North Country Environmental Services, Inc.
Permit Number: DES-SW-SP-03-002 (Stage IV)

Type I-B Modification to Solid Waste Management Facility Permit

Application to NH Department of Environmental Services:

- Type I-B Modification to Solid Waste Management Facility Permit

February 2009

Submitted by:

North Country Environmental Services, Inc.
Bethlehem, New Hampshire

Prepared by:

CMA Engineers, Inc
Civil and Environmental Engineers
35 Bow Street
Portsmouth, New Hampshire 03801

North Country Environmental Services, Inc.
Stage IV, Phase II

Bethlehem, New Hampshire

February 2009

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Submitted by:

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Section I

APPLICATION FORMS

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

For Office Use Only:
WMD Log #:
Date Rec'd.:
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APPLICATION FORM FOR

TYPE 1 MODIFICATION TO SOLID WASTE MANAGEMENT FACILITY PERMIT

pursuant to

RSA 149-M and New Hampshire Administrative Solid Waste Rule Env-Sw 315

SECTION I. FACILITY IDENTIFICATION

(1)	Facility name: North Country Environmental Services, Inc.
(2)	Functional classification: ☐ collection/storage/transfer ☐ processing/treatment ☒ landfill
(3)	Mailing address: : 581 Trudeau Road, Bethlehem, NH 03574
(4)	Permit number: DES-SW-SP-03-002 (Stage IV)
(5)	Location, by street address and municipality: 581 Trudeau Road, Bethlehem, NH 03574

SECTION II. PERMITTEE IDENTIFICATION

(1)	Permittee/applicant name: North Country Environmental Services, Inc.			
(2)	Mailing address: 3 Pitkin Court, Montpelier, VT 05602			
(3)	Telephone number: 802-223-7221			
(4)	If different than above, identify the individual associated with and designated by the permittee/applicant to be the contact individual for matters concerning this application:			
	(a)	Name: John Gay	(b)	Title: Manager, Central Region EPCC
	(c)	Mailing address: 3 Pitkin Court, Montpelier, VT 05602		
	(d)	Telephone number: 802-223-7221		

SECTION III. DESCRIPTION OF PROPOSED MODIFICATION

Describe the proposed modification by answering each of the following questions. Use additional paper as necessary.

(1)	Provide a **BRIEF** description of the proposed modification. [Check box if response is provided on separate paper ☒]
	See Attachment A
(2)	Identify whether the proposed modification is a "type I-A" or "type I-B" modification. (If uncertain, use the worksheet provided with the instructions for this form): ☐ Type I-A ☒ Type I-B
(3)	Identify, either below or on separate paper, each written permit condition that will require amendment to effect the proposed modification and provide draft language for the same. [Check box if response is provided on separate paper ☒]
	See Attachment B

(4)	Identify, below, each "last approved plan of record" identified in the permit which will be affected by the proposed modification and will therefore require amendment/revision:			
	Check here if affected	*TYPE OF PLAN*	*DES APPROVAL DATE*	**WMD LOG # (Find this number on your copy of the approval)**
	☒	Facility design plans/specifications	Permit for Stage IV March 13, 2003 Type II Modification for Stage IV Phase I August 5, 2005	200200068, 00200191, 200200192, 200300057 200500163, 200500173
	☒	Facility operating plan	Permit for Stage IV March 13, 2003 Type II Modification for Stage IV Phase I August 5, 2005	200200068, 00200191, 200200192, 200300057 200500163, 200500173
	☒	Facility closure plan	Permit for Stage IV March 13, 2003 Type II Modification for Stage IV Phase I August 5, 2005	200200068, 00200191, 200200192, 200300057 200500163, 200500173
	☒	Facility financial assurance plan	Permit for Stage IV March 13, 2003 Type II Modification for Stage IV Phase I August 5, 2005	
	☐	Other plan (specify):		

(5)	Submit, on separate paper, the proposed amendments/revisions for each document identified pursuant to (4) above, based on the below listed instructions. (Note: The revisions may be presented in the form of replacement pages ready for substitution into the last approved plan of record, each page being clearly marked to show the date of revision. In the event there is no last approved plan of record for any of the following, you must prepare and submit a full plan, including the proposed modification(s), in accordance with the applicable cited Rules.)	
	☒	Facility design plans must be prepared in accordance with Env-Sw 1103.05.
	☒	Facility operating plans must be prepared in accordance with Env-Sw 1105.11.
	☒	Facility closure plans must be prepared in accordance with Env-Sw 1106.04.
	☒	Financial assurance plans must be prepared as specified in Env-Sw 1400 and must include all related draft financial assurance documents required to effect the proposed modification.
(6)	In order for DES to approve the proposed modification, the agency must be able to conclude from the information provided in this application that the proposed modification meets all applicable requirements of the Rules. Therefore, for any aspect of the proposed modification where it may not be self-evident that the proposed change meets all applicable requirements of the Rules, you should explicitly provide such information. Provide your response below and/or use separate paper as necessary. (Check box if response is attached on separate paper ☐)	

SECTION IV. SCHEDULE

Provide a proposed schedule for implementing the modification. Use separate paper if necessary. (Check box if response is attached on separate paper ☒)

See Attachment C

SECTION V. STATEMENT OF NEED

Provide a statement of need describing why the proposed change is necessary or desirable. Use separate paper if necessary. (Check box if response is attached on separate paper ☒)

See Attachment D

SECTION VI. IMPACT EVALUATION

On separate paper, identify all impacts, both positive and adverse, which the proposed modification will have, including each of the below listed considerations.

(1) The effect the modification will have on facility function, capacity, life expectancy, service type and service area.

(2) The effect the modification will have on the environment, public health and safety.

(3) The effect the modification will have on the state's ability to achieve the goals and objectives specified in RSA 149-M:2, namely achieving a 40% minimum weight reduction in the solid waste stream on a per capita basis by the year 2000 and avoiding the disposal of recyclable materials in a lined landfill with a leachate collection system.

(4) The effect the modification will have on establishing and maintaining integrated waste management systems consistent with the hierarchy of waste management methods in RSA 149-M:3 [the methods, in descending order of preference as specified in RSA 149-M:3, are: source reduction; recycling and reusing; composting; waste-to-energy technologies (including incineration), incineration without resource recovery; and landfilling].

(5) Consistency with the state solid waste management plan and the applicable district plan, pursuant to RSA 149-M:12,I(b). If necessary, contact the P&DRS at (603) 271-2925 for plan information.

SECTION VII. PUBLIC BENEFIT DEMONSTRATION

Provide a "demonstration of public benefit" based on the below listed instructions. Check which one of the listed instructions applies to your particular application.

☐	**For a type I-A modification of a standard permit**, provide a "demonstration of public benefit" in accordance with RSA 149-M:11 and in conformance with the provisions of Env-Sw 1005.05. Prepare and submit the demonstration on separate paper.
☐	**For a type I-A modification of an emergency permit or a research and development permit, or a permit-by-notification**, there is a presumption of public benefit, provided that the proposed modification meets all requirements of the Rules. Therefore, you may skip this section and go to Section VIII.
☒	**For a type I-B modification**, there is a presumption of public benefit, provided that the proposed modification meets all requirements of the Rules. Therefore, you may skip this section and go to Section VIII.

SECTION VIII. OTHER PERMITS

Complete the following table to identify and provide the status of all other permits or approvals necessary to effect the proposed modification.

Type of Permit/Approval Required	Date the Application was/will be Submitted	Status/Comments
NHDES Significant Alteration of Terrain Permit (Site Specific Permit)	March 2009	
Groundwater Permit	November 2007	Issued
Temporary Air Permit	November 2000	Issued
NPDES Stormwater Permit	July 2004	Issued

SECTION IX. LEGAL NOTICES

Submit proof of having provided certain legal notifications and filings; as follows:

(1) You must send by certified mail, or deliver in hand, a complete copy of this application to the host municipality, host solid waste management district and other affected entities, with a "notice of filing," as specified by Env-Sw 303.

(2) For a type I-A modification, you must send by certified mail, or deliver in hand, a "notice of filing" to each owner of property abutting the facility site, as specified by Env-Sw 303. If the applicant/permittee or the owner of the facility site owns any abutting parcel of land, the "notice of filing" must be sent to the owner(s) of the next parcel(s) not owned by the permittee/applicant or facility site owner.

(3) You must also provide a "notice of filing" to the New Hampshire Department of Justice/Office of the Attorney General (NH DoJ/AGO) if, pursuant to Section X(2) of this form, you are required to submit business and personal disclosure information.

(4) You must attach to this application "proof" that notification has been provided as required by (1) through (3) above. Therefore, attach a copy of the notice(s) of filing and the signature(s) of all required recipients, acknowledging receipt.

SECTION X. CERTIFICATION OF COMPLIANCE/COMPLIANCE REPORT

All applications for permit modification must be submitted with either certification of compliance or a compliance report, as follows:

(1) If you are ABLE to certify that each of the statements numbered (1) - (8) below are true, do so by your signature.

(2) If you are UNABLE to certify that each of the statements numbered (1) - (8) below are true, you must:

☒ Prepare and submit a separate Compliance Report as specified by Env-Sw 303.15; and

☐ If the proposed modification involves a change in organizational structure, or a change in individuals/entities holding 10% or more of the permittee's debt or equity, or a change in officers, directors, partners or key employees, none of which constitutes a change in operational control of the facility or a change in ownership per Env-Sw 315.02(f), also submit completed "business and personal disclosure forms" for each non-compliant individual and entity involved in the change. Obtain the required forms from the P&DRS at (603) 271-2925. Submit the completed forms, with the notice of filing referenced by Section IX(3) of this form and a copy of the Compliance Report, direct to the New Hampshire Department of Justice/Office of Attorney General, Environmental Protection Bureau, 33 Capitol Street, Concord, NH 03301-6397. [Note: Copies of the completed disclosure forms should NOT be attached to this application when it is submitted to DES or to the host municipality, host solid waste management district and other effected entities, pursuant to Section IX(1) above. Only the NH DoJ/AGO should receive copies of the disclosure forms].

COMPLIANCE STATEMENT

The applicant shall certify that each of the statements listed in (1)-(8) below are true for each of the following individuals and entities:

- ☐ **The applicant.**
- ☐ **The facility owner.**
- ☐ **The facility operator.**
- ☐ **All individuals and entities holding 10% or more of the applicant's debt or equity.;**
- ☐ **All of the applicant's officers, directors, and partners.**
- ☐ **All individuals and entities having managerial, supervisory or substantial decision making authority and responsibility for the management of the facility operations or the activity(s) for which approval is being sought.**

(1)	No individual or entity listed above has been convicted of or plead guilty or no contest to a felony in any state or federal court during the 5 years before the date of the application.
(2)	No individual or entity listed above has been convicted of or plead guilty or no contest to a misdemeanor for a violation of environmental statutes or rules in any state or federal court during the 5 years before the date of the application.
(3)	No individual or entity listed above has owned or operated any hazardous or solid waste facility which has been the subject of an administrative or judicial enforcement action for a violation of environmental statutes or rules during the 5 years before the date of the application.
(4)	No individual or entity listed above has been the subject of any administrative or judicial enforcement action for a violation of environmental statutes and rules during the 5 years before the date of the application;

(5)	All hazardous and solid waste facilities owned or operated in New Hampshire by any individual or entity listed above are in compliance with either.	
	(a)	All applicable environmental statutes, rules, and DES permit requirements; or
	(b)	A DES approved schedule for achieving compliance therewith.
(6)	All individuals and entities listed above are in compliance with all civil and criminal penalty provisions of any outstanding consent agreement, settlement, or court order to which DES is a party.	
(7)	All individuals and entities listed above have paid, or are in compliance with the payment schedule for any administrative fine assessed by DES.	
(8)	All individuals and entities listed above are in compliance with all terms and conditions under every administrative order, court order or settlement agreement relating to programs implemented by DES.	

Signature of the permittee/applicant certifying the above statements are true:

Permittee/Applicant Name **(Print Clearly or Type)** _____

Permittee/Applicant Signature _____

Date _____

SECTION XI. PERMITTEE/APPLICANT SIGNATURE REQUIREMENTS

The permittee/applicant must sign the following statement prior to submitting this application. All copies of the application filed with DES must bear the permittee's/applicant's ORIGINAL signature. If the permittee/applicant is not an individual, an individual duly authorized by the permittee/applicant shall sign the application.

To the best of my knowledge and belief, the information and material submitted herewith is correct and complete. I understand that any approval granted by DES based on false and/or incomplete information shall be subject to revocation or suspension, and that administrative, civil or criminal penalties may also apply. I certify that this application is submitted on a complete and accurate form, as provided by DES, without alteration of the text.

Permittee/Applicant Name **(Print Clearly or Type)** _____

Permittee/Applicant Signature _____

Date _____

SECTION XII. PROPERTY OWNER SIGNATURE

If the permittee and property owner are not the same, the property owner must also sign this form as follows. All copies of the application filed with DES must bear the property owner's ORIGINAL signature. If the property owner is not an individual, an individual duly authorized by the property owner shall sign the application.

(1)	I hereby affirm that the permittee/applicant has the legal right to occupy and use the property on which the subject facility is or will be located for the purposes specified in this application.
(2)	I hereby affirm that I shall grant access to the property for closure and post-closure monitoring of the subject facility and site as required by RSA 149-M and the New Hampshire Solid Waste Rules (Env-Sw 100 - 300 and Env-Sw 400 - 2000), as amended.

Property Owner Name **(Print Clearly or Type)** _____

Property Owner Signature _____

Date _____

Section VI. Impact Evaluation

Per the Type I Permit Modification form, the following responses are given to the (5) enumerated questions. As an overview, this Type I-B permit modification will utilize most of the remaining capacity permitted for Stage IV, in the standard permit issued by the Department in 2003. The capacity will be within the 51 acres of land for which the courts have held that NCES has all local approvals for landfilling and the Town has designated landfilling as a permitted use. The capacity is also within portions of the original Stage IV permitted footprint.

