86
	10/11/2023	56.5	43.5	0.0	0.0	80	-3.40
	11/28/2023	57.8	36.0	0.0	6.3	72	-2.68
	12/20/2023	61.7	35.4	0.0	2.9	60	-4.33
EW-37	7/12/2023	59.1	35.6	0.0	5.2	90	-4.11
	8/16/2023	60.8	39.2	0.0	0.0	100	-4.56
	9/5/2023	60.1	36.5	0.0	3.4	102	-4.50
	10/11/2023	57.0	43.0	0.0	0.0	80	-2.62
	11/28/2023	60.7	36.1	0.0	3.2	68	-2.71
	12/20/2023	62.3	34.9	0.0	2.7	60	-2.33
EW-38	7/12/2023	59.4	37.0	0.0	3.6	80	-1.33
	8/16/2023	59.8	40.0	0.2	0.0	90	-1.40
	9/5/2023	59.1	37.0	0.0	3.9	94	-1.58
	10/11/2023	55.4	44.6	0.0	0.0	78	-1.10
	11/28/2023	61.4	37.3	0.0	1.3	60	-1.09
	12/20/2023	61.0	35.6	0.0	3.3	58	-0.74
LCO-1	7/13/2023	18.9	17.1	9.6	54.4	68	-6.00
	8/16/2023	15.4	12.1	12.1	60.3	70	-6.00
	9/5/2023	18.4	15.3	11.0	55.3	68	-6.00
	10/11/2023	58.7	40.8	0.5	0.0	76	-9.82
	11/28/2023	60.1	36.7	0.1	3.2	38	-6.71
	12/20/2023	44.3	33.2	0.0	22.3	40	-7.61
LCO-2	7/13/2023	0.1	0.2	20.3	79.5	90	-0.40
	8/16/2023	1.9	1.5	19.4	77.3	98	-0.10
	9/5/2023	0.0	0.2	19.2	80.6	102	-9.21
	10/11/2023	0.7	0.8	20.8	77.6	80	-0.30
	11/28/2023	1.1	1.8	20.6	76.5	38	-0.10
	12/20/2023	0.2	0.3	22.1	77.4	44	-0.18
LCO-3	7/12/2023	58.4	36.3	0.0	5.3	98	-6.54
	8/16/2023	60.5	39.5	0.0	0.0	80	-6.48
	9/5/2023	59.4	36.5	0.1	4.1	84	-7.19
	10/11/2023	56.9	43.1	0.0	0.0	80	-5.78
	11/28/2023	59.9	36.1	0.1	3.9	68	-5.85
	12/20/2023	62.0	35.2	0.0	2.9	70	-6.87

LCO-4	7/13/2023	0.4	3.2	18.4	77.9	98	-0.50
	8/16/2023	0.8	2.9	18.3	78.0	80	-0.02
	9/5/2023	0.9	2.9	17.6	78.6	82	-0.33
	10/11/2023	0.6	2.5	19.5	77.5	80	-0.05
	11/28/2023	0.5	2.6	20.3	76.5	38	-0.02
	12/20/2023	0.2	0.7	20.8	78.3	60	-0.32
LCO-5	7/12/2023	59.8	35.8	0.0	4.3	80	-1.27
	8/16/2023	60.5	39.5	0.0	0.0	82	-2.20
	9/5/2023	60.8	36.7	0.0	2.5	80	-2.21
	10/11/2023	56.8	43.3	0.0	0.0	80	-1.65
	11/28/2023	62.2	36.8	0.0	0.9	78	-1.59
	12/20/2023	62.5	35.2	0.0	2.2	78	-1.72
LCO-30	7/13/2023	39.8	28.3	4.8	27.1	78	-0.90
	8/16/2023	34.7	25.3	6.7	33.3	78	-0.99
	9/5/2023	38.4	27.7	4.2	29.7	80	-1.00
	10/11/2023	55.9	41.1	0.8	2.2	76	-0.52
	11/28/2023	38.0	27.5	5.9	28.6	70	-1.59
	12/20/2023	37.9	26.0	6.2	29.9	70	-0.08
LCO-34	7/13/2023	0.3	0.3	20.5	78.9	100	-0.16
	8/16/2023	0.5	0.1	20.3	79.0	98	-0.14
	9/5/2023	0.5	0.2	18.2	81.3	90	-0.49
	10/11/2023	50.3	36.0	2.4	4.3	82	-0.04
	11/28/2023	36.8	25.4	7.5	30.4	62	-0.12
	12/20/2023	50.4	33.5	1.3	15.0	70	-0.15

Notes:

1. Landfill cover is inspected for integrity during the monthly wellhead readings. Any necessary repairs are reported to Rowan County Landfill staff.

