GAS COLLECTION AND CONTROL SYSTEM PLAN

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Solid Waste Section
Raleigh Central Office

Municipal Solid Waste Landfill Facility
Unit 1 and Unit 2

Wayne County
North Carolina

September 2001

Municipal Services
Garner, N.C.

Engineering Company, P.A.
Boone, N.C.

OPERATION/CONSTRUCTION MANAGERS

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September 5, 2001

Mr. Booker T. Pullen, EI
State of North Carolina
DENR, Division of Air Quality
2728 Capital Boulevard
Raleigh, North Carolina 27604

Re: **Gas Collection and Control System (GCCS) Plan**
Municipal Solid Waste Landfill Facility – Unit 1 and Unit 2
Wayne County, North Carolina
MESCO Project No. G00012.0

Dear Mr. Pullen:

Attached please find the GCCS Plan for the Wayne County MSW Landfill – Unit 1 and Unit 2 in Dudley, North Carolina, for your review and approval. If you have questions or comments, please contact us at 919-772-5393.

Very truly yours,
MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

NORTH CAROLINA PROFESSIONAL SEAL 19937 09/05/01 ENGINEER C. NALLAINATHAN

C. Nallainathan, PE
NC Registration No. 19937

Copy without attachments:
Mr. Lloyd Cook, Wayne County
Mr. Wayne Sullivan, MESCO

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SECTION 1: INTRODUCTION AND CERTIFICATION

1.1 PURPOSE

The purpose of this design plan is to document that the landfill gas collection and control system (GCCS) at Wayne County Landfill (WCL) will be designed and installed in general accordance with the requirements of NSPS, *40 CFR Part 60, Subpart WWW: Standards of Performance for Municipal Solid Waste Landfills*. The County of Wayne owns and operates the landfill under Permit No. 96-06 from the North Carolina Department of Environment and Natural Resources (NCDENR). This report describes the various components of the landfill GCCS and construction methods that will be used to install the system. The scope of this report is limited to description, documentation, and certification that the landfill gas (LFG) control system meets 40 CRF §60.759 Specifications for Active Collection Systems and §60.752 Standards for Air Emissions from Municipal Solid Waste Landfills [specifically Subsections (b)(2)(i) and (b)(2)(ii)].

This report is organized in three sections:

1.0 Introduction and Certification
2.0 Existing Site Conditions
3.0 Compliance Review and Evaluation

1.2 CERTIFICATION

Municipal Engineering Services Company, P.A. as authorized by the County of Wayne, prepared this NSPS Landfill Gas System Certification Report for Unit 1 and Unit 2 GCCSs at Wayne County Landfill.

I certify that the GCCS described in this report was designed in general accordance with the requirements specified in 40 CFR §60.759 and §60.752(b)(2)(i) and (ii). 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.

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

C. Nallainathan

C. Nallainathan, PE, NC Registration No. 19937

NORTH CAROLINA PROFESSIONAL SEAL 19937 ENGINEER C. NALLAINATHAN

09/05/01

Date

SECTION 2: EXISTING SITE CONDITIONS

The purpose of this section is to briefly describe and document the existing conditions of the landfill and the proposed landfill GCCS that are pertinent to this compliance review.

2.1 LANDFILL DESCRIPTION

The WCL, located in Dudley, North Carolina (see Appendix A – Site Location Map), has a total of 3 units. The unlined Unit 1 (approximately 40 acres of closed MSW landfill surface area) began operation in 1974 and received waste until 1981 at an average rate of 71,038 Mg per year. Unit 1 was then reopened in 1990 and received a total waste of 738,796 Mg (from 1990 through June 30, 2001). The unlined Unit 2 (approximately 36.5 acres of closed surface area) began operation in 1981 and received waste until 1990 at an average rate of 71,038 Mg per year and was closed in 1990. The active, lined Unit 3 (approximately 29 acres of lined area) began operation in January 1998 and received a total waste of 293,514 Mg through June 30, 2001.

Based on the information provided by WCL, the unlined Unit 1 apparently accepted municipal solid waste (MSW), industrial waste, Construction & Debris (C&D) waste, and possibly other wastes. Unit 1 stopped receiving MSW in January 1998 and received only C&D waste since then. The MSW section within Unit 1, that received waste after October 1991 and stopped receiving waste on January 1, 1998, was closed in early 1999. The permit for C&D waste in Unit 1 expires in January 2003. The unlined Unit 2 apparently accepted MSW, industrial waste, and possibly other wastes. The active lined Unit 3 accepts MSW and industrial waste.

2.2 LANDFILL GAS CONTROL SYSTEM

The proposed GCCS is designed to collect the landfill gas generated within Unit 1 and Unit 2 through a network of collection wells and piping within the limits of these landfill units. The gas collected will be routed through an open flare system for destruction by combustion. A separate GCCS will be designed and installed within the lined Unit 3 by January 2003, by which time the initial solid waste would have been placed for a period of 5 years.

Based on the ages of Unit 1 and Unit 2, the proposed initial GCCS set-up is presented in Appendix B (Approach 1). If Approach 1 system did not adequately perform, then we propose using the GCCS presented in Appendix C (Approach 2).

Approach 1

The GCCS for Unit 1 will have a total of 25 gas extraction wells (1GCW-1 through 1GCW-25) with depths ranging from approximately 25-35 feet. Since the original configuration of the unit is unknown, the depth determination was made from the available survey contours. About 7,300 lineal feet of gas collection header and lateral piping that ranges from 4 to 10 inches in diameter will connect the well field with the gas disposal equipment.