(1) The effect the modification will have on facility function, capacity, life expectancy, service type, and service area.

The proposed modification request proposes no change to the facility function, capacity, service type, and service area. The modification will result in a modest increase in the life expectancy of the facility beyond the 10.5 years originally contemplated for Stage IV.

(2) The effect the modification will have on the environment, public health, and public safety.

The proposed modification would have no change in effect on the environment, public health, and public safety. The same siting, design, operating, and closure criteria are met with the proposed modifications, as were permitted for Stage IV. The same types of environmental controls (including groundwater protection and landfill gas management, for example) to protect public health and safety as in the existing permitted Stage IV are proposed.

(3) The effect the modification will have on the state's ability to achieve the goals and objectives specified in RSA 149-M:2, namely achieving a 40% minimum weight reduction in the solid waste stream on a per capita basis by the year 2000 and avoiding the disposal of recyclable materials in a lined landfill with a leachate collection system.

The proposed modification would have no change in effect on the state's ability to achieve the goals and objectives specified in RSA 149-M:2.

(4) The effect the modification will have on establishing and maintaining integrated waste management systems consistent with the hierarchy of waste management methods in RSA 149:M (the methods, in descending order of preference as specified in RSA 149-M:3, are: source reduction; recycling and reusing; composting; waste-to-energy (including incineration), incineration without energy recovery; and landfilling.

The proposed modification would have no change in effect on establishing and maintaining integrated waste management systems consistent with the hierarchy of waste management methods in RSA 149: M.

(5) Consistency with the state solid waste management plan and the applicable district plan, pursuant to RSA 149-M12 I(b).

The proposed modification is consistent with the state solid waste management plan pursuant to RSA 149-M12 I(b). NCES understands that there is no applicable district plan in effect.

Section X. CERTIFICATION OF COMPLIANCE/COMPLIANCE REPORT

ATTACHMENT X(2)

APPLICATIONS OF NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.
FOR TYPE I-B AND TYPE II MODIFICATIONS TO
STANDARD PERMIT NO. DES-SW-SP-03-002 (STAGE IV)

COMPLIANCE REPORT

North Country Environmental Services, Inc. ("NCES") submits the following compliance report in accordance with Env-Sw 303.15(a).

Env-Sw 303.15(b) requires that a compliance report address the following subjects:

(1) **A complete explanation of the circumstances which cause any statement in Env-Sw 303.14(b)(1) through (b)(8) to be untrue;**

On or about November 20, 2007, NCES entered into a consent decree with the State of New Hampshire settling a judicial enforcement action the State proposed to bring against NCES. The consent decree settles allegations by the State that NCES's waste inspection procedures were insufficient with respect to the detection and exclusion of prohibited wastes.

(2) **For each circumstance which causes a statement in Env-Sw 303.14(b)(1) through (b)(8) to be untrue, an explanation as to why the department should not find it to be grounds for denying the requested approval pursuant to the provisions of RSA 149-M:9, IX or X; and**

The consent decree contains the terms that DES has prescribed for the remediation of the alleged insufficiencies in NCES's inspection procedures. DES did not conclude that the alleged violations warranted revocation of NCES's permit, and NCES expects to comply fully with the terms of the consent decree.

None of the grounds for denial of an application under RSA 149-M:9, IX and X is implicated here.

(3) **For each circumstance which causes a statement in Env-Sw 303.14(b)(5) through (b)(8) to be untrue, a plan and schedule by which the applicant proposes to achieve full compliance.**

The consent decree sets out the means and schedule by which NCES must comply with its terms.

Attachment A - Brief Description of Proposed Modification

On March 13, 2003, North County Environmental Services, Inc. (NCES) received Solid Waste Permit No. DES-SW-SP-03-002 from the New Hampshire Department of Environmental Services (NHDES) for Stage IV, an expansion of the NCES landfill in Bethlehem, New Hampshire with a permitted capacity of 2,050,000 cubic yards. On April 24, 2003 the Grafton County Superior Court issued an order in litigation between NCES and the Town over several aspects of the NCES development. In that order, the Superior Court upheld a Town ordinance banning the expansion of privately operated landfills. The Town had sought to impose this ordinance to prohibit the development of Stage IV of the landfill.

NCES appealed the Superior Court's order to the New Hampshire Supreme Court and on March 1, 2004, the Supreme Court issued an opinion on the appeal. With regard to development of landfill capacity on that portion of NCES' land outside of the 51 acres -- where the courts in prior decisions had ruled that landfill development could take place -- the Supreme Court found that the issue of whether the ordinance is lawful had not been fully addressed in the trial court. The matter was remanded back to the trial court for resolution. Meanwhile, the Town passed another ordinance making landfilling a permitted use within the 51 acres but prohibiting it elsewhere. Because NCES's right to expand the landfill outside the 51 acres remains unsettled, NCES has decided to seek approval to continue development of Stage IV capacity within the 51 acres.

In 2004, NCES obtained a Type II Permit Modification to the Stage IV permit for grading modifications allowing the development of 153,000 cubic yards of Stage IV capacity above the side slopes of Stages II and III through the use of berms.

In 2005, NCES obtained a Type II Permit Modification to the Stage IV permit to construct Phase I of Stage IV, providing 470,000 cubic yards of the Stage IV capacity within the 51 acres.

NCES is now seeking construction approval for Phase II of Stage IV, which involves developing capacity within the 51 acres.

Description of Modification

This modification, called Stage IV Phase II, involves development of 1,280,000 cubic yards of Stage IV capacity within the permitted 51 acre footprint. Construction plans and technical specifications are enclosed. Supporting design calculations are also provided as well as a revised Facility Operating Plan, Revised Closure Plan, Stage IV Phase II Final Grading Plan and associated details, Gas Extraction System Plan and related details, and Closure Cost Estimate.

Capacity

A volume calculation comparing proposed final grades blended to previously approved grades demonstrates that the proposed modification provides 1,280,000 cubic yards of capacity. The total capacity of the requested modification, together with the capacity previously approved in the 2004 and 2005 modifications to the Stage IV permit is within the 2,050,000 cubic yards approved for all of Stage IV. All capacity is proposed within the maximum elevation originally permitted for Stage IV. All of the capacity of Phase II is gained through vertical development within the existing landfill's footprint and a small horizontal development of the Stage I footprint within the 51 acres.

Construction

Phase II construction involves narrow expansion of the liner system to the north, west and southern limits of Stage I. The modifications consist of extending the interior side slopes of the existing perimeter berm to raise the berm height. These berm modifications expand the Stage I lining system by 63 feet to the south, 78 feet to the west and 48 feet to the north. The modified limits of waste establish a 100-foot setback to property western and southern site property lines in accordance with Env-Sw 804.04(a). The northern modified berm and the entire Phase II development are located entirely within the 51-acre parcel.

Details of the liner connections are generally consistent with those provided in the Stage IV permit plans. It is proposed to modify and completely reconstruct the Stage I, Phase I, II, and III sumps such that they drain to a new sump and Pump Station I, simplifying leachate management in this area. Temporary leachate controls will be employed as necessary to contain and collect leachate at all times during construction.

NCES will excavate waste to expose the liner connections in Stage I, in a manner similar to that employed in the construction of Stage IV, Phase I, with temporary landfill gas (LFG) and odor controls including a temporary geomembrane cover in the excavations, and perimeter gas collection.

Leachate Management

The project will involve construction to simplify and improve the leachate management system, including pump stations and piping. From new Pump Station I in the Stage I area, a new force main will be constructed along the northern perimeter berm. The force main will extend from the Stage I area along an alignment located inside of the Stage IV Phase I anchor trench to the leachate handling and storage area located northeast of Stage IV Phase I and Stage II. The force mains will be constructed using dual-walled HDPE pipe, which includes a carrier pipe within a larger diameter containment pipe. The modified Stage I leachate system will allow for the decommissioning of the current Stage I pump stations and piping system, leachate flow metering building and wet well pump station.

Excavation of the Stage I sumps will require interim leachate management during construction. The design depicts details of the proposed leachate management system, which are consistent with the details presented in the March 2002 (Revised February 2003) permitted Stage IV Design drawings, and Phase I Type II modification. The leachate from Stage I and the new Stage IV Phase II areas will be directed to a reconstructed Stage I, Phase IV sump and Pump Station I.

Contingency Leachate Storage

Based on the calculations presented, the contingency leachate storage provided exceeds the NH Solid Waste Rules (Rules) Env-Sw 805.06(g). Leachate production from Stages I, II, III, and Stage IV Phase I and II were combined in performing the calculations.

The volume of leachate generated from the 25 year 24 hour storm can be stored in the Stage IV Phase II sump without developing more that 12 inches of head on the liner system. A 85 gpm pumping rate would remove the leachate generated from the contingency event from Stage IV Phase II during initial filling within approximately 1-5 days. Therefore, leachate pumps were selected to provide a pumping rate at 85 gpm for Pump Station I.

Leak Detection System Travel Time

Based on Env-Sw 805.07(b)(1), the leak detection system is to convey liquids to an observation point for detection (sump) based on a maximum time of concentration of 24 hours under saturated hydraulic conditions. All new liners are being constructed consistent with the permitted Stage IV design, and include highly transmissive geonet (geocomposite) above the secondary liner. New liners extend up the expanded perimeter berms and beyond those currently constructed to the limits of waste. Calculations included in Section VII, Appendix A indicate the leak detection system of the applicable new liners in these areas meets the travel time requirement.

The sumps are being reconstructed within Stage I, with the installation of new lining systems and collection piping. Again, because of the geocomposite included with all new liners, and the proximity to the collection piping, the calculations indicate the leak detection requirement is met.

In Phases I, II, and III of Stage I, the flatter portions of the secondary collection system did not include geonet, as it was not required by NHDES rules at the time, and was not widely applied on landfill projects. Stage I, Phase IV was constructed with geonet in the secondary collection system and meets the current standards. Critical areas including side slopes, berms, sumps, and pipe trenches do have geonet. Under the proposed construction, waste will be excavated to expose the liner system upslope of the sumps, so that the sumps and associated piping can be re-built. The reconstructed liner systems will be constructed to current standards as permitted for Stage IV. Accordingly, a significant improvement to the liner systems will be effected, including at the most sensitive locations: the low points associated with the sumps.

In order to comply with Env-Sw 805.07, an overlay liner will be constructed over the existing waste materials in Stage I, Phases I, II and III. The overlay liner will be constructed from bottom to top with: woven geotextile fabric; 12 inches of drainage sand; 60 mil secondary geomembrane; drainage geocomposite; 60 mil primary geomembrane; drainage geocomposite, and 12 inches of drainage sand. The liner section is consistent with the section approved for Stage IV, Phase I except the woven geotextile is added to enhance liner integrity. The overlay liner will direct primary and secondary leachate to proposed collection systems at the new sump of Stage IV, Phase II and to a proposed leachate conveyance pipe at the southern limit of Stage I that will be connected to the existing leachate collection system of Stage I, Phase IV.

Landfill Gas Management

During the excavation of the sumps in Stage I, temporary measures are proposed to reduce the potential release of landfill gas and possible odors. The side slopes of the excavations will be lined with 12-mil scrim reinforced high-density polyethylene (HDPE) geomembrane. Below the geomembrane, perforated gas collection pipes beneath panels of geocomposite will be extended down the slopes and connect to the gas extraction system. Each of the perforated collection pipes will be regulated with a wellhead to measure and control the gas flow. The temporary geomembrane will be removed as fill placement in the excavations proceeds. However, the drainage geocomposite and perforated landfill gas collection pipes will be left in place. This is the same system as was successfully applied during the construction of Phase I. Other odor control measures will include use of deodorizing mister, application of granular reactive media, and other measures as needed.

The construction of the overlay liner will require modification of several of the existing vertical and horizontal landfill gas collection wells. Prior to installation of the overlay liner materials, the existing vertical wells will be lowered 15 feet and connected to a new lateral pipe via flexible piping. The laterals will extend outside the limit of the over lay liner and connect to existing or proposed header pipes with a wellhead for control of gas extraction rates. Horizontal gas collectors will also be constructed beneath the overlay liner to remove accumulated landfill gas beneath the overlay liner.

The landfill will be filled to the grades indicated on the Final Grading Plan. Several wells, and associated wellheads and laterals outside the overliner will be affected by fill placement. These locations will be maintained as part of the active system for as long as practical during operations. At the completion of filling, gas extraction wells, and header and lateral piping will be installed in the general locations indicated on the Gas Extraction System Plan.

Storm Water Management

NCES received Site-Specific Permits #WPS-5513 and #WPS-6228 for the proposed development of Stages III and IV respectively. The stormwater management plan is being slightly modified with the requested modification. NCES is applying concurrently for a modification to the applicable Site Specific permits for the site. The modified conditions are consistent with the requirements of the existing permits.

Construction will eliminate Detention Pond No. 2. The calculations, based on the 25-year 24-hour storm event, are provided in attachments, and the associated Site Specific Permit modification. The calculations indicate that the peak storm water discharge from the site will be less than the predevelopment condition.

In addition, the facility has a USEPA, NPDES multi-sector General Permit for Stormwater Management, and an associated Storm Water Pollution Prevention Plan (SWPPP) including application of Best Management Practices (BMP's) for stormwater management.

Groundwater Monitoring

While the installation of road boxes and extensions of some existing wells is proposed, no additions, deletions, or replacement wells are proposed. A plan showing specific actions to monitoring wells is provided on Sheet C-3 of the drawings.

Financial Assurance

Cost estimates for closure and post closure monitoring and maintenance for the proposed modification are included in the Revised Closure Plan. The most recent financial assurance mechanism was established in September 2006. NCES will update the policies providing financial assurance when the revised closure cost estimates have been approved by NHDES, and prior to construction, as part of a subsequent Notice of Intent to Construct after a Type II Permit Modification is issued.

Attachment B - Permit Conditions Requested to be Modified

The following conditions of the Stage IV Landfill Permit No. (DES-SW-SP-03-002) are requested to be modified with this Type I-B modification:

3. Basis of Approval/Supporting Documentation

(a) Standard Landfill Permit Application documents prepared by Sanborn Head & Associates, Inc. (SHA), WMD Log 200200068, received April 03, 2002, and follow-up materials.