Attachment 1

2024 Monthly Wellhead Monitoring							
Well	**Date**	**CH4 Concentration**	**CO2 Concentration**	**O2 Concentration**	**Bal. Concentration**	**Temp**	**Pressure**
		%	**%**	**%**	**%**	**F**	**(H20 ")**
EW-1	1/22/2024	60.5	36.3	0	3.2	50	-10.39
	2/27/2024	58	41.9	0.1	0	50	-14.93
	3/14/2024	58.3	36	0.1	5.5	84	-17.47
	4/30/2024	61.4	38.5	0.1	0	78	-15.32
	5/29/2024	59.3	36.2	0	4.2	90	-14.59
	6/5/2024	60.8	37.2	0	2.1	70	-14.27
EW-2	1/22/2024	52.9	28.4	2.6	16.1	54	-5.19
	2/27/2024	48.4	26.7	4.9	20	50	-1.51
	3/14/2024	53.3	27.2	1.5	18	80	-0.17
	4/30/2024	50.2	27.5	2	20.3	78	-5.14
	5/29/2024	48.0	27.9	0.1	24.0	90	-0.97
	6/5/2024	47	27.7	0.4	24.9	80	-0.84
EW-3	1/22/2024	60.4	36.4	0	3.2	52	-10.27
	2/27/2024	57.7	42.3	0.1	0	60	-14.29
	3/14/2024	58	36.7	0.3	5	80	-16.72
	4/30/2024	59.6	40.3	0.1	0	80	-15.99
	5/29/2024	57.2	37.9	0.2	4.7	80	-16.42
	6/5/2024	58.8	38.9	0	2.4	78	-16.16
EW-4	1/22/2024	32.9	27.6	0	39.4	56	-5.58
	2/27/2024	33.8	26.5	0	39.6	60	-6
	3/15/2024	3	2.7	20	74.2	70	-11.89
	4/30/2024	0.4	0.2	19.9	79.5	82	-8.2
	5/29/2024	0.2	0.2	19.9	79.8	92	-7.15
	6/5/2024	0.2	0.2	20.4	79.2	74	-6.36
EW-5	1/22/2024	47.9	26	3.2	22.9	58	-10.92
	2/27/2024	46.7	24	3.5	25.8	60	-11.43
	3/15/2024	55.9	25.7	2.4	16	70	-3
	4/30/2024	72	27.8	0.2	0	82	-3
	5/29/2024	54.3	32.7	1.5	11.5	90	-16.23
	6/5/2024	59.4	36.4	0	4.3	80	-15.28

EW-6	1/22/2024	16.3	19.4	4.4	59.9	58	-0.62
	2/27/2024	15.3	20.0	4.7	60.0	60	-0.74
	3/14/2024	21.9	23.0	1.6	53.6	80	-0.56
	4/30/2024	23.2	24.6	1.0	51.1	84	-0.15
	5/29/2024	21.6	24.3	0.3	53.8	88	-0.41
	6/5/2024	26.1	25.7	0.0	48.1	80	-0.42
EW-7	1/22/2024	59.1	36.4	0	4.4	58	-7.35
	2/27/2024	58.3	41.7	0	0	60	-10.42
	3/14/2024	56.8	36.5	0	6.6	80	-12.5
	4/30/2024	57.2	39.3	0.1	3.54	72	-11.27
	5/29/2024	56.7	37.9	0.1	5.3	90	-12.18
	6/5/2024	56	38.6	0.2	5.2	80	-11.98
EW-8	1/22/2024	39.7	28.7	0.7	30.9	70	-1.56
	2/27/2024	53.3	35.7	0	11	60	-0.55
	3/14/2024	49.6	31	0	19.4	82	-1.28
	4/30/2024	57.3	35.8	0.1	6.8	80	-0.12
	5/29/2024	50.5	33.3	0	16.1	90	-0.56
	6/5/2024						
EW-9	1/22/2024	58.7	35.5	0	5.7	58	-6.05
	2/27/2024	58.7	41.3	0	0	60	-8.12
	3/14/2024	56.9	35.9	0	7.2	90	-9.5
	4/30/2024	60.2	38.8	0	0.1	72	-8.86
	5/29/2024	56.3	37.4	0	6.3	80	-9.73
	6/5/2024	57.1	39.3	0	4.6	80	-9.53
EW-10	1/22/2024	55.1	36.5	0	8.4	80	-4.7
	2/27/2024	57.1	42.3	0	0.5	80	-6.64
	3/14/2024	51.2	36.2	0.1	12.6	84	-9.1
	4/30/2024	54.9	39.7	0.1	5.4	90	-7.05
	5/29/2024	52.3	38.4	0.1	9.3	90	-8.08
	6/5/2024	52.9	39.1	0	8.1	90	-7.88
EW-11	1/22/2024	61	37.2	0	1.8	100	-7.2
	2/27/2024	59.7	40.2	0	0	112	-10.73
	3/14/2024	58.9	38.3	0	2.7	112	-13.52
	4/30/2024	58.4	41.6	0.1	0	106	-15.85
	5/29/2024	57.6	39.7	0	2.6	110	-16.28
	6/5/2024	58	40.2	0	1.7	110	-16.37