The GCCS for Unit 2 will have a total of 22 gas extraction wells (2GCW-1 through 2GCW-22) with depths ranging from approximately 25-35 feet. Since the original configuration of the unit is unknown, the depth determination was made from the available survey contours. About 7,500 lineal feet of gas collection header and lateral piping that ranges from 4 to 10 inches in diameter will connect the well field with the gas disposal equipment.

Approach 2

The GCCS for Unit 1 will have a total of 32 gas extraction wells (1GCW-1 through 1GCW-32) with depths ranging from approximately 25-35 feet. Since the original configuration of the unit is unknown, the depth determination was made from the available survey contours. About 8,800 lineal feet of gas collection header and lateral piping that ranges from 4 to 10 inches in diameter will connect the well field with the gas disposal equipment.

The GCCS for Unit 2 will have a total of 28 gas extraction wells (2GCW-1 through 2GCW-28) with depths ranging from approximately 25-35 feet. Since the original configuration of the unit is unknown, the depth determination was made from the available survey contours. About 8,500 lineal feet of gas collection header and lateral piping that ranges from 4 to 10 inches in diameter will connect the well field with the gas disposal equipment.

A centrifugal blower system serving the open flare will provide the vacuum necessary to remove the gas from within the landfill units. The extracted gas is routed to an open flare. The blower will be automatically shutdown if the flare is inoperable. The maximum potential capacity for the flare combination is approximately 1,200 standard cubic feet per minute (scfm).

Operations of the flare and blower are monitored at remote control panels located adjacent to the flare and blower compounds. These control stations are capable of start-up and shutdown activities as well as recording the continuous flow rates of gas to the flare.

Condensate produced from the gas extraction process is collected in low-point sumps in the gas collection piping and also in a knockout tank prior to the blower. From these collection points, the condensate is pumped into a transfer truck for subsequent disposal.

Based on the attached calculations, the anticipated landfill gas flow rate to the flare system is approximately 1,100 scfm. The open flare is rated for a maximum flow rate of 1,200 scfm. The anticipated design life of the GCCS is 15 years.

2.3 MODIFICATIONS TO THE LANDFILL GAS CONTROL SYSTEM

The GCCS will be monitored as per state and federal regulations. As the landfill matures and the site conditions change, the GCCS will be evaluated and appropriate modification will be implemented.

SECTION 3: COMPLIANCE REVIEW AND EVALUATION

The purpose of this section is to describe and document information required to certify compliance of the landfill gas control system with 40 CFR §60.759 Specifications for Active Collection Systems. This section is organized to address each portion of §60.759 that is divided into sub-sections (a) compliance with §60.752(b)(2)(ii); (b) construction procedures; and (c) conveyance of landfill gas in compliance with §60.752(b)(2)(iii).

In addition, portions of §60.755 Compliance Provisions relevant to landfill gas system specifications will be addressed including (a)(1) calculations of maximum expected gas generation flow rate; (a)(2) sufficient density of gas collectors; (a)(3) collection system flow rate sufficiency; (a)(4) no additional wells during 180 day start-up period; and (a)(5) identification of excess air infiltration.

3.1 COMPLIANCE WITH §60.759(a)(1)

§60.759(a) Each owner or operator seeking to comply with §60.752(b)(2)(i) shall site active collection wells, horizontal collectors, surface collectors, or other extraction devices at sufficient density throughout all gas producing areas using the following procedures unless alternative procedures have been approved by the Administrator as provided in §60.752(b)(2)(i)(C) and (D):

(1) The collection devices within the interior and along the perimeter areas shall be certified to achieve comprehensive control of surface emissions by a professional engineer. The following issues shall be addressed in 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 refuse decomposition heat.

3.1.1 Control of Surface Emissions

The proposed GCCSs are designed to control both surface emissions and subsurface lateral migration of landfill gas from Unit 1 and Unit 2. The control of subsurface lateral migration is discussed in Subsection 3.2 of this report. Per NSPS Surface Monitoring requirements, landfill gas surface emissions will be monitored in the future. Should the GCCS fail to comply with the NSPS performance standards for surface emissions, the GCCS will be evaluated and modified as necessary to bring the system into compliance.

3.1.2 Depths of Refuse

Depths of refuse vary up to approximately 40 feet. The landfill gas extraction wells are anticipated to be constructed to depths of approximately 25 to 35 feet. The depths of refuse were determined during design phases of the GCCS by taking landfill surface elevations and subtracting assumed base elevations. The calculated depth of refuse was then utilized to determine depth of wells, spatial placement, pipe sizing, and GCCS operating flow rates.

3.1.3 Refuse Gas Generation Rates and Flow Characteristics

This issued is addressed in §60.755 Compliance Provisions:

§60.755(a)(1) For the purposes of calculating the maximum expected gas generation flow rate from the landfill to determine compliance with §60.752(b)(2)(ii)(A)(2), one of the following equations shall be used. The k and L_o kinetic factors should be those published in the most recent Compilation of Air Pollutant Emission Factors (AP-42) or other site-specific values demonstrated to be appropriate and approved by the Administrator.

As per §60.755(a)(1)(ii), the estimated maximum flow rate is approximately 1,100 scfm. The components of the GCCS were sized based on the maximum flow rate.

3.1.4 Landfill Cover Properties

The closed MSW landfill Unit 1 cover system is comprised of a low permeability barrier layer system providing resistance to air intrusion allowing flexibility in range of operating conditions for wellhead vacuum. This closed portion of the landfill has a final cover system that includes the following:

18-inch thick compacted soil liner (permeability of $1x10^{-5}$ cm/sec) and

18-inch thick cover soil layer (lightly compacted general fill).