➔ ***Revisions to these documents submitted herewith, including :***

Modified Design Drawings
Modified Technical Specifications
Modified Operating Plan
Modified Closure Plan

Attachment C - Schedule

With NHDES approval of this Type I-B Modification, in the Summer of 2009, NCES intends to submit a Type II Permit Application, to prepare for construction, submit the Intent to Construct, and commence with certain elements of construction in the Fall of 2009. Completion of construction of Stage IV Phase II would occur in 2010, with capacity being available by mid-2010. Certain construction elements may be accomplished after 2010, depending on the need for capacity.

In subsequent Notice of Intent to Construct filings with the Division, construction sequences may be determined to construct portions of Stage IV Phase II to meet the capacity requirements of NCES sequentially.

Attachment D - Statement of Need

The proposed change is both necessary and desirable. In the Stage IV permit issued in 2003 by NHDES, a Determination of Public Benefit was made in which the Department determined that the Stage IV facility can provide a substantial public benefit per RSA 149-M:11, X. This determination included the provision of 2.05 million cubic yards of capacity over at least 10.5 years of service to NH municipalities.

Because of the status of local land use litigation in the courts, it is not yet resolved whether all of the originally permitted Stage IV footprint can be utilized. The proposed modification will enable NCES not only to provide capacity approved by the NHDES permit but to do so within the 51 acres in which landfilling is now a permitted use under the Town's zoning ordinance.

The modification is necessary and desirable so that NCES can continue to provide uninterrupted disposal capacity to the more than 10,000 households and businesses throughout the 28 New Hampshire communities that rely upon NCES for disposal of some or all of their solid waste.

Section II

DESIGN DRAWINGS

(Bound Separately)

Section III

TECHNICAL SPECIFICATIONS

02220	Selective Demolition
02221	Clearing and Grubbing
02222	Excavation
02223	Filling
02232	Stone Fill
02234	Select Sand
02270	Erosion Control
02273	Drainage Composite
02274	Woven Geotextile Fabric
02275	Non-Woven Geotextile Filter Fabric
02276	High Density Polyethylene (HDPE) Liner
02279	Geosynthetic Clay Liner
02541	Gravel Roadway
02542	Bituminous Pavement
02555	Temporary HDPE Tarp
02614	Culverts and Stormdrains
02617	Polyvinyl Chloride (PVC) Pipe and Fittings
02619	High Density Polyethylene Pipe and Fittings
02751	Precast Valve Vaults and Chambers
02834	Reinforced Earth Berm
02850	Testing Concrete Vaults and Chambers
02930	Loaming and Seeding
02960	Decommissioning / Extension of Monitoring Wells
03300	Cast-in-Place Concrete
09800	Underground Storage Tank
09900	Coatings
11310	Leachate Pump Station Pipe & Accessories
11312	Leachate Pump and Controls
13001	Site Safety and Contingency Work Plan Outline
15083	Piping Insulation
16402	Electrical Work
16610	Lightening Protection System

Appendix A – Boring Logs

SECTION 02220
SELECTIVE DEMOLITION

PART 1- GENERAL

1.10 SCOPE OF WORK

A. CONTRACTOR shall provide all labor, materials, equipment and incidentals necessary to perform the selective demolition required to complete the Work shown on the Plans and specified herein. Work may include, but not be limited to, excavation, backfill, landfill cap and liner removal, removal of portions of the active landfill gas extraction system, building demolition, salvage of valves, instrumentation, flow meters, and electrical and control equipment.

1.20 SUBMITTALS

A. CONTRACTOR shall submit to ENGINEER a Work Plan for performing the Work described in this Section and indicated on the Plans.

PART 2- PRODUCTS

(Reserved)

PART 3- EXECUTION

3.01 STAGE I – FLOW METERING BUILDING

A. CONTRACTOR shall demolish the existing Stage I Flow Metering Building including the concrete foundations, slab, wooden structure and roof. Waste materials shall be disposed on-site in the area(s) designated by OWNER.

B. CONTRACTOR shall remove and salvage the following items where practical:
   1. Force Mains
      a. Air release valve;
      b. Pressure gauges;
      c. 2-inch PVC Ball Valves;
      d. ½ inch PVC Ball Valves; and
      d. Paddle wheel flow meters;
   2. Building Systems
      a. Electric Unit Heaters;

b. Incandescent ceiling lamp assemblies;
c. Ventilation fan and exhaust shutter assembly;
d. Air inlet louver/shutter assembly;
e. Electric distribution panels and disconnects;
f. Communication Control panel;
g. Explosion-proof thermostat;
h. Floor flood float switch;
i. Exterior lighting fixtures.
j. Personnel Door

C. Salvaged items shall be cleaned and stored on-site in the location designated by OWNER. All salvaged items shall remain the property of OWNER.

D. Salvaged unit heaters, light fixtures, paddle wheels, exhaust fan and louvers, shall be reused in the proposed Pump Station I. Usable items not listed, and items not able to be reused shall be delivered to OWNER.

3.02 STAGE I – PUMP STATIONS AND WETWELL

A. CONTRACTOR shall remove and salvage the following items where practical:
1. Pumping Systems from the HDPE Phase I Primary and Secondary Pump Stations and Wetwell
   a. Leachate pumps, discharge piping, pump disconnects; and
   b. Submersible pressure transducers
   c. Floats and brackets
   d. Leak detection sensor

B. Existing HDPE Manhole Phase I Pump Stations and Wet Well are installed with concrete ballasts at the base. Each structure shall be removed and provided to the OWNER for their use or disposal on the site.

C. Existing Phase II, III and IV Primary Pump Stations and Secondary Side Slope Riser Pipes and Access manholes will require removal during excavation of waste materials and construction of new Phase I Sump and Pump Station II. Existing Pumps and pressure transducers shall be salvaged and provided to OWNER. Structures shall be demolished and relocated to area on-site for dispoosal designated by OWNER.

D. Existing force main piping between the existing Stage I pump station and the Flow

Metering Building and the force main and gravity lines connection the Pump Stations, Wet Well and Flow Metering Building shall be demolished to the limits shown on the Drawings.

3.03 STAGE I GEOSYNTHETIC LANDFILL CAP

A. CONTRACTOR shall expose and remove existing geosynthetics from the landfill cap section in the area indicated on the Plans. The remaining edge of the geosynthetics shall be anchored and terminated in accordance with the details provided on the Plans.

B. CONTRACTOR shall dispose the geosynthetics where directed by the OWNER.

3.04 STAGE I GEOSYNTHETIC LANDFILL LINER

A. CONTRACTOR shall expose and remove existing geosynthetics from the landfill liner section in the area indicated on the Plans. The remaining edge of the geosynthetics shall be anchored and terminated in accordance with the details provided on the Plans.

B. CONTRACTOR shall dispose the geosynthetics where directed by the OWNER.

3.05 ACTIVE LANDFILL GAS EXTRACTION SYSTEM

A. CONTRACTOR shall expose and remove portions of the active landfill gas (LFG) extraction system where shown on the plans. This may include removal of LFG header and lateral pipes, LFG condensate traps, and LFG condensate drain pipes.

B. CONTRACTOR shall coordinate all work on the LFG extraction system with the OWNER. CONTRACTOR shall provide OWNER with notice of disturbance or interruption of service of the system at least 24 hours prior to the work. The LFG extraction system shall be shut down for no more than 8 hours, and shall operate for no less than 24 hours between service interruptions.

C. CONTRACTOR shall dispose of LFG system materials on-site where directed by the OWNER.

END OF SECTION

SECTION 02221
CLEARING AND GRUBBING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Clearing and grubbing, including the disposal of cleared and grubbed materials, within the limits shown on the Plans or as ordered by the Engineer.

1.02 RELATED REQUIREMENTS

A. Section 02222 - Excavation.

PART 2 PRODUCTS

A. Materials - Existing trees, stumps, and brush.

PART 3 EXECUTION

3.01 CLEARING

A. Clearing shall consist of the satisfactory felling and removal of all trees and vegetation (except grass), together with the down timber, snags, brush, and rubbish occurring within the area to be cleared. Trees, other vegetation, stumps, roots, and brush in areas to be cleared shall be cut off flush with or below the original ground surfaces. Contractor shall remove all cleared material from site including all brush, stumps, and lumber.

B. Individual trees and groups of trees designated to be left standing by the Engineer within the cleared areas, shall be trimmed of dead branches 1½ inches or more in diameter, and shall be trimmed of live branches to such heights and in such manner as are indicated on the Plans or directed by the Engineer.

C. Limbs and branches required to be trimmed shall be neatly cut close to the bole of the tree or to main branches, and all cuts more than 1½ inches in diameter thus made shall be painted with an approved tree-wound paint.

D. Individual trees, groups of trees, and other vegetation to be left standing shall be thoroughly protected from damage incident to construction operations, by the erection of fencing or by such other means as the circumstances require, as approved by the Engineer.

E. Clearing operations shall be conducted so as to prevent damage by falling trees to trees left standing, to existing structures and installations, and to work under construction, so as to provide for the safety of employees and others.

3.02 GRUBBING

A. Grubbing shall consist of the removal and disposal of stumps, roots larger than 1½ inches in diameter, matted roots, and other organic or metallic debris from the designated grubbing areas to a depth required to remove all such material.

3.03 DISPOSAL OF MATERIAL

A. The Contractor's attention is particularly directed to the fact that no burning of cleared and grubbed material will be allowed under this Contract. All cleared and grubbed materials shall be removed from the site including all stumps, brush, and trees. If the Contractor chooses to chip materials on-site, the Contractor shall submit a plan for the proposed staging area for approval by the Owner. All chipped materials shall be removed from the site.

END OF SECTION

SECTION 02222
EXCAVATION

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Excavation and processing of excavated materials.

B. Stockpiling of fill materials.

C. Excavation for liner subgrade, utilities and roadways.

D. Excavation and disposal of unsuitable and excess materials.

E. Excavation of MSW and transport of excavated materials to the active landfill on site.

1.02 RELATED REQUIREMENTS

A. Section 01400 - Quality Assurance/Quality Control

B. Section 01500 - Construction Facilities and Temporary Controls

C. Section 02223 - Filling

D. Section 02270 - Erosion Control

E. Section 13001 – Site Safety and Contingency Work Plan

1.03 PROTECTION

A. Protect the bench-marks established for project construction.

B. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in or loose soil from falling into the excavation.

C. Notify the Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

D. Grade the perimeter to prevent surface water run-off into the excavation.

E. Barricade or otherwise protect, consistent with the project safety program, open excavations occurring as part of this work and post with warning lights.

F. Protect adjacent structures and facilities from damage caused by settlement, movement, undermining and other hazards created by earthwork operations.

G. Dust Control: Use all necessary means to control dust caused by the Contractor's operation. Prevent dust from being a nuisance to the public. The use of calcium chloride is not acceptable. Moisture addition must be limited so as not to adversely affect soil handling. The use of other agents for dust control is subject to the approval of the Engineer.

H. Dewatering: Remove water from excavations to a point lower than the proposed subgrade of the work.

I. Odor Control: The Contractor shall install the temporary geomembrane cover and extend the existing landfill gas collection system to assist with the control of odors when final waste excavation grades are completed. At the end of each day of waste excavation, Contractor shall install a minimum of 4-inches of common borrow cover over exposed waste materials.

1.04 JOB CONDITIONS

A. SITE CONDITIONS: Data referring to subsurface conditions in Appendix A are not intended as representations or warrants of continuity of such conditions between soil borings. The information is made available for the convenience of the Contractor and the Owner will not be responsible for interpretations or conclusions drawn by the Contractor.

1.05 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION

A. The Contractor shall take the necessary steps to avoid subgrade disturbance during excavations, including dewatering and restricting the use of equipment in areas above optimum moisture level.

B. All areas disturbed during excavation that will not meet compaction requirements shall be removed and replaced with fill meeting structural requirements at no extra cost to Owner.

PART 2 PRODUCTS

2.01 MATERIALS

1. Loam/Topsoil - Topsoil materials shall be excavated and may be processed, as necessary, to meet the requirements of loam in Section 02930 for re-use.

2. Common Borrow - Soil to be excavated and utilized as common borrow fill shall have all rocks and material greater than eight (8) inches in diameter removed and no more than 30% fines passing the #200 sieve. Common Borrow in contact with geosynthetic materials shall have a maximum particle size of one (1) inch. Suitable fill shall be free from combustible, organic, and frozen materials, loam, roots, topsoil, wood, trash, snow, ice and other objectionable material, or as identified by the Engineer, or laboratory analysis. Granular materials excavated from the existing landfill cover system may be segregated from waste, till, and/or sludge and topsoil material and re-used if it meets the requirements above.

3. Unclassified Waste - Waste materials including soil cover and cover to be excavated from areas as indicated on the Drawings. May include refuse, wood chips, metal, masonry, concrete, boulders, or debris and other unclassified waste.

4. Till- Existing till materials to be excavated shall be processed as necessary to meet the requirements of Common Borrow or Screened Till in Section 02223, for use as fill beneath the liner system and other areas indicated on the Drawings.

5. Unsuitable Fill - Excavated material not meeting the requirements for reuse as topsoil, common borrow or screened till that which may not be used as fill due to excess moisture, trash, organics, or other unsatisfactory materials.

6. Boulders- Excavated rock boulders greater than 24 inches in diameter shall be relocated to an area of the site designated by the Owner. Contractor may crush and or process the boulders for use on-site as NHDOT Stone Fill or Rip Rap or as 1 ½" crushed stone fill per Section 02232 or crushed stone per Section 02541.

PART 3 EXECUTION

3.01 PREPARATION

A. Set and verify required lines and grades prior to starting the excavation. This work should be performed and verified by a registered land surveyor or professional engineer licensed to practice in the State of New Hampshire.