EW-12	1/22/2024	58.6	37.1	0	4.2	68	-11.52
	2/27/2024	57.2	42.8	0	0	70	-15.73
	3/14/2024	56.7	37.9	0	5.4	80	-18.3
	4/30/2024	59	41	0	0	78	-14.5
	5/29/2024	54.7	38.5	0.8	5.9	84	-16.01
	6/5/2024	56.2	39.7	0	4.1	78	-15.87
EW-13	1/22/2024	32.9	28.2	0.5	38.4	98	-11.26
	2/27/2024	31.1	28.2	0.8	39.9	100	-15
	3/14/2024	37.6	29.7	0.2	32.5	100	-17.49
	4/30/2024	59.1	40.9	0	0	80	-1
	5/29/2024	33.6	29.9	0.5	36	100	-12.44
	6/5/2024	34	30	0.3	35.7	95	-12.23
EW-14	1/22/2024	61.1	36.3	0	2.6	80	-7.04
	2/27/2024	60	39.3	0	0.7	80	-8.88
	3/14/2024	59	37.8	0	3.2	80	-10.85
	4/30/2024	59.2	40.7	0.1	0	84	-8.71
	5/29/2024	57.9	38.9	0	3.2	90	-9.41
	6/5/2024	56.4	38.8	0	4.8	84	-9.05
EW-15	1/22/2024	60.6	37.6	0.1	1.7	62	-2.02
	2/27/2024	58.4	40.5	0	1.1	64	-6.69
	3/14/2024	58.5	38.7	0.1	2.7	76	-9.68
	4/30/2024	58	40	0.8	1.2	80	-7.99
	5/29/2024	55.3	39.2	0	5.5	80	-9.06
	6/5/2024	56.4	40.6	0	3	80	-9.07
EW-16	1/22/2024	23	24	2.2	50.7	58	-11.33
	2/27/2024	26.3	26	1.4	46.3	74	-15.5
	3/14/2024	31.9	26.7	1.3	40	78	-16.71
	4/30/2024	27.2	27	0.8	44.9	86	-15
	5/29/2024	27.5	27.2	0.6	44.8	84	-17.69
	6/5/2024	28	27.9	0.5	43.6	80	-17.53
EW-17	1/22/2024	42.8	31.2	0	26.1	68	-6.97
	2/27/2024	45.9	34.1	0	20	78	-8.19
	3/14/2024	48.2	33	0.1	18.6	78	-9.46
	4/30/2024	47.6	34.5	0.8	17	82	-7.97
	5/29/2024	47.3	34.6	0	18.1	82	-9
	6/5/2024	47.1	35	0	17.9	80	-9.05