The closed Unit 2 is assumed to have a cover system consisting of 24-inch thick cover soil layer. The nature of placement/compaction of this cover system is unknown.

3.1.5 Gas System Expandability

As discussed in Section 2.2 earlier, if Approach 1 GCCS did not adequately perform, then we propose using the Approach 2 GCCS. The Approach 1 GCCS is designed to facilitate future gas extraction system expansion. The system could be further expanded beyond Approach 2, if necessary/needed.

3.1.6 Condensate Management

The GCCS condensate is collected in sumps and transferred to the existing leachate lagoon. At this point the condensate is combined with the leachate before being routed to the City of Goldsboro Wastewater Treatment Plant (WWTP).

3.1.7 Accessibility

Wellheads, control valves, and condensate sumps are all accessible from the perimeter of the landfill for operations, monitoring, and maintenance. Access roads will be constructed to provide access to the GCCS.

3.1.8 Compatibility with Filling

In Unit 1 where C&D waste is presently being placed, the proposed GCCS will be expanded vertically to accommodate C&D filling sequences.

3.1.9 Integration with Closure End Use

Final use of the landfill units is currently thought to be an open green space with security fencing for the post closure period.

3.1.10 Air Intrusion Control

This issue is addressed in §60.755 Compliance Provisions: Subsection (a)(3) and it describes the procedures used to demonstrate that landfill gas is collected at a sufficient extraction rate. Extraction wells must be operated at a negative pressure without excess air intrusion. If this cannot be accomplished, additional wells must be installed.

The landfill gas operation plans require monthly monitoring of the landfill gas extraction system and operation of extraction wells at a negative pressure. Vacuum pressure and gas quality will be monitored at the wellhead on a monthly basis.

3.1.11 Corrosion Resistance

Components of the landfill gas collection system are comprised of materials resistant to corrosion including:

Header and lateral piping – High Density Polyethylene (HDPE).

Well String – HDPE.

Well Head and Valves – HDPE Fittings, PVC Valves, stainless steel clamps and sample ports, and Kanaflex flexible piping.

Underground Isolation Valves – HDPE bodies, Viton A elastomeric sealing members, and underground flanges are wrapped in plastic prior to burial.

Condensate Sumps and Pumps – HDPE pipe and fittings, corrosion resistant pump, and hose.

Flare – Corrosion resistant, designed specifically for combusting landfill gas, parts exposed to gas are stainless steel.

Condensate Knock out – HDPE pipe and fittings.

3.1.12 Fill Settlement

The landfill gas collection system is designed to resist settlement through the use of an HDPE well string. This flexible material can accommodate settlement without breakage. The header and lateral piping will be installed with a minimum 2% slope to accommodate settlement while maintaining a positive gravity flow of condensate and to minimize obstructions that could reduce gas flow.

3.1.13 Resistance to Decomposition Heat

HDPE pipe and well string materials will accommodate expected heat of decomposition temperatures. The maximum allowable temperature for HDPE is approximately 140°F while maximum temperatures within the landfill vary from 100°F to 120°F.

3.2 COMPLIANCE WITH §60.759(a)(2)

§60.759(a)(2) 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.

3.2.1 Density of Gas Collection Devices

The GCCS is designed to control off-site migration while minimizing emission losses and collecting methane gas. The effectiveness of GCCS will be indirectly evaluated by monthly monitoring of the existing perimeter gas probes to detect the presence of gas migration and by evaluating the concentration of methane within the gas extracted from the landfill.

If either the gas probes or the surface monitoring indicate a problem with the GCCS, it will be evaluated and corrective measures enacted. These corrective measures may include, but are not limited to, expansion or upgrading of the GCCS, adjustment of flow rates, and/or cover repair. Corrective actions will be performed based on implementation schedules provided in the NSPS requirements.

The planned construction of the GCCS will encompass all areas of the landfill with waste placement. The proposed wells are spaced at intervals of about 200 feet (along perimeter) to about 400 feet (interior), under Approach 1. Under Approach 2, the proposed wells are spaced at intervals of about 200 feet (along perimeter and interior). No areas of the landfill are planned to be excluded from the landfill gas collection system.

3.3 COMPLIANCE WITH §60.759(a)(3)

§60.759(a)(3) 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.

3.3.1 Asbestos and Nondegradable Materials

There are no dedicated areas for the disposal of asbestos-containing material or other nondegradable material at this facility.

3.3.2 Nonproductive Areas

All areas of this facility that have received waste material are considered productive areas for LFG generation. Based on this information, the GCCS was designed to provide full coverage of landfilled areas.

3.4 COMPLIANCE WITH §60.759(b)(1),(2) and (3)

§60.759(b) Each owner or operator seeking to comply with §60.752(b)(2)(i)(A) shall construct the gas collection devices using the following equipment or procedures:

The landfill gas extracting 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 intrusion.

Vertical wells shall address the occurrence of water within the landfill. Holes and trenches constructed for pipe welds 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.

Collection devices may be connected to the collection header pipes below or above the landfill surface. The collector assembly shall include a positive closing throttle valve, any necessary seals and couplings, access couplings, and at least one sampling port and one thermometer port. The collection devices shall be constructed of PVC, HDPE, fiberglass, stainless steel, or other nonporous material of suitable thickness.