B. It will be the responsibility of the Contractor to establish a construction baseline on-site. The Contractor shall perform all necessary construction layout from this baseline, maintain the baseline as necessary, and perform whatever survey is required to control his work.

3.02 EXCAVATION

A. Excavation consists of the removal and stockpiling or disposal of materials encountered when establishing required grade elevations as shown on the Plans and in accordance with these Specifications. If rock boulders greater than twelve

(12) inches diameter are encountered within six (6) inches of the depth of excavation, they shall be removed and the resulting hole shall be backfilled with Common Borrow, or Screened Till.

B. Excavation for utilities: The trench for the pipes shall be excavated to the required line and grade and of sufficient width to permit thorough compacting and tamping of the fill material under the haunches and around the pipe. In general, utility trenches shall be excavated to 6 inches below the bottom of the utility line to accommodate bedding material as specified hereinafter. Soft or unsuitable material encountered below the normal bedding line of the pipe shall be removed as directed, replaced with regular fill, and thoroughly compacted.

C. Excavation for structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from structures to permit installation of service, other construction required, and for inspection.

D. Excavation of Unclassified Waste Material: Excavation of existing cover material and waste material shall be completed to the limits indicated on the Drawings. All work will be completed in accordance with the Site Safety and Contingency Work Plan developed by the Contractor, in accordance with Section 13001. Excavated capping system materials may be utilized for fill in areas as required to achieve proposed subgrade. Excavated waste materials and shall be placed in the active landfill at a location designated by the Owner.

Excavation of waste materials shall be performed in a manner which controls odors, dust, vectors, and migration of waste. At a minimum, the "active area" of the excavation shall be covered with a minimum four (4) inches of suitable fill at the end of each day.

3.03 COMPACTION OF EXCAVATED SUBGRADE

A. Upon completion of the excavation to proposed subgrade, the conditions shall be inspected by the Engineer for acceptance. The entire area shall be fine graded to remove undulations or isolated high or low spots. The subgrade shall be proof rolled, and any soft yielding areas shall be excavated and backfilled with common borrow, or screened till.

B. Upon completion of excavation in areas beneath the proposed liner system, the natural subgrade shall be compacted to at least 95% of the maximum dry density as determined by ASTM D698, Method C.

C. Compaction equipment in open areas shall consist of vibratory rollers, or other equivalent compaction equipment reviewed by the Engineer.

D. Compaction equipment in confined areas (in trenches and adjacent to walls, piers, footings and standpipes) shall consist of hand-guided vibratory equipment or mechanical tampers reviewed by the Engineer.

E. Upon completion of the excavation in areas outside the landfill where fill will be placed, the subgrade shall be proof-rolled by two coverages of the rear wheels of a fully loaded ten-wheel dump truck, or by other suitable equipment as reviewed by the Engineer.

3.04 STOCKPILING

1. Suitable fill excavated including borrow, till materials, and topsoil shall be stockpiled until required for filling. Place, grade and shape stockpiles for proper drainage. Erosion control devices shall be used as necessary to minimize sediment transport away from the area.

2. Fill unsuitable for use as regular fill and excess materials shall be handled in accordance with Part 3.05.

3.05 DISPOSAL OF UNSUITABLE and EXCESS MATERIALS

The Contractor shall dispose of all unsuitable and excess materials on-site in a location or locations designated by the Owner or as shown on the Plans. Contractor shall take no material from the site.

Unsuitable and excess materials are defined as follows:

A. Unsuitable Material - Material containing significant clay, silt, or organic material, or material greater than eight inches (8") in diameter, or other materials identified on the contract drawings.

B. Excess Materials - Materials not meeting the definition in "A" above but which do not meet any of the specifications for materials required for this project, and/or materials in excess of the total quantity of materials required for this construction project.

C. No material shall be removed from the site. Unsuitable and excess materials shall be stored at separate locations on site as directed by the Owner.

3.06 STABILITY OF EXCAVATIONS

A. Slope sides of excavations to comply with OSHA regulations and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible due to space restrictions or instability of material excavated. Maintain the sides and the slopes of excavations in a safe condition until completion of backfilling.

B. Shoring and bracing: Provide adequate shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition. Trench shoring and bracing shall comply with local codes and authorities having jurisdiction. Maintain shoring and bracing in excavation regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses. All temporary shoring and bracing plans shall be designed and stamped by a New Hampshire licensed professional engineer.

3.07 DEWATERING

A. Control of surface water is a critical requirement of the work. All necessary actions shall be taken to minimize the effect of precipitation and runoff on the work. Upgradient runoff shall be diverted from active or completed work areas, and all work shall be graded and crowned to promote runoff.

B. The Contractor shall prevent surface water and subsurface or groundwater from flowing into excavations or onto any work and from flooding the project site and surrounding area.

C. Water shall not accumulate in excavations. Contractor shall remove water to prevent softening of subgrades and soil changes detrimental to stability of the subgrade. The Contractor shall dewater excavated areas as required to perform the work, and in such a manner as to preserve the undisturbed state of subgrade material.

D. The Contractor shall provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

E. The Contractor shall prevent migration of sediment in accordance with erosion control requirements of this Contract.

3.08 COLD WEATHER PROTECTION

A. Protect excavation bottoms against freezing when the atmospheric temperature is less than 35° F. The Contractor shall take whatever actions are necessary during the period of construction, to prevent freezing of any areas which are to receive fill as part of this work. No fill shall be placed on areas which are frozen. The Contractor shall also comply with the requirements of Section 203, Paragraph 3.7.8 of the NH DOT Standard Specifications.

3.09 REMOVAL OF UNSATISFACTORY SOIL MATERIALS

A. Unsatisfactory soil materials shall be as defined in Paragraph 3.05 (unsuitable materials).

B. Excavate unsatisfactory soil materials encountered that extend below required elevations, to the additional depth directed by the Engineer. Do not over-excavate without prior authorization of the Engineer.

C. Such additional excavation, provided it is not due to fault or neglect of Contractor, will be measured as directed by Engineer and paid for in accordance with the measurement and payment section.

D. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Engineer, and is disturbed by the Contractor during construction operations so that proper compaction cannot be reached shall be construed as unsuitable bearing material or unsatisfactory soil material. This material shall be removed and replaced with compacted gravel fill at no additional charge to the Owner.

END OF SECTION

SECTION 02223
FILLING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing, placing, and compaction of suitable fill (borrow) and bedding sand.
B. Production, placing and compaction of screened till from on-site till materials.
C. Coordination with the Engineer for completion of all required tests.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance/Quality Control
C. Section 02222 – Excavation
D. Section 02232 - Stone Fill
E. Section 02234 - Select Sand
F. Section 02270 - Erosion Control
G. Section 02541 - Gravel Roadway
H. Section 02930 - Loaming and Seeding

1.03 REFERENCES

A. ASTM C136/C117 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate and Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

B. ASTM D1557 Method "C" - Moisture-Density Relations of Soils and Soil-Aggregate Mixture using 10 lb. (4.54 kg) Hammer and 18-inch (457 mm) Drop.

C. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.

D. ASTM D6938 - 08a Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

E. ASTM D5084 - Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

F. ASTMD5321 – Standard Test Method for Direct Shear Testing of Geosynthetic Material and Soil Interfaces.

1.04 TESTS

A. Soil testing and compaction tests shall be performed by the Engineer in coordination with the Contractor.

B. Test and analysis of fill materials shall be performed by the Engineer in coordination with the Contractor.

C. Tests and analyses of fill materials will be performed in accordance with ASTM C136/C117, ASTM D1557, ASTM D6938-08a, ASTM D5084 and ASTM D5321 and conditions set forth in Section 02223, 2.02 "Quality Control and Quality Assurance."

PART 2 PRODUCTS

2.01 FILL

A. General

For all fill materials to be used, samples, sieve analysis, and laboratory data indicating maximum dry densities and optimum moisture for field control tests shall be reviewed by the Engineer prior to use as fill on site. Where materials for fill may be available on-site for common borrow, screened till and loam, the Contractor shall be required to excavate test pits as required from processed or existing stockpiles to allow sampling and evaluation of the materials by the Engineer. The Contractor shall excavate, screen, and stockpile materials for sampling purposes prior to placement within proposed fills.

B. Common Borrow Fill

Suitable borrow, either from on-site or off-site sources, to be utilized as regular fill shall consist of sands with all rocks or material greater than 8" removed and no more than 30% passing the No. 200 sieve. Suitable fill shall be free from combustible, organic and frozen materials, loam, roots, topsoil, wood, trash, snow, ice, and other objectionable materials, or as identified by the Engineer. The on-site till materials (some of which are anticipated >30% passing No 200 sieve and stones larger than 8" removed) may be used for common borrow fill, provided the Contractor properly manages soil water content and the materials can be properly compacted and maintained.

C. Screened Till

Screened Till for use as the 12 inches of secondary liner subgrade fill and pipe bedding shall consist of inorganic mineral soil free of organic material, loam, trash, snow, ice, frozen soil, or other unsuitable materials and shall conform to the following gradation:

U. S. Standard Sieve Size	% Finer By Weight
1 inch	100
No. 4	80-100

No. 40	60-100
#200	20 – 70

Screened till shall have a hydraulic conductivity of less than $1x10^{-4}$ cm/sec when as demonstrated by ASTM D5084, when placed and compacted as specified as a subgrade fill beneath the secondary liner.

The on-site 'till' soils to be excavated as part of the earthwork operation may be considered for use as Screened Till provided that the Contractor screen the materials to remove all stones 1" or larger (anticipated to be significant effort) and the material meets all other requirements of this section. Otherwise, Screened Till for the select secondary subgrade fill and pipe bedding shall be provided from off-site sources at no additional cost to the Owner.

1. Interface Shear Strength: Testing completed by the Engineer shall demonstrate that the interface shear strength is equal to or greater than a strength envelope of 26^0 between the 60-mil textured HDPE liner and the proposed screened till.

2. The interface shear strength shall be determined by an interface shear test performed in accordance with ASTM D5321. The normal stresses applied shall be 1, 3, 10, 25, and 50 psi. The strain rate shall not exceed 0.04 inches per minute. The 60-mil textured HDPE geomembrane shall be tested in the machine direction. The tests shall be continued until residual shear strengths are achieved, or to a maximum 2-inch displacement. The Screened Till shall be compacted to 95% of maximum dry density per ASTM D1557, and a moisture content of 2% wet of optimum.

   The laboratory test reports shall include plots of shear strength versus normal stress for peak and large displacement values, and stress versus strain plots for tests run at each normal load application. A minimum of two (2) tests shall be completed.

3. Test results not meeting the minimum requirements shall be reviewed by the Engineer for possible conformance with the overall design objectives.

D. For other fill materials see Section 02234 Select Sand, Section 02541 - Gravel Roadway, and Section 02930 - Loaming and Seeding.

2.02 QUALITY CONTROL AND QUALITY ASSURANCE

A. During earthwork operations, the Engineer will be present on the site to monitor and document the Contractor's activities relative to contract compliance.

B. The Engineer shall complete laboratory analyses of a minimum of two (2) representative samples of common borrow and screened till. The Engineer shall conduct laboratory grain size analysis, moisture density testing, and permeability in

accordance with ASTM C136/C117, ASTM D1557, and ASTM D5084, respectively, to demonstrate conformance with Parts 2.01 and 3.02 of this Section.

C. The Contractor shall provide a sample for Engineer's laboratory analysis of at least one (1) representative sample of common borrow fill and screened till for each 5,000 cubic yards of material to be placed. The Engineer shall conduct laboratory grain size analysis and moisture density testing in accordance with ASTM C136/C117 and D1557, respectively, to demonstrate conformance with Parts 2.01 and 3.02 of this Section.

D. The results of laboratory testing shall be reviewed by the Engineer prior to placement of fill materials. Costs for re-sampling and subsequent laboratory testing of all non-complying materials shall be borne by the Contractor.

E. Field tests will be performed by the Engineer on in-place fill and backfill materials to confirm that specified densities are being achieved with the minimum required coverages and compaction equipment utilized by the Contractor. The Engineer will select locations and frequency for in-place density testing. At a minimum, the frequency of field tests shall be as follows:

1. Common Borrow Fill: 1 test per lift per 10,000 ft^2
2. Screened Till: 1 test per lift per 10,000 ft^2

F. Acceptable materials placed and compacted to below the specified density shall alternatively be:

1. Recompacted as required to achieve the specified density.
2. Removed and replaced with properly placed and acceptably compacted material.

G. Materials placed and compacted which do not conform to project specifications for the area placed shall be removed and replaced with suitable material by the Contractor.

H. The Contractor will bear all costs incurred in the recompaction, removal, and replacement of fill not meeting density requirements.

PART 3 EXECUTION

3.01 PREPARATION

A. Fill to be used must be reviewed by the Engineer.

B. The subgrade which is to receive the fill shall be fine-graded and compacted in accordance with Section 02222 "Excavation" and reviewed by the Engineer.

C. All excavated surfaces shall be within 0.10'(+) and 0.20'(-) ft. of required line and grade.

D. Surfaces to be filled against which are steeper than 4:1 shall be scarified or stepped and compacted to provide a bond with the new material.

E. Fill materials will not be placed or compacted on frozen ground or during unfavorable weather conditions. Backfill operations will not be resumed until the moisture content and fill density is satisfactory to the Engineer.

F. All fill material shall be placed "in-the-dry" on a prepared ground surface acceptable to the Engineer. The Contractor shall drain away ponded areas as required to perform the placement of fill in-the-dry.

3.02 FILLING AND COMPACTION

A. Approved suitable material shall be installed in lifts no greater than as specified.

B. Lifts shall be compacted to at least the specified percentage of maximum dry density, within 3% of optimum moisture content. Field testing of these lifts will be performed in accordance with ASTM D6938-08a, and Paragraph 2.02 of this Section.

C. Do not proceed with the next layer of fill until the preceding layer has been tested and approved by the Engineer.

D. Areas at which tests indicate insufficient compaction shall be recompacted and retested until the areas conform to the requirements of this specification.