EW-18	1/22/2024	39	30.5	0	30.5	115	-3.22
	2/27/2024	41.4	33.9	0	24.7	110	-3.63
	3/14/2024	43.4	33.2	0.2	23.1	110	-5.04
	4/30/2024	42.2	34.1	0.3	23.4	110	-3.64
	5/29/2024	40.2	33	0	26.8	110	-4.58
	6/5/2024	40.6	33.4	0	26	100	-4.19
EW-19	1/22/2024	Raised- Too High					
	2/27/2024	Raised- Too High					
	3/14/2024	Well repaired, but need fittings for testing					
	4/30/2024	58.3	39.5	0.7	1.3	80	-5.01
	5/29/2024	57.2	39	0	3.5	90	-8.83
	6/5/2024	57.9	40.6	0	1.5	80	-8.71
EW-20	1/22/2024	6.9	16.5	3.5	73	58	-1.27
	2/27/2024	6.9	27.4	4	61.6	68	-0.8
	3/14/2024	7.7	30	1.6	60.8	80	-1.06
	4/30/2024	11.7	34.8	0	53.5	82	-0.4
	5/29/2024	11.5	34.3	0	54.2	90	-1.33
	6/5/2024	11.6	33.7	0.3	54.4	80	-0.86
EW-21	1/22/2024	18.6	21.4	2.8	57.2	90	-7.21
	2/27/2024	20.9	23.5	2.3	53.3	84	-6.11
	3/14/2024	22.8	21.3	4.8	51.6	80	-5.7
	4/30/2024	18.5	24	0.7	56.8	84	-1.53
	5/29/2024	18.4	24.9	0.2	56.5	90	-1.21
	6/5/2024	18.9	25	0.1	56	80	-1.29
EW-22	1/22/2024	29	26.8	0	44.2	78	-10.47
	2/27/2024	34.3	29.8	0	35.9	76	-14.77
	3/14/2024	34.8	28	0.7	36.6	78	-17.15
	4/30/2024	43.1	33.1	0.1	23.7	80	-16.01
	5/29/2024	41.5	32.4	0	26.1	80	-17.3
	6/5/2024	42.2	33	0	24.7	80	-16.89
EW-23	1/22/2024	38.9	29.3	1.2	30.6	94	-5.04
	2/27/2024	36.7	29.2	2.1	32	100	-6.48
	3/14/2024	36	27	3.4	33.6	100	-8.01
	4/30/2024	39.5	30.2	1.8	28.4	98	-3.69
	5/29/2024	39.6	30	1.2	29.3	100	-4.36
	6/5/2024	39.8	30.9	1.2	28.2	100	-4.1

Attachment 1

EW-24	1/22/2024	1.4	9	8.8	80.9	60	-0.23
	2/27/2024	54.7	35.2	0	10	60	-0.05
	3/14/2024	51.6	33.7	0.2	14.5	70	-0.24
	4/30/2024	61.2	38.7	0	0	78	-0.1
	5/29/2024	41.9	33.4	0	24.7	82	-0.25
	6/5/2024	45.6	34.4	0	20.1	80	-0.31
EW-25	1/22/2024	3.4	13.6	2.2	80.8	60	-0.32
	2/27/2024	40.7	38	0.1	21.2	48	-0.06
	3/14/2024	38.7	31.4	0.3	29.5	90	-0.25
	4/30/2024	57.2	36.4	0.1	6.3	90	-0.1
	5/29/2024	37.1	30.3	0	32.5	98	-0.25
	6/5/2024	36.5	30.5	0	33	98	-0.33
EW-26	1/22/2024	1	6.8	12	80.8	92	-0.5
	2/27/2024	4.6	11.9	9.2	74.3	90	-0.28
	3/15/2024	5.7	12.5	8.2	73.6	75	-0.67
	4/30/2024	10.3	14.8	7.6	67.4	82	-0.16
	5/29/2024	14.4	19	4.1	62.4	98	-0.21
	6/5/2024	15.7	20	3.4	61	90	-0.21
EW-27	1/22/2024	30.5	28	0.3	41.3	70	-10
	2/27/2024	32.7	29.5	0.5	37.3	71	-15.14
	3/15/2024	49.3	32.5	0	18.2	75	-0.41
	4/30/2024	50.4	35.6	0	14.1	82	-4.61
	5/29/2024	50.5	34.7	0	14.8	90	-5.42
	6/5/2024	49.9	35	0.2	15	80	-5.12
EW-28	1/22/2024	52	34.2	0.8	13	60	-0.98
	2/27/2024	45.3	36.2	1	17.6	60	-1.19
	3/14/2024	35.3	28.5	2.1	34	88	-3.13
	4/30/2024	55.7	37.5	1.1	5.3	80	-5.26
	5/29/2024	23	22.1	5.1	49.7	84	-7.18
	6/5/2024	24.3	23	5	47.7	80	-6.73
EW-29	1/22/2024	56	35.9	0	8.1	60	-6.08
	2/27/2024	54.1	38.9	0	7	65	-8.08
	3/14/2024	53.6	36.9	0.2	9.3	80	-10.04
	4/30/2024	56.7	40.2	0.1	2.9	78	-9.03
	5/29/2024	52.1	38.4	0	9.4	88	-9.81
	6/5/2024	52.8	39	0	8.3	80	-9.62