3.4.1 Construction of System Components

Extraction Wells

Gas extraction wells will consist of several components; 18-inch diameter well bore, gravel pack, HDPE well pipe, two stainless steel sample ports, and a PVC valve. The installation process begins by drilling the 18-inch diameter well bore through the waste body to the bottom. Once the well bore is completed to the desired depth, an HDPE well string is constructed out of solid and perforated pipe sections and centered in the well bore. The pipe sections use a heat fusion process to provide structural integrity during and after placement. A basic rule applied to length of perforated pipe and solid pipe is that 1/3 of the well is solid pipe and 2/3 is perforated pipe. This ratio is modified as wells become more shallow. In all cases, at least 10 feet of solid pipe will be maintained at the top of each well. An HDPE cap is fused on the bottom end of the well pipe and a tee is fused to the top of the well pipe, which extends a minimum of about 3 feet above grade. Utilization of HDPE for the well pipe and all related fittings provides the flexibility and corrosion resistance needed for a landfill environment.

The gravel pack consisting of 1½ inch washed stone is placed into the well bore around the well pipe to a level 1-foot above the top of the perforated section. A 2-3 inch layer of bentonite chips is then placed and hydrated over the top of the rock to seal off the surface and prevent siltation from layers placed above the gravel pack in the well bore. The remainder of the well bore is backfilled with two bentonite seals separated by a layer of soil. The upper bentonite seal surface typically matches up with surface of the landfill barrier layer, if the well is being installed on a section of final cover system.

A PVC valve is then installed on the branch of the tee on top of the well pipe. This valve allows isolation and throttling of each extraction well. Throttling is a means of adjusting the gas extraction rates by controlling the amount of vacuum applied. The PVC valve body and interior valve seals constructed of Viton have proven over time on numerous sites to be corrosion resistant and an effective way to control gas flow form extraction wells.

A PVC end cap is placed on the top of the well pipe extending above grade. The cap allows for easy removal and access to the interior of the well pipe for measurement of liquid levels and pumping of the liquid if necessary.

Two stainless steel sample ports are threaded into the well pipe to allow for measurement of the landfill gas methane content, applied vacuum, temperature, and flow rate. A ½ inch stainless steel plug is removed from the outer ¾ inch by ½ inch bushing for testing purposes; thereby minimizing wear on the HDPE threaded holes.

A flexible PVC hose (Kanaflex or equivalent) makes the final connection between the extraction well and the corresponding HDPE lateral pipe. The hose material is flexible to allow for the settlement and subsequent misalignment between the lateral pipe and wellhead assembly common to landfill applications while maintaining a high level of corrosion resistance commensurate with the HDPE piping.

Header and Lateral System

The header and lateral piping system is designed to minimize the impact of the daily operations of the landfill while providing that both a reliable and effective system is installed. Some of the major considerations and requirements for this system are:

All pipes are to slope toward condensate low point sumps at a minimum grade of two percent.

All pipes are to have a minimum of three feet of cover material placed over the entire alignment.

Header and lateral piping is constructed to utilize landfill side slopes whenever possible to achieve minimum required pipe grades and reduce the number of condensate sumps required.

HDPE reducers placed in header and lateral piping are installed from smaller diameter to larger diameter in the direction of expected gas flow to maintain laminar flow design criteria.

All underground pipe and fittings are constructed of HDPE due to the material's high resistance to corrosion, flexibility, and durability. HDPE pipe is well suited to withstand the stresses imposed by the differential settlement within a landfill.

HDPE pipe used in the header and laterals is joined using the butt (heat) fusion technique. This joining technique has been the accepted procedure in the gas and municipal service industries for nearly 20 years.

Other header and lateral connections may include the use of flanged connections. Flanged connections are used mainly for in-line isolation valves along the header and lateral alignments. These connections are installed using 316 stainless steel bolts and ductile iron back-up rings wrapped in plastic prior to backfilling. All pipe, joints, and connections are pressure tested to 50 pounds per square inch (psi) for a period of 8 hours to insure the integrity of the piping system prior to use.

3.5 COMPLIANCE WITH §60.759(c)(1) or (2)

§60.759(c) Each owner or operator seeking to comply with §60.752(b)(2)(i)(A) shall convey the landfill gas system 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.

3.5.1 Landfill Gas Conveyance

The proposed GCCS is sized to convey the maximum LFG generated from each unit. The system flow and operation data will be monitored to make sure that the GCCS is capable of conveying the maximum LFG generated from the landfill units. Should the maximum LFG generation rate exceed the system capacity, the GCCS will be evaluated and the appropriate modifications will be made in accordance with NSPS requirements.

3.6 COMPLIANCE WITH §60.752(b)(2)(i)

§60.752(b)(2)(i) Submit a collection and control system plan prepared by a professional engineer to the Administrator within 1 year.

The GCCS for Unit 1 and Unit 2 are described in this report. The signed and sealed certification in Section 1 indicates that the proposed GCCS is designed in general accordance with the requirements specified in 40 CFR §60.759 and §60.752(b)(2)(i) and (ii).

3.7 COMPLIANCE WITH §60.752(b)(2)(i)(C)

§60.752(b)(2)(i)(C) The collection and control system design plan shall either conform with specifications for active collection systems in §60.759 or include a demonstration to the Administrator's satisfaction of the sufficiency of the alternative provisions to §60.759.

The effectiveness of GCCS for landfill gas migration control will be monitored with a series of gas probes strategically located around the landfill unit footprint. Per NSPS Surface Monitoring requirements, landfill gas surface emissions also will be monitored. If either the probes or surface monitoring indicate a problem with the GCCS, it will be evaluated and corrective measures will be taken. These measures may include expansion or upgrading of the GCCS, adjustment of flow rates, and/or cover repair. Corrective actions will be performed based on implementation schedules provided in the NSPS requirements.