E. For the materials specified herein, the following placement and compaction requirements are included:

	Maximum Lift Before Compaction	Minimum % of Maximum Density per ASTM D1557
Common Borrow Fill	12"	95
Screened Till	12"	95

3.03 BACKFILLING OF UTILITES AND PIPING

A. After pipes and joints have been inspected and approved by the Engineer, screened till bedding or crushed stone (See Section 02232) shall be carefully placed and compacted and tamped in 6-inch layers under, around, and to the spring line of the pipe to firmly support the pipe, and prevent lateral movement.

B. Care shall be taken to provide recesses in the bedding or trench bottom, as required, to relieve each bell of any load.

C. Backfill from the top of the bedding to 12-inches above the pipe shall be completed in 12-inch layers with screened till sand, evenly on both sides of the pipe.

D. The remainder of the backfill may be material removed from the trench excavation and shall be placed in approximately 12-inch layers and compacted to 95% of the maximum dry density, as demonstrated by in-place density testing completed by the Engineer.

3.03 FINAL GRADING

A. Perform all finish grading required to attain the elevations shown on the Plans, to within 0.1 feet, to eliminate all ponded water, or as otherwise indicated.

B. Areas to be seeded shall be raked to remove all stones and other unsatisfactory material, and shall be suitably compacted.

3.04 TREATMENT AFTER COMPLETION OF GRADING

A. After grading is complete and the Engineer has finished his reviews, the Contractor shall permit no further excavating, filling, grading, or vehicular access except to maintain erosion or sediment control. Use all means necessary to prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

END OF SECTION

SECTION 02232
STONE FILL

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Production of Stone fill, rip-rap, and crushed stone from existing on site boulders/rock and rock materials encountered during completion of the work, or procured from off-site source.

B. Placement of stone and rip-rap stone fill for stabilization of drainage swales as shown on the Drawings or as ordered by Engineer.

1.02 RELATED REQUIREMENTS

A. Section 02275 - Non-Woven Geotextile Fabric
B. Section 02270 - Erosion Control
C. Section 02273- Drainage Geocomposite

PART 2 PRODUCTS

2.01 MATERIALS

A. Stone and Rip-rap Fill for Placement in Leachate Sumps, Stabilization of Drainage Swales, and Culvert Outlet Protection:

1. Stone and rip-rap shall conform to NHDOT Specifications for Stone Fill Class B, Class C and Class D Section 585 "Stone Fill" and Rip-rap Type A, Section 583 "Rip-rap", as indicated on the Drawings.

2. Stone and rip-rap fill shall be hard, durable, angular in shape; resistant to weathering and to water action; free from overburden, spoil, and organic material.

3. The acceptability of the processed stone will be determined by visual inspection or by suitable tests. If testing is required, suitable samples of stone shall be taken in the presence of the Engineer at least fourteen (14) days in advance of the time when the placing of stone fill is expected to begin.

4. Control of gradation will be by visual inspection. If necessary, the Contractor shall provide two (2) samples of rock, at least five tons (5T) each, meeting the gradation specified above. These samples shall be used as a reference for judging the gradation of the stone fill supplied.

5. Any difference of opinion between the Engineer and the Contractor shall be resolved by dumping and checking the gradation of two (2) random truckloads of stone. Mechanical equipment, a sorting site, and labor

needed to assist in checking gradation shall be provided by the Contractor at no additional cost of the Owner.

B. 1½" Crushed Stone

1. Crushed stone shall be hard, durable, angular in shape; resistant to weathering and to water action; free from overburden, spoil, and organic material.
2. Crushed stone shall be washed, uniformly blended and meet the following gradation:

Sieve Size	Percent Passing by Weight
1 ½ -inch	100
1 inch	75-100
¾ inch	45-75
No. 4	10-45
No. 200	0-5

3. The Engineer shall collect a sample of the processed crushed stone for laboratory testing. Materials not meeting the requirements of this section shall not be used in the Work.

PART 3 EXECUTION

3.01 PLACEMENT OF STONE FILL AND FOR RIP RAP STABILIZATION

A. Stone fill in the landfill shall be placed directly over the drainage geocomposite and pipes as shown on the Drawings. Stone fill in drainage swales shall be placed directly over a 10 oz. non-woven geotextile fabric within the prepared swales and on slopes, starting at the downstream end. Rip rap shall be placed over a 16 oz non-woven geotextile fabric within prepared swales, and slopes, starting at the downstream end.

B. Stone fill and rip rap for culvert outlet protection shall be placed directly over a 10 oz. and 16 oz. non-woven geotextile fabric, respectively, to the limits shown on the Plans.

C. All stone fill and rip rap shall be placed in a manner which will produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed, so as to be in conformance with the lines, grades, and thicknesses shown on the plans.

D. Stone fill and rip rap shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the underlying material. Placing of stone fill in layers, or by dumping into chutes, or by similar methods likely to cause segregation, will not be permitted.

E. The larger stones shall be well distributed and the entire mass of stone shall conform to the gradation specified in paragraph 2.01. All material going into stone fill protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone.

F. It is the intent of these specifications to require compact stone fill protection in which all sizes of material are distributed within their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

END OF SECTION

SECTION 02234
SELECT SAND

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Procurement of select sand and placement of the twelve (12) and eighteen (18) inch layers of select sand as part of the landfill liner system, and at greater thicknesses as shown on the Drawings.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance / Quality Control
C. Section 02223 - Filling
D. Section 02273 - Drainage Geocomposite
E. Section 02279 - Geosynthetic Clay Liner

1.03 REFERENCE STANDARDS

A. ASTM C136/C117 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate and Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

B. ASTM D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort

C. ASTM D5084: Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

D. ASTM D5321: Test Method for Direct Shear Testing of Geosynthetic Material and Soil Interfaces

E. ASTM D4373: Test Method for Determining Calcium Carbonate Content of Soils

1.04 SUBMITTALS

A. The Contractor shall provide a sample for laboratory testing by the Engineer to determine that the select sand meets the specified grain size distribution and hydraulic conductivity for at least every 3,000 cy delivered to the site.

B. The Contractor shall submit all proposed low ground pressure (LGP) equipment for Engineer's review.

C. The Engineer shall complete direct shear box tests of the select sand and the proposed drainage geocomposite to demonstrate compliance of interface friction, in accordance with Part 2.01 of this Section.

D. The Contractor shall provide one sample for laboratory testing by the Engineer for calcium carbonate content from each source of select sand.

PART 2 PRODUCTS

2.01 SELECT SAND

A. Select sand shall be well graded sand without excessive fines, free from loam clay, and organic matter and meeting the following grain size distribution:

U.S. Standard Sieve Size	% Finer By Weight
1 in.	100
#4	60-100
#10	40-95
#40	10-50
#100	0-20
#200	0-10

B. Select sand shall not contain more than 15 percent calcium carbonate as determined by ASTM D 4373. At least one test shall be performed on a representative sample from each source.

C. Select sand shall have a hydraulic conductivity greater than or equal to 1×10^{-3} cm/sec as determined by ASTM D 2434.

D. Interface Shear Strength

1. The Engineer shall complete interface shear strength testing to determine if the strength is equal to or greater than a strength envelope of 26° between the following surfaces as determined by ASTM D 5321:
   a. The proposed select sand and the proposed non-woven geotextile of the drainage geocomposite.
   b. The proposed select sand and the proposed Geosynthetic Clay Liner (GCL).
2. The interface shear strength shall be determined by an interface shear test performed in accordance with ASTM D5321. The normal stresses applied shall be 1, 3, 10, 25, and 50 psi. The strain rate shall not exceed 0.04 inches per minute. The 60-mil textured HDPE geomembrane shall be tested in the machine direction. The tests shall be continued until residual shear strengths are achieved, or to a maximum 2-inch displacement. The low

permeability soil shall be compacted to 93 percent of maximum dry density per ASTM D1557, at a moisture content of 2% wet of optimum.

The laboratory test reports shall include plots of shear strength versus normal stress for peak and large displacement values, and stress versus strain plots for tests run at each normal load application. A minimum of two (2) tests shall be completed for each interface.

3. Test results not meeting the minimum requirements shall be reviewed by the Engineer for possible conformance with the overall design objectives. Test requirements for the select sand and drainage geocomposite interface are defined in Section 02273, 2.04.D.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that the stockpiled select sand is reviewed by the Engineer.

B. Verify the lines and grades to which the select sand is to be placed and compacted.

C. Verify that the area on which select sand is to be placed is free from debris, snow, ice, or water and that the ground surface is not frozen.

3.02 PLACEMENT OF MATERIALS

A. Placement of the select sand shall be by "low ground pressure" (LGP) rated equipment having a bearing pressure of no greater than 4.7 pounds per square inch measured at 12 inches above the geomembrane. No equipment will be allowed at any time directly on the liner or geotextile fabric.

B. Select sand shall be placed by LGP equipment in lifts no less than the proposed minimum thickness for that area. In no case shall this be less than 12 inches.

C. Non LGP equipment which is necessary to operate over the landfill shall be operated on additional depths of sand or other materials to provide an equivalent bearing pressure of 4.7 pounds per square inch at 12 inches above the geomembrane.

D. Select sand shall be placed on side slopes steeper than 3.5:1 starting from the bottom of the slope and proceeding in an upward direction. The Contractor shall exercise caution when operating on side slopes and shall limit turning and braking.

E. Coordinate placement and compaction of the select sand with the installation of other components of work shown on the Plans, taking all measures to prevent damage to these materials while placing the select sand.

F. The select sand layer will be spread to a consistent depth and uniform surface, being compacted only by passage of the low ground pressure machinery. No vibratory equipment is to be used in compacting the select sand.

G. The select sand layers may not require testing for compaction densities if the Engineer believes that the sand is being placed in layers and compacted as required. If requested by Engineer, Contractor shall coordinate for testing by the Engineer to demonstrate a minimum 90% of maximum dry density is achieved.

END OF SECTION

SECTION 02270
EROSION CONTROL

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Installation and maintenance of temporary erosion control devices.

B. Erosion control measures to fully manage runoff and potential erosion conditions which may develop during construction and prior to the functioning of completed permanent erosion control devices.

C. Compliance with federal, state and local regulations pertaining to erosion control, and the Site Specific Permit conditions for this project.

1.02 RELATED REQUIREMENTS

A. Section 02222 - Excavation
B. Section 02223 - Filling
C. Section 02232 - Stone Fill
D. Section 02930 - Loaming and Seeding

1.03 DESIGN CRITERIA

A. Conduct all construction in a manner and sequence that causes the least practical disturbance of the physical environment.

B. Stabilize disturbed earth surfaces in the shortest practical time and employ any and all such temporary erosion control devices as may be necessary until such time as adequate soil stabilization has been achieved.

C. The erosion control devices shown on the Drawings and as specified herein represent the minimum required work for erosion control. The Contractor shall add to these minimum devices any and all measures to effectively prevent migration of sediment from the work area.

PART 2 PRODUCTS

2.01 BALED HAY

20" X 20" X 30" - 40 lbs/bale minimum, free from primary noxious week seeds and rough or woody materials.

2.02 SAND BAGS

Heavy cloth bags of approximately one cubic foot capacity filled with sand or gravel.

2.03 MULCH

Mulch shall consist of cured hay. When air dried in the loose state, the contents of a representative bale shall lose not more than 15 percent of the resulting air dry weight of the bale. It shall be free from primary noxious weed seeds and rough or woody materials.

2.04 EROSION CONTROL BLANKET

A. Erosion control blankets shall be Curlex II, manufactured by American Excelsior Company, DS75 manufactured by North American Green, or approved equal.

B. The Contractor shall store the blanket in a manner which protects them from damage by construction traffic and extended ultraviolet exposure.

C. Type of fasteners and their spacing shall be in accordance with the manufacturer's recommendations.

2.05 STONE FILL

As defined in Section 02232 "Stone Fill" and as required by the Plans. Stone used to contingent check claims shall be crushed stone as defined in Section 02232.

2.06 SILT FENCE

A. The silt fence shall be Propex Silt-Stop sediment control fabric or approved equal.

B. Support poles and fastenings to be used shall be as specified by the manufacturer.

C. Spacing and location of poles and fastenings shall be in accordance with the manufacturer's recommendations, or more frequently if required.

2.07 TEMPORARY SEEDING

Prior to establishment of the final vegetation on disturbed areas, placement and establishment of temporary grasses will be completed if required. Seed for temporary control shall be annual or perennial ryegrass. Hay mulch shall be applied to temporary seeded areas at a rate of 1½ to 2 tons per acre.

2.08 BOND FIBER MATRIX

A. Bonded fiber matrix shall be installed on all vegetated slopes steeper than 3:1. Acceptable manufacturers include:
   1. Mat Inc. (Soil Guard);
   2. Central Fiber Corporation (Spray Matt);
   3. Terra Novo (Earthguard Fiber Matrix); or
   4. Approved equal.

PART 3 EXECUTION

3.01 TEMPORARY EROSION CHECKS

A. Construct temporary erosion checks in ditches and other locations required to effectively control erosion.

B. The erosion control procedures shall conform to NHDOT Specifications, Division 600, Section 645 "Erosion Control".

C. Construct temporary barriers along the toe of embankments when necessary or as designated by the Engineer.

D. Construct temporary side drains in intervals as necessary or as designated by the Engineer.

E Haybale barriers and stone check dams shall be installed in drainage swales where shown on the Plans. Haybales will be staked and maintained prior to and during construction until disturbed areas have a healthy stand of grass and sediment transport has ceased. Additional haybale barriers may be required as conditions dictate, and shall be placed as necessary.

F. Silt fence shall be installed along the limits of work where shown on the Plans, and at any other locations as necessary to control erosion as conditions dictate.

3.02 BONDED FIBER MATRIX

A. Contractor shall apply a Bonded Fiber Matrix on vegetated slopes steeper than 3:1 in accordance with the manufacturers' recommendations for long-term erosion control.