Attachment 1

EW-30	1/22/2024	58.1	35.7	0	6.3	62	-6.11
	2/27/2024	58.7	41.3	0	0	70	-9.52
	3/14/2024	55.1	35.8	0	9.1	80	-11.99
	4/30/2024	49.9	35.8	0.7	13.6	78	-9.87
	5/29/2024	49.6	36.5	0	14	80	-11.72
	6/5/2024	49.2	36.8	0	14.1	80	-11.23
EW-31	1/22/2024	Raised- Too High					
	2/27/2024	Raised- Too High					
	3/14/2024	59.4	38.5	0	2.1	72	-16.27
	4/30/2024	59.9	39.7	0.4	0	78	-9.08
	5/29/2024	70.1	38.9	0	0	90	-0.73
	6/5/2024	59.4	40.3	0	0.3	84	4.45
	6/10/2024	57.3	38.5	0.2	3.8		6.27
	6/19/2024	58.2	41.6	0.2	0	80	4.68
EW-32	1/22/2024	57.4	35.7	0.1	6.8	50	-12.17
	2/27/2024	57.9	38.6	0	3.5	60	-16.12
	3/14/2024	58.7	37.1	0.1	4.1	80	-18.32
	4/30/2024	58.2	38	1.1	2.8	80	-17.02
	5/29/2024	56.7	38.5	0	4.8	88	-17.9
	6/5/2024	58.9	39.8	0	1.3	78	-17.27
EW-33	1/22/2024	62	35.5	0	2.5	50	-3.52
	2/27/2024	58.2	41.8	0	0	60	-4.76
	3/14/2024	57.2	35.8	0.1	6.9	82	-5.15
	4/30/2024	59.7	40.2	0..1	0	78	-5.07
	5/29/2024	58.7	38.4	0	2.9	86	-5.97
	6/5/2024	58	38.7	0	3.3	80	-5.87
EW-34	1/22/2024	60.3	35.5	0	4.2	70	-10.27
	2/27/2024	58.9	41.2	0	0	60	-13.83
	3/14/2024	56.3	35.7	0	8	90	-15.1
	4/30/2024	53.1	37.7	0.1	9.1	78	-15.16
	5/29/2024	57.4	38.4	0	4.3	90	-16.19
	6/5/2024	56.1	38.9	0	5.1	80	-15.98
EW-35	1/22/2024	32.2	27.9	1.6	38.3	58	-2.14
	2/27/2024	29.9	28.4	1.9	39.8	68	-2.39
	3/14/2024	32.3	27.1	1.8	38.7	90	-3.59
	4/30/2024	29.1	28.2	2.1	40.7	80	-2.4
	5/29/2024	28.5	27.6	1.8	42.1	90	-3.04
	6/5/2024	27.9	27.9	1.8	42.4	82	-2.92

EW-36	1/22/2024	Raised- Too High					
	2/27/2024	Raised- Too High					
	3/14/2024	Well repaired, but need fittings for testing					
	4/30/2024	Well repaired, but need fittings for testing					
	5/29/2024	Well repaired, but need fittings for testing					
	6/5/2024	Well repaired, but need fittings for testing					
EW-37	1/22/2024	62.1	35.6	0	2.3	60	-4.27
	2/27/2024	60.6	38.3	0	1.1	62	-6.32
	3/14/2024	60.1	36	0.6	3.2	72	-8.03
	4/30/2024	60.6	38.2	0.7	0.5	80	-5
	5/29/2024	59.7	38	0	2.2	90	-1.26
	6/5/2024	59.6	38.9	0	1.4	80	-0.87
EW-38	1/22/2024	61.5	36.2	0	2.3	68	-1.51
	2/27/2024	56.7	43.3	0	0	62	-1.8
	3/14/2024	57	36.2	0.2	6.6	86	-2.25
	4/30/2024	59.4	39.5	0.1	0	78	-1.75
	5/29/2024	58.3	39	0	2.7	88	-1.95
	6/5/2024	59.1	39.4	0	1.5	80	-2.09

Notes:

1. Grey highlighted cells indicate monitoring that occurred outside of monthly monitoring to check exceedances.
2. Landfill cover is inspected for integrity during the monthly wellhead readings. Any necessary repairs are reported to Rowan County Landfill staff.