3.8 COMPLIANCE WITH §60.752(b)(2)(ii)

§60.752(b)(2)(ii) Install a collection and control system within 18 months of the submittal of the design plan under paragraph (b)(2)(i) of this section that effectively captures the gas generated within the landfill.

Commencement of the installation of GCCSs for Units 1 and 2 are anticipated to begin by October 5, 2001.

3.9 COMPLIANCE WITH §60.752(b)(2)(ii)(A)(1)

§60.752(b)(2)(ii)(A)(1) An active collection system shall: Be designed to handle the maximum expected gas flow rate from the entire area of the landfill that warrants control over the intended use period of the gas control or treatment system equipment.

As discussed in Subsection 3.1.3, the GCCS was designed to handle the maximum expected gas flow rate from Units 1 and 2. The GCCS and gas flow rates will be monitored to ensure compliance with NSPS requirements. If the GCCS fails to meet NSPS requirements in the future, the system will be evaluated and the appropriate modifications will be implemented to meet NSPS requirements.

3.10 COMPLIANCE WITH §60.752(b)(2)(ii)(A)(2)

§60.752(b)(2)(ii)(A)(2)(i) An active collection system shall: Collect gas from each area, cell, or group of cells in the landfill in which the initial solid waste has been placed for a period of 5 years or more if active; or 2 years or more if closed or at final grade.

The GCCS for Units 1 and 2 will be installed and therefore meets this requirement. A separate GCCS will be designed and installed within the lined Unit 3 by January 2003, by which time the initial solid waste would have been placed for a period of 5 years.

3.11 COMPLIANCE WITH §60.752(b)(2)(ii)(A)(3)

§60.752(b)(2)(ii)(A)(3) An active collection system shall: Collect gas at a sufficient extraction rate.

As discussed in Subsections 3.1.1. and 3.2, the proposed GCCS is specifically designed to collect gas at a sufficient extraction rate to control both surface emissions and subsurface lateral migration of gas from Units 1 and 2 of the landfill. The surface emissions monitoring and perimeter gas probe monitoring will be used to determine the effectiveness of the GCCS extraction rate. If the GCCS fails to maintain a sufficient extraction rate in the future, the system will be evaluated and the appropriate modifications will be implemented to meet NSPS requirements.

3.12 COMPLIANCE WITH §60.752(b)(2)(ii)(A)(4)

§60.752(b)(2)(ii)(A)(4) An active collection system shall: Be designed to minimize off-site migration of subsurface gas.

As discussed in Subsection 3.2, the proposed GCCS is specifically designed to minimize subsurface lateral migration of gas from Units 1 and 2 of the landfill. Perimeter gas probe monitoring is used to determine the effectiveness of the GCCS in controlling off-site migration of subsurface gas. If the GCCS fails to control off-site migration of subsurface gas in the future, the system will be evaluated and the appropriate modifications will be implemented to meet NSPS requirements.

Maximum Expected Gas Generation Flow Rate Calculation

As per § 60.755(a)(1)(ii): $Q_M = \Sigma 2kL_oM_i(e^{-kt_i})$

where, Q_M = maximum expected gas generation flow rate, m^3/year
k = methane generation rate constant, 0.05/year
Lo = methane generation potential, 170 m^3/Mg
M_i = mass of solid waste, Mg
t = age, years

Unit 1

Year	t (years)	M_i (Mg)	Q_M (m^3/year)
1974	27	71,038	313,070
1975	26	71,038	329,122
1976	25	71,038	345,996
1977	24	71,038	363,736
1978	23	71,038	382,385
1979	22	71,038	401,990
1980	21	71,038	422,601
1990	11	100,986	990,486
1991	10	88,534	912,876
1992	9	92,470	1,002,345
1993	8	84,133	958,733
1994	7	78,928	945,534
1995	6	82,576	1,039,955
1996	5	93,731	1,240,962
1997	4	38,519	536,124
1998	3	16,027	234,508
1999	2	34,857	536,179
2000	1	28,035	453,351
		TOTAL	**11,409,953**

Unit 2

Year	t (years)	M_i (Mg)	Q_M (m^3/year)
1981	20	71,038	444,268
1982	19	71,038	467,046
1983	18	71,038	490,992
1984	17	71,038	516,166
1985	16	71,038	542,630
1986	15	71,038	570,452
1987	14	71,038	599,699
1988	13	71,038	630,446
1989	12	71,038	662,770
		TOTAL	**4,924,469**

Header Pipe Sizing Calculation

Unit 1 Flow Rate = 11,409,953 m^3/yr = 402,938,688 ft^3/yr = 766.63 ft^3/min

Unit 2 Flow Rate = 4,924,469 m^3/yr = 173,905,982 ft^3/yr = 330.87 ft^3/min

Unit 1 and 2 combined Flow Rate = 766.63 + 330.87 = 1,097.50 ft^3/min

$Q = AV$ and $A = \pi d^2/4$ $\Rightarrow$ $d = \sqrt{(4Q/\pi V)}$

where,
A = area of the pipe, ft^2
d = diameter of the pipe, ft
Q = maximum expected gas generation flow rate, ft^3/min (scfm)
V = minimum allowable velocity, 2000 ft/min

Unit 1

$d = \sqrt{[(4x766.63)/(\pi x2000)]}$ = 0.699 ft = 8.4 inches

Therefore, Use 8-inch diameter pipe.