3.03 INSTALLATION OF EROSION CONTROL BLANKET

A. CHANNEL INSTALLATION

1. Erosion control blankets shall be installed as directed by the Engineer in accordance with manufacturer's instructions. The extent of erosion control blankets shall be as shown on Drawings.

2. Erosion control blankets shall be installed parallel to the flow of water. The first roll shall be centered longitudinally in mid-channel and anchored with staples, as required by the manufacturer. Subsequent rolls shall follow from channel center outward and be abutted to allow installation of a common row of staples.

3. Successive lengths of erosion control blankets shall be overlapped ("shingled") sufficiently for a common row of staples with the upstream end on top. Staple the overlap across the end of each of the overlapping lengths.

4. A trench shall be located at the upstream termination. Erosion control blanket shall be stapled to the bottom of the trench. Backfill and compact the trench.

B. SLOPE INSTALLATION

1. Erosion control blankets shall be installed as directed by the Engineer in accordance with manufacturer's instructions. The extent of erosion control blankets shall be as shown on Drawings.

2. Erosion control blankets shall be oriented in vertical strips and anchored with staples, as required by the manufacturer. Adjacent strips shall be abutted to allow for installation of a common row of staples. Horizontal joints between erosion control blankets shall be overlapped sufficiently for a common row of staples ("shingled") with the uphill end on top.

3. Where exposed to overland sheet flow, a trench shall be located at the uphill termination. Erosion control blanket shall be stapled to the bottom of the trench. Backfill and compact the trench.

4. Where terminating in a channel, slope erosion control blanket shall overlap channel erosion control blanket sufficiently for a common row of staples.

3.04 EROSION CONTROL IMPLEMENTATION

A. During construction and thereafter, erosion control measures are to be implemented as shown on the Plans, and additionally as may be necessary to manage conditions as they occur. The smallest practical areas of land should be exposed at any one time during development. When the land is exposed during development, the exposure should be kept to the shortest practical period of time as approved by the Engineer.

B. Erosion rills or gullies in the Work area or in areas topographically below the work area shall be regraded and seeded at no additional cost to the Owner until an accepted vegetative stand is established.

END OF SECTION

SECTION 02273
DRAINAGE GEOCOMPOSITE

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing and installation of a high flow drainage geocomposite, consisting of an HDPE drainage net bonded on both sides to non-woven polypropylene geotextile fabrics.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance/Quality Control
C. Section 02223 - Filling
D. Section 02234 - Select Sand
E. Section 02276 - High Density Polyethylene (HDPE) Liner
F. Section 02279 - Geosynthetic Clay Liner (GCL)

1.03 QUALITY CONTROL

A. Provide the manufacturer's certification that the drainage geocomposite has been manufactured and successfully tested in accordance with the appropriate ASTM standards.

B. Drainage geocomposite shall be supplied in rolls marked or tagged with the following:
1) Name of manufacturer.
2) Product identification.
3) Lot number.
4) Roll number.
5) Roll dimensions.

1.04 SUBMITTALS

A. The Contractor shall submit manufacturer or laboratory data indicating that the proposed materials meet the specifications outlined in Part 2.02, 2.03 and 2.04 A, B and C of this section.

B. The Contractor shall submit quality control certificates issued by the manufacturer for the geonet and geotextile components of drainage geocomposite. The certificates shall include roll numbers and identification, and results of quality control tests completed at the minimum frequency specified in Part 2 of this section.

C. The Contractor shall submit representative samples form the proposed drainage geocomposite to the Engineer for interface sheer strength testing. Per Part 2.04 of this section.

D. Requirements for testing of interface shear strength between the drainage geocomposite and the textured HDPE geomembrane and the drainage geocomposite and the proposed drainage sand are included in Part 2.04 of this section.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Skaps Industries - Transnet 330
B. GSE Lining Technology, Inc. - PermaNet HL
C. Approved equivalent

2.02 NON-WOVEN POLYPROPYLENE GEOTEXTILE FILTER FABRIC

A. The filter fabric shall consist of non-woven continuous polypropylene filament fibers. It shall be tear resistant and be capable of conducting water.

B. The fabric shall retain its durability and strength when it is wet.

C. The Contractor shall provide quality control certificates from the manufacturer for the fabric used in the manufacturing of the drainage geocomposite. The filter fabric shall have the following minimum physical properties as determined by the appropriate test method. Tests shall be completed at a minimum of every 100,000 square feet and at least one per lot. A lot is defined as a group of rolls manufactured from the same production line.

Physical Property	**Test Method**	**Minimum Average Roll Value**
Fabric Weight	ASTM D5261	8.0 oz./yd^2
Water Flow Rate	ASTM D4491	100 gpm/ft^2
Grab Strength[1]	ASTM D4632	220 lbs
Grab Elongation[1]	ASTM D4632	50%
Puncture Resistance	ASTM D4533	90 lbs
Apparent Opening Size[2]	ASTM D4751	Sieve Seize #80

1. Weakest Principal Direction
2. AOS sieve # must be #80

2.03 HIGH DENSITY POLYETHYLENE (HDPE) DRAINAGE NET

A. The Contractor shall provide quality control certificates from the manufacturer for the drainage net used in the manufacturing of the drainage geocomposite. The HDPE drainage net shall have the following minimum physical properties as determined by the appropriate test method. Tests shall be completed at a minimum of every 100,000 square feet or at least one per lot. A lot is defined as a group of rolls manufactured from the same production line.

Physical Property	Test Method	Physical Properties
Polymer Density	ASTM D1505	0.94 g/cm^3 min
Polymer Melt Index	ASTM D1238	1.0 g/10 min maximum.
Carbon Black Content	ASTM D4218	2 % to 3% range
Nominal Thickness	ASTM D5199	0.270 inches average
Tensile Strength Machine Direction	ASTM D5035	75 lbs/in min

2.04 DOUBLE-SIDED DRAINAGE GEOCOMPOSITE

A. The double-sided drainage geocomposite shall be manufactured by heat bonding geotextile filter fabric to both faces of the HDPE drainage net. No burn through geotextiles shall be permitted. No glue or adhesive shall be permitted.

B. The bond between the geotextile and HDPE drainage net shall exhibit a minimum average peel strength of 1 lb. per inch and a minimum per roll of 0.5 lb. per inch (GRI-GC7). Peel strength of the manufactured geocomposite shall be tested at a minimum of every 50,000 square feet.

C. The double-sided drainage geocomposite shall have a minimum transmissivity of $1x10^{-3}$ m^2/s when tested with ASTM D4716 between screened sand and textured HDPE liner at a normal load of 10,000 psf and a gradient of 0.1 with a seat time of 100 hours in accordance with GRI-GM8. Transmissivity tests shall be completed at a minimum frequency of 1 per 50,000 square feet and at least one per lot.

D. Interface Shear Strength – Testing Completed by Engineer

1. Laboratory testing shall demonstrate that the interface shear strength is equal to or greater than a strength envelope of 26^0 between the following surfaces:

   a. The double-sided drainage geocomposite and the proposed 60-mil textured HDPE geomembrane.

2. The laboratory testing shall also demonstrate that the interface shear strength between the double-sided drainage geocomposite and the proposed select sand is equal to or greater than a strength envelope of 26°.

3. The interface shear strength shall be determined by an interface shear test performed in accordance with ASTM D5321. The normal stresses applied shall be 1, 3, 10, 25, and 50 psi, all under inundated conditions. The strain rate shall not exceed 0.04 inches per minute. The drainage geocomposite and the 60-mil textured HDPE geomembrane shall be tested in the machine direction. The tests shall be continued until residual shear strengths are achieved, or to a maximum 2-inch displacement.

   The laboratory test reports shall include plots of shear strength versus normal stress for peak and large displacement values, and stress versus strain plots for tests run at each normal load application. A minimum of two (2) tests shall be completed for each interface.

4. Test results that do not meet the minimum requirements are to be reviewed by the Engineer for possible conformance with the overall design objectives.

2.05 STORAGE

A. Materials shall be stored on-site in a manner consistent with the manufacturer's recommendations.

B. Damaged materials will not be used for installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. The installer shall handle all composite rolls in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

   The composite shall be placed as shown on the plans and with the preferential flow direction (if any) perpendicular to the topographic contours. Wherever possible, the composite shall be rolled down the slope over the "textured" HDPE in such a manner as to continually keep the composite in tension. If necessary, the composite shall be positioned by hand after being unrolled to minimize wrinkles. The composite cannot be placed in the horizontal direction (i.e., across the slope and mid-slope seams are unacceptable).

   In the presence of wind, all composite rolls in place shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

Installation of geocomposite shall be done in a manner to protect underlying geomembrane, as applicable. No cutting of geocomposite shall be allowed directly on geomembrane. Use of four or six wheel ATV's weighing less than 650 lbs may be permitted to operate directly over the geocomposite provided that they do not exceed a speed of 5 mph, and refrain from abrupt starts, stops and turns. If operation of ATV is not done in a manner to protect the geocomposite and the integrity of the geotextile, the Engineer may prohibit their use, at no additional cost to the Owner, and require that damaged areas be repaired. Any other equipment used shall provide protection of the geomembrane and geocomposite and meet low ground pressure requirements.

B. When joining two pieces along the roll length, the white or yellow geotextile filter fabric and net shall be lapped a minimum of 4 inches, and plastic ties shall secure the net at intervals no greater than every 5 feet. The spacing of the ties within anchor trenches shall not exceed 6 inches. The bottom layers of the geotextile shall be overlapped and the top layers shall be stitched along the entire length of the seam. Metallic ties are unacceptable. The composite shall not be welded to this geomembrane. Heat fusion of seams will not be allowed.

C. When joining two pieces end to end, the net shall be lapped a minimum of 12 inches, and shall be secured by plastic ties approximately every 12 inches. The geotextile shall be overlapped a minimum of 6 inches, shingled in a downslope manner consistent with the direction of flow, and sewn or heat bonded to each other. Any exposed edge of geonet shall be covered with a continuous strip of geotextile (same as geocomposite), sewn to the top geotextile and folded under the geocomposite a minimum of 6 inches.

D. Care shall be taken to keep the composite clean and free from debris prior to installation. If composite is not free of soil and debris before installation, it shall be cleaned by the Contractor just prior to installation. Geocomposite damaged during or prior to installation shall be removed and replaced at no additional cost to the Owner.

E. The Contractor shall sequence construction so that select sand or other geosynthetics can cover the geocomposite within 14 days of deployment. Areas that have been exposed for longer than 14 days shall be protected from UV degradation with an acceptable material (i.e., sacrificial geotextile, or opaque plastic).

F. The Contractor shall limit the dust accumulation on the upper geotextile after installation and prior to placement of select sand, stone or geosynthetics. Excessive dust accumulation, as determined by the Engineer, may require replacement of geocomposite materials.

3.02 REPAIR

A. Any holes or tears in the geocomposite shall be repaired by placing a patch extending a minimum of twelve (12) inches beyond the edge of hole or tear. The patch shall be secured by tying fasteners through the patch material and to the geotextile and geonet of the installed panel at a minimum spacing of 6 inches. A geotextile cap shall be heat bonded to the geotextile of the panel and patch shall extend a minimum of 6 inches beyond the patch.

3.03 PLACEMENT OF OVERLYING MATERIALS

A. The Contractor shall place all overlying sand, stone and geosynthetic materials in a manner so that the underlying material is not damaged, excessive stresses are not introduced, and wrinkles are minimized.

B. Contractor shall utilize hand placement of materials or casting of materials in advance of dozer grading of cover soils or stone to minimize wrinkles and to prevent geocomposite from folding over on itself.

END OF SECTION

SECTION 02274
WOVEN GEOTEXTILE FABRIC

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Furnishing and installation of woven geotextile fabric.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Control

1.03 QUALITY CONTROL

Provide the manufacturer's certification that the woven geotextile fabric has been manufactured and successfully tested in accordance with the appropriate ASTM standards.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Propex 200 ST
B. US Fabrics US 200
C. Approved equal by Engineer

2.02 WOVEN GEOTEXTILE FABRIC

A. Geotextile fabric shall consist of woven polypropylene monofilament yarns which are designed for geotechnical applications. It shall be treated for ultraviolet light resistance.

B. The geotextile fabric shall retain its durability and strength when it is wet.

C. Geotextile fabric shall be resistant to tears; abrasion and the forces generated by installation of specified backfill materials and shall meet the following minimum requirements:

PHYSICAL PROPERTY	TEST METHOD	PERFORMANCE REQUIREMENTS
Grab Tensile Strength	ASTM D-4632	200 lbs
Trapezoidal Tear Strength	ASTM D-4533	75 lbs
Mullen Burst Strength	ASTM D-3786	400 psi
Puncture Strength	ASTM D-4833	70 lbs

PART 3 EXECUTION

3.01 PREPARATION

A. Areas to receive woven geotextile fabric shall be graded to lines and grades shown of the Construction Drawings. Contractor shall remove protruding rocks or other materials that may damage the fabric.

3.02 INSTALLATION

A. Place fabric immediately prior to installation of backfill.

B. Install and anchor fabric to minimize wrinkles and in accordance with the manufacturer's recommendations and as specified herein. The fabric surface shall conform closely with the prepared subgrade. Fold-over wrinkles shall be eliminated prior to backfill.

C. The ends of fabric on slopes shall be keyed into the soil at least six (6) inches to hold the fabric in place.

D. The fabric shall be lapped a minimum of three (3) feet when joining two pieces together. Shingle all laps in the direction of anticipated water flow.

E. Fabric damaged during or prior to installation shall be removed and replaced at no additional cost to the Owner.

END OF SECTION

SECTION 02275
NON-WOVEN GEOTEXTILE FILTER FABRIC

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing and installation of non-woven geotextile filter fabric.