ATTACHMENT G
Financial Proposal Forms

ROWAN COUNTY LANDFILL
FINANCIAL PROPOSAL FORM
EXAMPLE FORM

Directions to Proposer:

1. Fill out the **REQUIRED** information in green-highlighted cells and **AS APPLICABLE** information in yellow-highlighted cells. For financial estimates, use 2025 dollars (do not account for inflation); however, if desired, specify an esclalation clause at the bottom of the appropriate page.
2. Provide the anticipated quantities of LFG recovered, used by the project, and excess on the LFG Collection/Recovery Worksheet. Also indicate the anticipated contract term and any proposed renewal term(s).

Anticipated Contract Term[1]: **2026** - 2045 **Option for Renewal[2]:** 1 x 5-year

Calendar Year	Collected LFG (annual average SCFM)		Anticipated LFG Recovery (annual average SCFM)	Anticipated LFG Used by Project (annual average SCFM)	Anticipated Excess LFG Not Used by Project (annual average SCFM)
	County Estimate: Baseline Recovery Scenario	County Estimate: Enhanced Recovery Scenario			
2026	1,572	1,797	1,797	1,400	397
2027	1,537	1,751	1,751	1,400	351
2028	1,500	1,700	1,700	1,400	300
:	:	:	:	:	:

3. Provide the anticipated capital costs for GCCS expenditures (do not include costs for operations and maintenance) and the proposed LFG purchase price per MMBtu (at a point specified in the contract) on the LFG Purchase Worksheet. Provide this purchase price as either a fixed annual price or as a fraction of the index designated on the bottom of the page.

Calendar Year	Estimated Annual Expenditure for GCCS Expansion (Capital Costs Only)	Payment for Raw LFG	
		Fixed Raw LFG Purchase Price/MMBtu ($/per million Btu)	Percent of Indexed LFG Purchase Price/MMBtu ($/per million Btu)
2026	$2,000,000	$5.00	-
2027	$2,000,000	$5.25	-
2028	$0	$5.50	-
:	:	:	:

4. Provide the proposed annual shared revenue in the columns according to the technology offered by the proposer (medium-Btu, electrical generation, high-Btu, or other) on the designated Revenue Sharing Worksheet. If technology is categorized as "other," provide a brief description at the bottom of the page. Note the anticipated annual availability (up-time) on the bottom of the sheet. Revenue sharing for a high-BTU proposal is shown below as an example.

Calendar Year	Annual Royalty Attributed to High-BTU (RNG) Gas Sales ($)			Annual Royalty Attributed to RINS ($)	Annual Royalty Attributed to LCFS ($)	Total Estimated Revenue to City ($)
	MMBtu Generated for Sale	$/MMBtu	Percentage of Net Revenue	Percentage of Net Revenue	Percentage of Net Revenue	
2026	336,000	-	2.50%	2.50%	2.50%	$218,000
2027	336,000	-	2.50%	2.50%	2.50%	$218,000
2028	336,000	-	2.50%	2.50%	2.50%	$218,000
:	:	:	:	:	:	:

5. Provide a total of the annual compensation on an annual basis over the contract term on the Compensation Summary Form. This should include raw LFG gas sales and any sources of shared revenue. The total from the example from above is carried out below.