Unit 2

$d = \sqrt{[(4x330.87)/(\pi x2000)]}$ = 0.459 ft = 5.5 inches

Therefore, Use 6-inch diameter pipe.

Unit 1 and 2 combined

$d = \sqrt{[(4x1,097.5)/(\pi x2000)]}$ = 0.836 ft = 10.0 inches

Therefore, Use 10-inch diameter pipe.

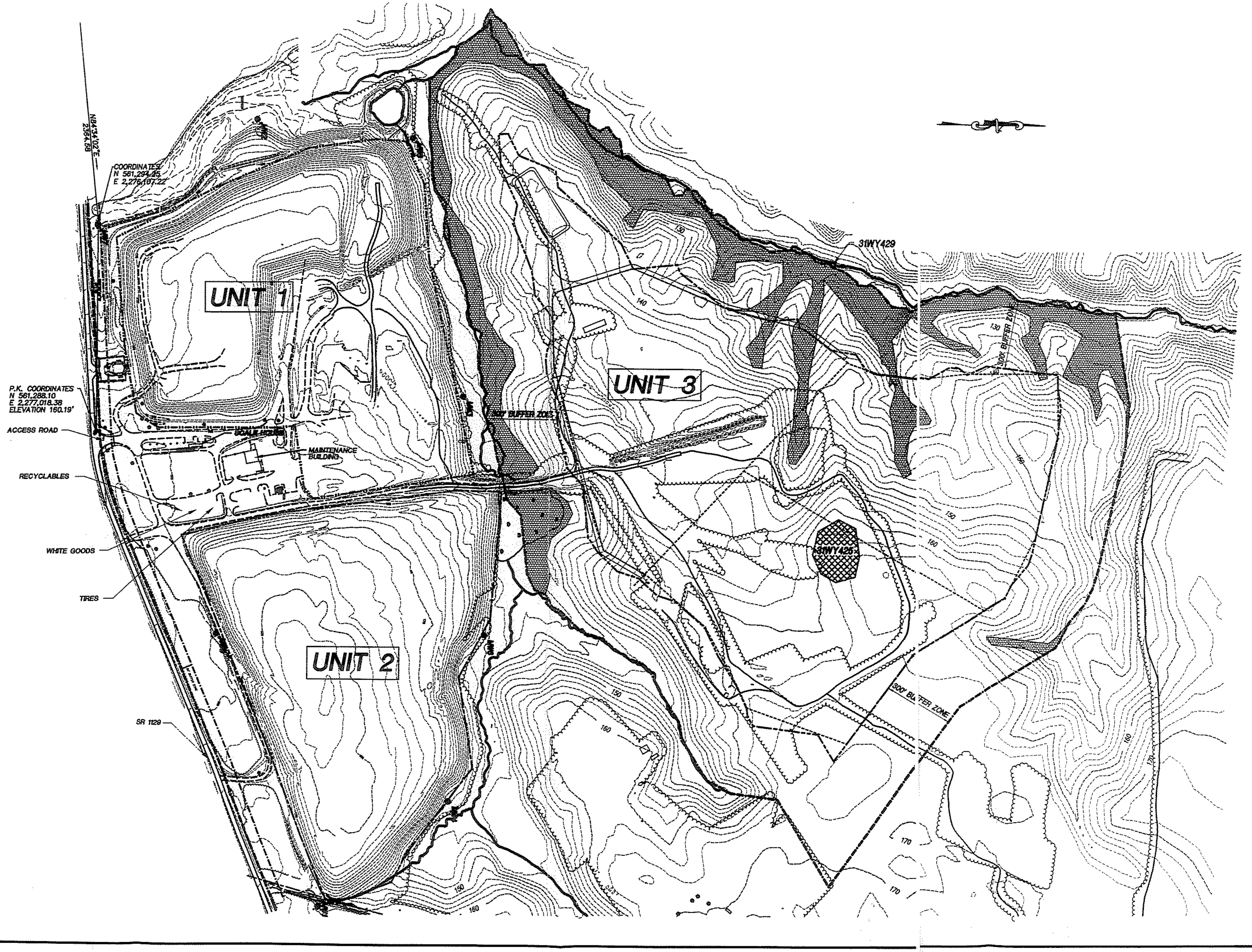
Flare Sizing Calculation

Maximum expected gas generation flow rate = 1,097.5 scfm

Therefore, use Flare @ 1,100 scfm.

APPENDIX A

SITE LOCATION MAP



LEGEND

---------------	EXISTING CONTOURS
—·—·—·—	PROPERTY LINE
═══════	EXISITING PAVED ROAD
═ ═ ═ ═	EXISITING UNPAVED ROAD
—···—···—	STREAM
◉	MONITORING WELLS
—·—·—·—	CLOSED MSWLF SANITARY UNIT
—II—II—II—	EXISTING MSWLF SANITARY UNIT
—I—I—I—	50' BUFFER ZONE
▪▪	POWER POLES
—•—•—	FENCE

DATE	BY	REV.	DESCRIPTION

MUNICIPAL ENGINEERING SERVICES CO., P.A.
CONSULTING ENGINEERS

BOONE, N.C. GARNER, N.C.