1.02 RELATED REQUIREMENTS

A. Section 02231 - Stone Fill
B. Section 02273 - Drainage Geocomposite
C. Section 02276 - High Density Polyethylene (HDPE) Liner
D. Section 02279 - Geosynthetic Clay Liner

1.03 QUALITY CONTROL

A. Provide the manufacturer's certification that the geotextile filter fabric has been manufactured and successfully tested in accordance with the appropriate ASTM standards.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Propex Geosynthetics
B. Skaps Industries
C. TNS Advanced Technologies
D. Approved Equivalent

2.02 GEOTEXTILE FILTER FABRIC

A. The filter fabric shall consist of non-woven continuous filament fibers which are formed into a sheet by heat bonding. It shall be tear resistant and be capable of conducting water. Fabric materials provided shall be 8 oz. beneath NHDOT "C" Stone and 16 oz. beneath NHDOT Rip Rap, or as indicated on the Drawings.

B. The fabric shall retain its durability and strength when it is wet, and shall be non-biodegradable.

C. The fabric shall be capable of withstanding direct exposure to sunlight for 30 days without measurable deterioration.

D. The filter fabric shall have the following minimum physical properties as determined by the appropriate test method:

Physical Property	**Test Method**	**Minimum Average Roll Value**	
		8 Oz.	16 Oz.
Fabric Weight	ASTM D5261	8 oz./S.Y.	16 oz./S.Y.
Water Flow Rate (through fabric)	ASTM D4491	100 gpm/S.F.	50 gpm/S.F.
Grab Strength (Weakest Principal direction)	ASTM D4632	200 lbs.	380 lbs.
Grab Elongation (Weakest principal direction)	ASTM D4632	50%	50%
Trapezoid Tear (Weakest principal direction)	ASTM D4533	80 lbs.	140 lbs.
CBR Puncture Resistance	ASTM D6241	500 lbs.	1000 lbs.
Mullen Burst Strength	ASTM D3786	375 psi	750 psi
Apparent Opening Size	ASTM D4751	Sieve Size #70	Sieve Size #70

PART 3 EXCECUTION

3.01 INSTALLATION

A. Fabric shall be hand placed in all locations as shown on the Plans, and where specified. The fabric shall be deployed on slopes in continuous lengths, parallel to slope direction. Mid-slope seams are not allowed.

B. When jointing two pieces, the filter fabric shall be lapped a minimum of 18 inches, shingled to shed water.

C. Filter fabric damaged during or prior to installation or during placement of overlying soil or stone shall be removed and replaced at no additional cost to the Owner.

END OF SECTION

SECTION 02276
HIGH DENSITY POLYETHYLENE (HDPE) LINER

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing of Textured 60-mil HDPE liner
B. Quality Control for liner materials
C. Field installation of the liner
D. Leak location survey

1.02 RELATED REQUIREMENTS

A. Section 01400 - Quality Assurance/Quality Control
B. Section 01720 - Project Record Drawings
C. Section 02223 - Filling
D. Section 02232 - Stone Fill
E. Section 02234 - Select Sand
F. Section 02273 - Drainage Geocomposite
G. Section 02279 - Geosynthetic Clay Liner (GCL)

1.03 APPLICABLE STANDARDS, CODES, AND REGULATIONS

A. ASTM Standards for High Density Polyethylene Geomembrane
B. Geosynthetics Research Institute – GRI-GM13 – latest revision
C. ASTM D5321 - Test Method for Direct Shear Testing of Geosynthetic Material and Soil Interfaces
D. ASTM D6747 - Standard Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembranes

1.04 QUALIFICATIONS

A. Liner Manufacturer:

The liner manufacturer shall have at least five (5) years continuous experience in the manufacture of HDPE geomembrane rolls and/or experience totaling 10,000,000 sq. ft. of manufactured HDPE geomembrane. The manufacturer shall permit the owner or his authorized representatives to visit the manufacturing plant.

B. Liner Installer:

The liner installer shall have successful experience in the installation of HDPE sheet using the dual hot wedge seaming method on projects with similar requirements to this project; and which is acceptable to, or licensed by the manufacturer of the primary materials for the installation of these materials.

Installer shall have a minimum of five (5) years experience performing this type of work.

C. Supervisor:

Installation shall be performed under the direction of a single competent English speaking installation supervisor who shall remain on-site and be in responsible charge throughout the liner installation, including subgrade acceptance, liner layout, seaming, testing and repairs, and all other related activities. The installation supervisor shall have supervised the installation of at least 3,000,000 sf of polyethylene geomembrane. Actual seaming shall be performed under the direction of a master seamer who may be the same person as the installation supervisor, and who has a minimum of 1,000,000 sf polyethylene geomembrane seaming experience using the same type of seaming apparatus as that specified in this project. The installation supervisor or master seamer must be on-site whenever seaming is being performed.

D. Quality Control:

The Contractor shall establish a Quality Control (QC) Representative who shall be responsible in the field for the quality and integrity of the HDPE liner installation. This responsibility shall include the inspection, testing, and documentation of all liner installation work as performed by the installer. The QC Representative shall have performed these duties on a minimum of 3,000,000 sf of HDPE membrane installation.

E. Laboratory:

The Engineer shall engage a qualified, independent laboratory acceptable by the Owner for use in completing the off-site tests of destructive samples specified herein.

Results of independent laboratory testing shall be transmitted directly from the lab to the Engineer and Contractor as soon as the data is available.

F. Liner Leak Location Survey:

The Contractor shall engage a qualified, independent testing company, acceptable by the Owner, to conduct a geomembrane electrical leak location survey following installation of the primary liner and placement of the geocomposite, select drainage sand, and select stone fill.

The independent testing company shall have performed these services on a minimum of 3,000,000 sf of geomembrane installation and shall have been performing such services for a minimum of 5 years.

Pre-qualified independent leak location contractors include:

1. Leak Location Services, Inc.
   16124 University Oak

San Antonio, TX 78249
(210) 408-1241

2. Hutchinson Group, Ltd.
4280 Old William Penn Highway
Murrysville, PA 15668
(724) 325-3996

G. Contractor Responsible for Subcontractors:

The roles of any subcontractor shall not relieve the Contractor of any responsibilities whatsoever under this contract. The Contractor shall be responsible for the actions and performance of the manufacturer, installer, supervisor, and QC representative under this contract. A Contractor's representative shall be on-site during all geomembrane installation activities.

1.05 SUBMITTALS

A. Prior to release of the geomembrane for shipment to the job site, the Contractor shall submit the following to the ENGINEER:

1. Written certification that the material was manufactured and tested in accordance with the requirements of GRI-GM13.

2. Quality control certificates for each batch of resin and production of geomembrane in accordance with the testing requirements of GRI-GM13.

3. Quality control certificates shall be signed by the responsible Quality Assurance (QA) personnel employed by the Manufacturer.

4. Conformance testing shall be performed in accordance with the requirements and standards specified in GRI-GM13 and as specified herein for the HDPE membrane and its installation. Certificates of compliance shall be submitted for each roll to be used on the project prior to its release for shipment to the job site. Certificates of Compliance for HDPE welding rod to be used on the project shall be submitted.

5. Shop Drawings showing the following:

a. Proposed layout of the HDPE membrane system.

b. Details of jointing the HDPE membrane, anchoring, penetrations, repair, testing, areas of slack for anticipated thermal contraction, locations of leak detection electrodes and wiring, and other construction details

6. Manufacturer's completed projects resume.

7. Installer's completed project resume.

8. Installer's crew identification list and resumes.

9. Installation schedule.

10. Manufacturer's and installer's warranty as described in Part 1.07.
11. Leak Location Contractor's completed projects resume.
12. Leak location Contractor's crew identification list and resumes.
13. The Contractor shall provide representative samples of the proposed geomembrane to the Engineer to complete direct shear box testing of the proposed 60-mil textured HDPE geomembrane and screened till to demonstrate compliance of interface friction as required in Section 02223 (Filling).
14. The Engineer shall complete direct shear box testing of the proposed 60-mil textured HDPE geomembrane and drainage geocomposites to demonstrate compliance of interface friction as required in Section 02273 (Drainage Geocomposite).

B. Roll Identification:

1. Each roll shall have a permanently affixed label with the following information:
   a. Name of manufacturer
   b. Date of manufacture
   c. Thickness of material (actual)
   d. Roll number
   e. Roll length
   f. Roll width

C. Record Drawings and QC Reports (See Parts 3 and 4)

1.06 QUALITY ASSURANCE

A. General:

Quality of the liner installation shall be the responsibility of the Contractor. The Contractor, in fulfilling this responsibility, will be assisted by his designated Manufacturer, Installer, QC representative, and Leak Location Contractor. The Contractor will be responsible for performing the Quality Assurance/Quality Control tasks outlined herein. The Engineer may conduct additional independent testing and inspections. These actions will not remove any responsibility of the Contractor under this Contract.

B. Lines of Authority:

The Contractor shall establish an Installation Supervisor and a QC Representative who will assist the Contractor in his responsibilities in the quality of the liner installation. The QC Representative shall assist in coordinating the timing and sequencing of liner installation and testing with the Engineer.

C. Leak Location Survey:

The Contractor shall coordinate an electrical leak location survey following installation of the primary liner and placement of geocomposite, and primary select sand and stone (as applicable). The Contractor shall be responsible for removing cover materials to expose located leaks and shall be responsible for coordinating and repairing leaks and geotextile, and replacing sand materials. The contractor shall also be responsible for coordinating and paying for re-testing of the repair areas.

1.07 MATERIAL AND WORKMANSHIP WARRANTY

A. Contractor shall provide a written material warranty signed by the Manufacturer and a workmanship warranty signed by the Installer, both for the repair/replacement of defective materials and workmanship characterized by leakage, abnormal aging or deterioration of materials, and other failures of the flexible membrane to perform as required. The specified warranty period is ten (10) years for materials and two (2) years for workmanship after date of final acceptance. The terms and conditions of the warranties are presented in Exhibits D and E to the Agreement.

B. The warranty shall be a direct warranty from the Manufacturer (or Installer as the case may be) to the Owner. The warranties shall be signed and presented to the Owner prior to Substantial Completion. No payment in excess of 90 percent of all payments to be due under the appropriate payment items for HDPE liner shall be made until the warranties, in their correct form hereunder, are received and approved by the Owner.

1.08 SUBGRADE CERTIFICATION

A. Prior to installation of liner materials, the Contractor shall submit a certification, signed also by the installer, that they have inspected the subgrade and accept the conditions for liner installation.

1.09 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A. As soon as practical after the Contractor mobilizes the installation crew, but before any installation activities occur, a specific pre-construction conference shall be held.

The following persons shall be present:

- Engineer Project Manager and Resident Engineer
- General Contractor and Superintendent
- Engineer Subconsultant QA Representative (if applicable)

- Geomembrane Installer Site Superintendent and Quality Control Representative
- Affected Subcontractors

B. Agenda:

1. Introductions and Explanation of Roles
2. General Overview of Specifications and Plans
3. Review Proposed Installation Schedule
4. Review of Installer/Contractor QC Procedures
5. Review of Engineers QA Procedures
6. Destructive Test Sites
7. Leak Location Survey
8. Review of Contractor Personnel - Roles and Responsibilities
9. Reports and Record Drawing Information
10. Site Cleaning

PART 2 PRODUCTS

2.01 MATERIALS

A. Properties:

1. The geomembrane shall be manufactured from new, first quality polyethylene resin of the type specified. Polyethylene geomembrane shall meet all requirements for the specified end use. Reclaimed polymer shall not be added to the resin except for regrind, reworked or trim polymer of exactly the same formulation as the geomembrane produced during the manufacturing process. "Regrind" polymer shall not exceed 10% by weight. Recycled or reclaimed sheet materials shall not be included in the manufacturing process.

B. Resin - all batches or resin shall be tested for the following characteristics:

Resin Density	ASTM D 1505/D 792	.932
Melt Index	ASTM D 1238 E	<1.0 g/10 min.

Any resin not meeting the above specification shall not be used in the manufacture of material. The Contractor shall furnish results of all such tests to the Engineer and shall certify the quality of the raw material.

C. The textured geomembrane shall demonstrate the following typical properties.

PROPERTY	TEST	VALUE	
Thickness	ASTM D5994	min avg	57 mils
		lowest for 8 of 10	54 mils
		lowest for 2 of 10	51 mils

Asperity Height	GRI-GM 12		10 mils
Tensile Strength (Yield) (lbs/in.)	ASTM D6693 Type IV		126
Tensile Strength (Break) (lbs/in.)	ASTM D6693 Type IV		90
Elongation at Yield (%)	ASTM D6693 Type IV (1.3" gauge)		12%
Elongation at Break (%)	ASTM D6693 Type IV (2.0" gauge)		100%
Tear Resistance (lbs)	ASTM D1004 Die C		42
Puncture Resistance (lbs)	ASTM D4833		90
Environmental Stress Crack Resistance	ASTM D5397 (Single point)		300 hours
Carbon Black Content	ASTM D1603		2% by weight
High Pressure Oxidative Induction Time (OIT)	ASTM D5885		400 min.
Oven Aging at 85°C High Pressure OIT	ASTM D5721 ASTM D5885	% retained after 90 days	80%
UV Resistance High Pressure OIT	GRI-GM11 ASTM D5885	% retained after 1600 hours	50%

D. The geomembrane shall be produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter, and shall not have striations, non-uniform texturing, pinholes or bubbles on the surface. Texturing shall be on both sides.

Rolls which have evidence of surface defects such as undispersed resin, incomplete texturing, creases, pinholes, non-uniform texturing or other defects, based upon the judgement of the Engineer, shall be rejected and removed from the site.

E. The Contractor shall provide quality control certificates from the manufacturer for each roll of material. These QC certificates shall match the resin lot numbers with the roll numbers for the 60-mil geomembrane.