Calendar Year	Total Annual Payment (Compensation) to City ($)
	Fixed Amount or Percentage of Net Revenue
2026	$1,768,400.00
2027	$1,856,800.00
2028	$1,945,300.00
:	:

ROWAN COUNTY LANDFILL

FINANCIAL PROPOSAL FORM

LFG COLLECTION/RECOVERY WORKSHEET

Anticipated Contract Term^1: 2026 -

Option for Renewal^2:

Calendar Year	Collected LFG (annual average SCFM)		Anticipated LFG Recovery (annual average SCFM^5)	Anticipated LFG Used by Project (annual average SCFM^5)	Anticipated Excess LFG Not Used by Project (annual average SCFM^5)
	County Estimate: Baseline Recovery Scenario^3	County Estimate: Enhanced Recovery Scenario^4			
2026	1,189	1,427			
2027	1,234	1,481			
2028	1,279	1,534			
2029	1,322	1,587			
2030	1,365	1,638			
2031	1,407	1,689			
2032	1,449	1,739			
2033	1,490	1,788			
2034	1,531	1,837			
2035	1,571	1,885			
2036	1,611	1,933			
2037	1,650	1,981			
2038	1,690	2,028			
2039	1,729	2,075			
2040	1,768	2,121			
2041	1,807	2,168			
2042	1,845	2,215			
2043	1,884	2,261			
2044	1,923	2,307			
2045	1,961	2,354			
2046	2,000	2,400			
2047	2,039	2,446			
2048	2,078	2,493			
2049	2,116	2,540			
2050	2,156	2,587			

Notes:

[1] The table shown assumes an initial contract period of 20-years (2026 - 2045). If a different period is proposed, indicate this here, and provide additional LFG quantities as needed.

[2] Note the duration of any proposed renewal periods here and fill in any additional anticipated LFG recovery quantities to match. Respond with N/A if not applicable.

[3] LFG recovery projection based on the base-case scenario as described in Section 3 of the RFP.

[4] LFG recovery projection based on the high-density wellfield scenario as described in Section 3 of the RFP.

[5] SCFM is nominal LFG at assumed 50% methane content.

ROWAN COUNTY LANDFILL

FINANCIAL PROPOSAL FORM

GCCS EXPANSION AND RAW LFG PURCHASE FORM

Calendar Year	Estimated Annual Expenditure for GCCS Expansion (Capital Costs Only)	Payment for Raw LFG[2]	
		Fixed Raw LFG Purchase Price/MMBtu ($/per million Btu)	Percent of Indexed[3] LFG Purchase Price/MMBtu ($/per million Btu)
2026			
2027			
2028			
2029			
2030			
2031			
2032			
2033			
2034			
2035			
2036			
2037			
2038			
2039			
2040			
2041			
2042			
2043			
2044			
2045			
2046			
2047			
2048			
2049			
2050			

Escalation Clause: ______________________

Specified Index: ______________________

Notes:

[1] All dollar values are to be presented in 2025 dollars. No adjustment should be made for inflation, however an escalation clause can be proposed above.

[2] For proposals that contemplate payment for raw LFG at the contractural point of ownership transition from City to Proposer.

[3] Indexed price assumes a base price that would be adjusted monthly (increase or decrease in $/MMBtu) to match the change in Henry Hub or other specified (please note above) natural gas index pricing on the last day of the prior month for which a price was published.

ROWAN COUNTY LANDFILL
FINANCIAL PROPOSAL FORM
REVENUE SHARING FORM - MEDIUM-BTU

Attention: **Only populate this form if you are a proposer offering medium-BTU gas sales revenue sharing.**

Calendar Year	Revenue Sharing Medium-BTU			
	Annual Royalty Attributed to Medium-BTU Gas Sales ($)			Total Estimated Revenue to City ($)
	MMBtu Generated for Sale	$/MMBtu	Percentage of Net Revenue	
2026				
2027				
2028				
2029				
2030				
2031				
2032				
2033				
2034				
2035				
2036				
2037				
2038				
2039				
2040				
2041				
2042				
2043				
2044				
2045				
2046				
2047				
2048				
2049				
2050				

Escalation Clause: ______________________

Estimate of LFGTE project equipment annual availability (up-time): __________

Notes:

[1] All dollar values are to be presented in 2025 dollars. No adjustment should be made for inflation, however an escalation clause can be proposed above.

[2] The table shown assumes an initial contract period of 20-years (2026 - 2045). If a different period was proposed on the previous sheets, provide additional information as needed.

[3] The Revenue Sharing form continues on the next page.