PROJECT: GAS COLLECTION AND CONTROL SYSTEM (GCCS)

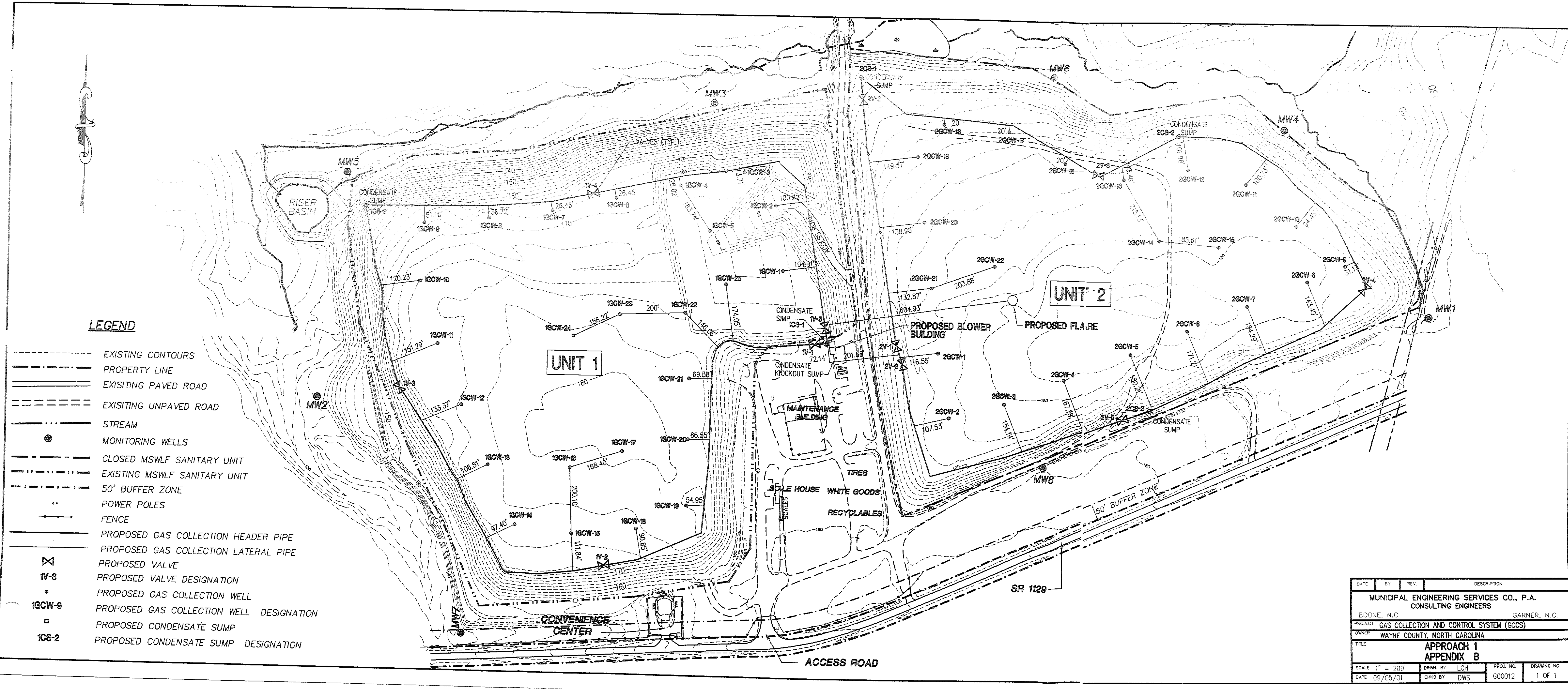
OWNER: WAYNE COUNTY, NORTH CAROLINA

TITLE: SITE LOCATION MAP
APPENDIX A

SCALE 1" = 400'	DRWN. BY LCH	PROJ. NO.	DRAWING NO.
DATE 09/05/01	CHKD BY DWS	G00012	1 OF 1

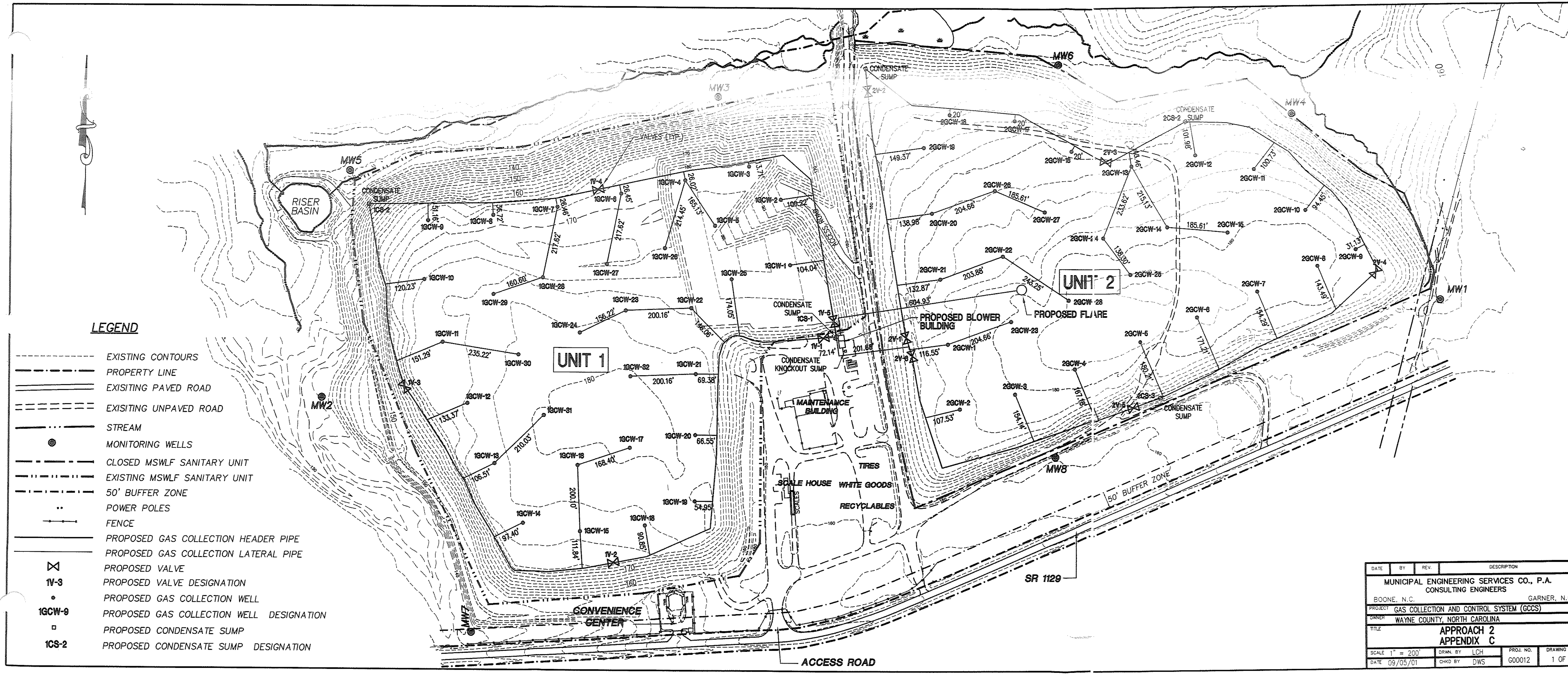
APPENDIX B

SITE AND GAS SYSTEM PLAN (APPROACH 1)


UNIT 1
UNIT 2
PROPOSED BLOWER BUILDING
PROPOSED FLARE
CONDENSATE KNOCKOUT SUMP
MAINTENANCE BUILDING
SCALE HOUSE
TIRES
WHITE GOODS
RECYCLABLES
CONVENIENCE CENTER
ACCESS ROAD
SR 1129
50' BUFFER ZONE
RISER BASIN
VALVES (TYP)
MW1
MW2
MW3
MW4
MW5
MW6
MW7
MW8
LEGEND
EXISTING CONTOURS
PROPERTY LINE
EXISITING PAVED ROAD
EXISITING UNPAVED ROAD
STREAM
MONITORING WELLS
CLOSED MSWLF SANITARY UNIT
EXISTING MSWLF SANITARY UNIT
50' BUFFER ZONE
POWER POLES
FENCE
PROPOSED GAS COLLECTION HEADER PIPE
PROPOSED GAS COLLECTION LATERAL PIPE
PROPOSED VALVE
1V-3 PROPOSED VALVE DESIGNATION
PROPOSED GAS COLLECTION WELL
1GCW-9 PROPOSED GAS COLLECTION WELL DESIGNATION
PROPOSED CONDENSATE SUMP
1CS-2 PROPOSED CONDENSATE SUMP DESIGNATION
MUNICIPAL ENGINEERING SERVICES CO., P.A.
CONSULTING ENGINEERS
BOONE, N.C.
GARNER, N.C.
PROJECT GAS COLLECTION AND CONTROL SYSTEM (GCCS)
OWNER WAYNE COUNTY, NORTH CAROLINA