ROWAN COUNTY LANDFILL
FINANCIAL PROPOSAL FORM
REVENUE SHARING FORM - ELECTRICAL GENERATION

Attention: **Only populate this form if you are a proposer offering electrical generation sales revenue sharing.**

Calendar Year	Revenue Sharing Electrical Generation				
	Annual Royalty Attributed to Power Sales ($)			Annual Royalty Attributed to RECs ($)	Total Estimated Revenue to City ($)
	kW-h generated for sale	$/kW-h	Percentage of Net Revenue	Percentage of Net Revenue	
2026					
2027					
2028					
2029					
2030					
2031					
2032					
2033					
2034					
2035					
2036					
2037					
2038					
2039					
2040					
2041					
2042					
2043					
2044					
2045					
2046					
2047					
2048					
2049					
2050					

Escalation Clause: ______________________

Estimate of LFGTE project equipment annual availability (up-time): __________

Notes:

[1] All dollar values are to be presented in 2025 dollars. No adjustment should be made for inflation, however an escalation clause can be proposed above.

[2] The table shown assumes an initial contract period of 20-years (2026 - 2045). If a different period was proposed on the previous sheets provide additional information as needed.

[3] The Revenue Sharing form continues on the next page.

ROWAN COUNTY LANDFILL
FINANCIAL PROPOSAL FORM
REVENUE SHARING FORM - HIGH-BTU

Attention: **Only populate this form if you are a proposer offering high-BTU gas sales revenue sharing.**

Calendar Year	Revenue Sharing					
	High-BTU					
	Annual Royalty Attributed to High-BTU (RNG) Gas Sales ($)			Annual Royalty Attributed to RINS ($)	Annual Royalty Attributed to LCFS ($)	Total Estimated Revenue to City ($)
	MMBtu Generated for Sale	$/MMBtu	Percentage of Net Revenue	Percentage of Net Revenue	Percentage of Net Revenue	
2026						
2027						
2028						
2029						
2030						
2031						
2032						
2033						
2034						
2035						
2036						
2037						
2038						
2039						
2040						
2041						
2042						
2043						
2044						
2045						
2046						
2047						
2048						
2049						
2050						

Escalation Clause: ______

Estimate of LFGTE project equipment annual availability (up-time): ______

Notes:

[1] All dollar values are to be presented in 2025 dollars. No adjustment should be made for inflation, however an escalation clause can be proposed above.

[2] The table shown assumes an initial contract period of 20-years (2026 - 2045). If a different period was proposed on the previous sheets provide additional information as needed.

[3] The Revenue Sharing form continues on the next page.

ROWAN COUNTY LANDFILL
FINANCIAL PROPOSAL FORM
REVENUE SHARING FORM - OTHER

Attention: **Only populate this form if you are a proposer offering sales revenue sharing via technology not previously listed.**

Calendar Year	Revenue Sharing Other: *Specify Technology Offered Below*			
	Annual Royalty Attributed to *Technology Described Below*			
	Units[3] Generated for Sale	$/Unit Sold	Percentage of Net Revenue	Total Estimated Revenue to City
2026				
2027				
2028				
2029				
2030				
2031				
2032				
2033				
2034				
2035				
2036				
2037				
2038				
2039				
2040				
2041				
2042				
2043				
2044				
2045				
2046				
2047				
2048				
2049				
2050				

Brief description of technology offered:

Escalation Clause:

Estimate of LFGTE project equipment annual availability (up-time):

Notes:

[1] All dollar values are to be presented in 2025 dollars. No adjustment should be made for inflation, however an escalation clause can be proposed above.

[2] The table shown assumes an initial contract period of 20-years (2026 - 2045). If a different period was proposed on the previous sheet provide additional information as needed.

[3] Proposer must specify units:

ROWAN COUNTY LANDFILL
FINANCIAL PROPOSAL FORM
COMPENSATION SUMMARY FORM

Calendar Year	Total Estimated Annual Payment (Compensation) to City ($)[2]
	Fixed Amount or Percentage of Net Revenue
2026	
2027	
2028	
2029	
2030	
2031	
2032	
2033	
2034	
2035	
2036	
2037	
2038	
2039	
2040	
2041	
2042	
2043	
2044	
2045	
2046	
2047	
2048	
2049	
2050	

Escalation Clause? ☐

Notes:

[1] All dollar values are to be presented in 2025 dollars. No adjustment should be made for inflation, however, check the box above if escalation clause was proposed in previous sheet(s).

[2] The total in the above columns should match the total payment to the City, including LFG purchases and all sources of revenue sharing.