TITLE APPROACH 1
APPENDIX B
SCALE 1" = 200'
DATE 09/05/01
DRWN. BY LCH
CHKD BY DWS
PROJ. NO. G00012
DRAWING NO. 1 OF 1

APPENDIX C

SITE AND GAS SYSTEM PLAN (APPROACH 2)


UNIT 1
UNIT 2
RISER BASIN
MW1
MW2
MW3
MW4
MW5
MW6
MW7
MW8
CONDENSATE SUMP
1CS-1
1CS-2
2CS-2
2CS-3
CONDENSATE KNOCKOUT SUMP
PROPOSED BLOWER BUILDING
PROPOSED FLARE
MAINTENANCE BUILDING
SCALE HOUSE
SCALES
TIRES
WHITE GOODS
RECYCLABLES
CONVENIENCE CENTER
ACCESS ROAD
SR 1129
50' BUFFER ZONE
VALVES (TYP.)
LEGEND
EXISTING CONTOURS
PROPERTY LINE
EXISITING PAVED ROAD
EXISITING UNPAVED ROAD
STREAM
MONITORING WELLS
CLOSED MSWLF SANITARY UNIT
EXISTING MSWLF SANITARY UNIT
50' BUFFER ZONE
POWER POLES
FENCE
PROPOSED GAS COLLECTION HEADER PIPE
PROPOSED GAS COLLECTION LATERAL PIPE
PROPOSED VALVE
1V-3 PROPOSED VALVE DESIGNATION
PROPOSED GAS COLLECTION WELL
1GCW-9 PROPOSED GAS COLLECTION WELL DESIGNATION
PROPOSED CONDENSATE SUMP
1CS-2 PROPOSED CONDENSATE SUMP DESIGNATION
MUNICIPAL ENGINEERING SERVICES CO., P.A.
CONSULTING ENGINEERS
BOONE, N.C.
GARNER, N.C.
PROJECT GAS COLLECTION AND CONTROL SYSTEM (GCCS)
OWNER WAYNE COUNTY, NORTH CAROLINA
TITLE APPROACH 2 APPENDIX C
SCALE 1" = 200'
DATE 09/05/01
DRWN. BY LCH
CHKD BY DWS
PROJ. NO. G00012
DRAWING 1 OF