1. Samples shall be taken evenly spaced across the entire width of the roll, if no sampling protocol is stipulated in the particular test method, and shall not include the first wrapping or outer layer of the roll (about 3 feet).
2. Quality Control testing of the manufactured geomembrane shall be performed as a minimum in accordance with GRI-GM13, and at the following frequency for the following material properties. Where the following differs from GRI-GM13, the more stringent shall apply. A QC certificate shall be provided for each roll, which documents the following testing:

TEST	PROCEDURE	FREQUENCY
Thickness	ASTM D5944	Each Roll
Specific Gravity	ASTM D1505	50,000 sf
Yield Strength	ASTM D6693-Type IV	50,000 sf
Yield Elongation	ASTM D6693-Type IV	50,000 sf

TEST	PROCEDURE	FREQUENCY
Tensile Strength (1.3" gauge)	ASTM D6693-Type IV	50,000 sf
Tensile Elongation (2.0" gauge)	ASTM D6693-Type IV	50,000 sf
Carbon Black Content	ASTM D1603	50,000 sf

HDPE extrusion welding rod or beads shall exhibit the same properties as the geomembrane.

F. Minimum width of manufactured flexible membrane sheets shall be 22 ft. The edge of the 60-mil rolls shall not have textured material (4-in min) to enable seaming of smooth, non-contaminated product.

G. Shipping and Storage

Material shall be packaged, handled, stored, transported, re-stored, re-handled, and deployed in a manner so as not to cause any damage.

1. Unloading of rolls or pallets at the site should be such that no damage to the geomembrane occurs.
2. Pushing, sliding, or dragging of rolls or pallets of geomembranes shall not be permitted.
3. Offloading at the site shall be performed with cranes or fork lifts in a workmanlike manner such that damage does not occur to any part of the geomembrane.
4. Suitable means of securing the rolls or pallets shall be used such that shifting, abrasion, or other adverse movement does not occur.

H. Storage

1. If storage of rolls or pallets of geomembranes at the site is to occur longer than 6 months, a sacrificial covering or temporary shelter should be provided to protect against precipitation, ultraviolet exposure, and accidental damage.
2. Temporary storage at the site should be in an area where standing water can not accumulate at any time.
3. Geomembranes shall be stored on-site in a manner consistent with the manufacturer's recommendations.
4. Geomembranes shall be stored to avoid deformation of rolled goods or contamination from foreign substances. Rolls shall be fully supported over their entire length. Rolls may be stacked no more than three rolls high.

    a. Appropriate handling equipment shall be used when moving rolled material, such as slings and spreader bars.

    b. Damaged rolls will not be used for installation.

I. Other materials: All welding material shall be of a type recommended and supplied by the Manufacturer and shall be delivered in the original sealed containers - each with an indelible label bearing the brand name, manufacturer's mark number and complete directions as to proper storage.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Conditions: Surfaces to be lined shall be smooth and free of vegetation, rocks, stones, sticks, roots, sharp objects or debris of any kind. Rounded corners shall be provided in all directional changes and in the anchor trench to avoid sharp bends in the membrane. No standing water or excessive moisture shall be allowed on the subgrade.

B. Acceptance: The Installer shall certify in writing that the surface to be lined is acceptable. Submittal of written acceptance may proceed incrementally according to the installation schedule. No geomembrane liner shall be placed on subgrade deemed unsuitable by the Engineer.

3.02 INSTALLATION

A. The liner shall be placed over the prepared subgrade in such a manner as to minimize handling. The sheets shall be placed to minimize field seaming. Horizontal field seams on the slopes shall not be acceptable. Only those sheets of liner material which can be seamed in one day shall be unpackaged and placed in position. Slope seams shall be minimized and run as close to the line of slope as possible particularly in corners.

Installation of the primary liner shall be sequenced and, where applicable, coordinated with the installation of the underlying geosynthetic clay liner (GCL) such that the GCL is covered by the liner at the end of each day and is kept dry. Any GCL which gets hydrated shall be removed and replaced at no cost to the owner.

B. Each panel of HDPE membrane shall be laid out and installed in accordance with the approved Shop Drawings. Any changes must be submitted to the Engineer in writing for approval prior to installation of liner.

C. Installation of the HDPE liner shall be done in the presence of the Engineer or his designated representative. Deployment shall proceed between ambient temperatures of 40°F to 104°F. Geomembrane placement shall not be done during any precipitation, or in the presence of excessive winds.

D. Bridging of the liner will not be accepted. The liner shall be installed to accommodate thermal contraction at the lowest anticipated operating temperature. Areas that exhibit bridging shall be temporarily ballasted. If the temporary ballast fails to mitigate the bridging, the panel will be cut and additional compensating geomembrane installed and tested.

E. Deployment:

1. No equipment or tools shall damage the geomembrane or subgrade by handling, traffic or other means. Subgrade ruts or ridges shall be removed prior to final positioning of the geomembrane.

2. No personnel working on the geomembrane shall smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.

3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil or underlying geomembrane.

4. Methods used to place panels shall minimize wrinkles, (especially differential wrinkles between adjacent panels or sheets).

5. Adequate loading (e.g., bagged drainage sand or similar items that will not damage the geomembrane) shall be placed to prevent uplift by wind. Continuous loading may be required along edges of panels during periods of high winds.

6. Direct contact by machinery or deployment vehicles (4 or 6-wheel cart) with the geomembrane shall be avoided, i.e., the geomembrane in traffic areas to be protected by geotextiles, extra geomembrane, or other suitable materials. Proposed protection plan shall be reviewed by Engineer.

F. Penetrations: The membrane shall be installed around pipes as shown on the Drawings. Install to provide an effective, watertight seal. Construction and installation of the pipe boot shall be performed in the presence of the Engineer or his designated representative. Testing of all pipe boots shall be required.

Liner installer shall coordinate with Contractor on space required for extrusion welding and vacuum testing around pipe/boot penetrations.

Boot fabrication and testing shall be as follows:

1. Boots shall be fabricated in the field to fit the pipe penetration.

2. The boot shall be temporarily removed, skirt attached to a temporary base sheet with the barrel of the boot welded shut, and air tested to 2-3 psi (min/max); apply soapy water to all prefabricated seams to locate any leaks.

3. If no leaks are found, remove temporary base sheet, open boot barrel, and reinstall on pipe.

4. Extrusion weld boot flap to liner, and boot barrel to HDPE pipe.

5. Place liner sleeve over boot barrel covering end of boot and weld sleeve to boot barrel and pipe.

6. Air test sleeve (2-3 min/max psi) for 5 minutes to evaluate boot barrel seal. If no pressure drop is observed, grind and extrude air test penetration and vacuum test extrusion.

7. Vacuum test extrusion seams of boot and skirt joint with liner.

All pipe boots, vents, and patches shall be of the same material as the membrane sheet. Gaskets, sealing materials, or other means used to secure the membrane shall be compatible with and have a lifespan at least equal to that of the HDPE membrane.

3.03 SEAMING METHODS

A. Approved process for seaming is fusion welding for all seams. Wherever possible, the split hot wedge seaming method shall be used to allow air pressure testing of the liner seams.

1. Extrusion welding may be allowed for repairs and around penetrations through the liner. All proposed extrusion weld locations shall be approved by the Engineer.

2. Proposed alternatives and locations must be submitted for review to the Engineer.

3. Details of the specific apparatus to be used for seaming, including seaming using approved methods, shall be submitted for approval by the Engineer prior to commencement of seaming.

B. Fusion Process: Fusion seams will be produced by self-propelled wedge welding apparatus.

1. The apparatus shall be equipped with gauges to monitor weld temperature.

2. Weld temperature and machine speed shall be varied according to ambient conditions to maintain and demonstrate a consistent acceptable weld, as described in Section 4.01.B.

3. All welding surfaces shall be kept clean and dry.

C. Extrusion Process: Extruded seams will be produced by extruding molten resin between or at the edge of two preheated overlapped sheets of geomembrane to affect a homogeneous bond.

1. The extrusion apparatus shall be equipped with gauges to monitor extrudate and operating temperatures.

2. Temperature and flow rates shall be varied according to ambient conditions to maintain and demonstrate a consistent acceptable weld, as described in Section 4.01.B.

3. The extruder shall be purged of all heat degraded or cooled extrudate prior to the commencement of each seaming sequence, and disposed of off the geomembrane surface.

4. The extrudate rod shall be certified by the Manufacturer and certification supplied as in Section 1.05, Submittals.

5. Following heat tacking, the weld area shall be prepared by grinding to a depth of less than 0.005 in in the sheet surface to be in contact with the extrudate. Extrudate shall cover all grind marks.

6. The weld area shall be kept clean and dry.

D. The installer shall maintain at least one spare operable seaming unit of each type on site at all times.

3.04 SEAMING PROCEDURES

A. To achieve the proper support and cleanliness of fusion welded seams, the installer shall use a temporary support surface or shield between the geomembrane and the subgrade.

At swales, drainage benches, anchor trenches, or other similar abrupt vertical changes, the installer shall provide temporary shoring or support systems to allow linear seaming of the geomembrane and prevent unnecessary damage. Temporary shoring or bridging shall be adequate to allow proper overlap of adjacent panels and adequate strength to support the weight of materials, equipment and personnel.

B. Seams shall be aligned so as to create a smooth and wrinkle free surface in the overlap area.

C. Extrusion Welding

1. Grinding required along a seam shall be done concurrent with or within ten minutes of the seaming operation and shall not damage the geomembrane, as in Section 3.02.

2. Installer shall determine preheat requirements and wind effects on extrusion seaming operations.

3. Artificially induced cooling of extrudate welds, by water or any other means, shall not be allowed. Care shall be taken during vacuum testing that extruded welds being vacuum tested are at ambient temperatures.

D. Cross Seams : The top and bottom excess overlap shall be removed and the top and bottom edge of the cross-seam shall be ground to a smooth transition prior to seaming.

E. No seaming shall be attempted in wet weather where the geomembrane is exposed to the elements.

F. Geomembrane deployment or seaming shall proceed between ambient temperatures of 40°F to 104°F.

G. Where possible, seam overlaps shall be shingled to shed water.

H. Where possible, low areas shall be patched, tested and inspected first to prevent interference of ponded water with testing procedures.

I. All patches shall have rounded corners, shall consist of the approved geomembrane material and shall extend beyond the edge of any defect a minimum of 4 in. in all directions.

J. All seams shall be labeled on the geomembrane with the following information:
1. Machine identification number
2. Operator, date, time
3. Direction of travel of seaming equipment

K. No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, patched, and welded.

L. Any membrane area showing injury due to scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of HDPE membrane at no cost to the Owner.

3.05 PANEL LAYOUT

A. Proposed

1. The Contractor shall submit shop drawings showing proposed placement of panels and seams, and these shall be reviewed by the Engineer, prior to commencement of installation.
2. Seams shall be numbered on an accepted plan and include dimensions.
3. Slope seams shall be run as close to the line of the slope as possible.
4. Penetrations and irregular configurations shall be detailed and submitted to the Engineer for review prior to installation.

B. Record Drawings

1. The Contractor shall provide final record layout drawings of the 60-mil liner to reflect any changes from proposed layout.
2. Record drawings shall include the identification by number and location of all panels, patches and detail work, including the location and identification of areas chosen for destructive test sampling.

   All panels, seams, repair patches, cap strips and penetrations shall be documented by field survey performed by a land surveyor licensed to practice in the project state. Locations of leak location electrodes installed beneath the primary liner and leak location test holes in the primary geomembrane shall also be documented by the surveyor on the record drawings.

   The survey shall be certified by the surveyor and submitted to the Engineer as an AutoCAD 2004, or higher version, drawing on a compact disk. The geomembrane survey information shall be submitted prior to covering the geomembrane.

   Repair locations of leaks discovered during the leak location survey of the primary geomembrane shall be documented by field survey performed by a land surveyor licensed to practice in the project state. Surveyor services are considered subsidiary to the geomembrane installation and repair and the costs of survey documentation shall be the responsibility of the Contractor.

3. Copies of the installer's field QC documentation shall be submitted to the Engineer prior to covering the geomembrane. The installer's report is required prior to acceptance of the geomembrane system. The Contractor shall not be allowed to place soil or geosynthetic materials over any

installed geomembrane until full, written field QC documentation is submitted to the Engineer.

Copies of the installer's field QC documentation shall be submitted to the Engineer prior to covering repair locations following the leak location survey of the primary geomembrane. The Contractor shall not be allowed to replace soil materials over repaired geomembrane until full, written field QC documentation is submitted to the Engineer.

PART 4 QUALITY CONTROL

4.01 QUALITY CONTROL DURING INSTALLATION

A. Site Test Equipment: The Contractor shall maintain on -site, in good working order, the following items:

1. Field Tensiometer

   a. The tensiometer shall be motor driven and have jaws capable of traveling at a measured rate of 2 in/min.
   b. The tensiometer shall be equipped with a gauge which measures the force in unit pounds exerted between the jaws.
   c. The tensiometer shall be calibrated and certified for use on this project. A copy of the calibration certificate shall be submitted to the Engineer.

2. Coupon Cutter

   A die cutter machined to cut 1"x5" liner sample coupons for field testing shall be provided and maintained in good working condition.

3. Vacuum Box

   a. The vacuum box shall consist of a rigid housing with a transparent viewing window on the top and a soft, closed-cell neoprene gasket completely attached to the bottom of the housing.
   b. The housing shall be equipped with a bleed valve.
   c. A separate vacuum source shall be connected to the vacuum box such that a negative pressure of 2 - 3 psi (5" - 6" mercury) can be created and maintained inside the box.
   d. A solution consisting of soap and water shall be dispensed on the seam immediately ahead of the vacuum box.
   e. Vacuum box testing shall not proceed when temperatures are below 32°F.

4. Air Pressure Test Equipment - This method shall apply when the split hot wedge seaming method is used.

a. Equipment shall consist of an air pump capable of generating and maintaining a positive pressure of between 20 and 30 psi.
b. A manometer capable of reading up to 30 psi attached to a needle or nipple shall be used to pressurize the air channel in the seam.

Spark Testing - This method shall be completed on welds in areas where both air pressure testing and vacuum testing are not possible.

a. Equipment shall consist of a hand held device capable of generating a high voltage.
b. Conductive aluminum tape shall be placed beneath the seam prior to welding.

6. Alternatives shall be submitted for review to the Engineer. All testing methods shall be submitted to the Engineer for review prior to commencement of testing.

B. Non-Destructive Testing

1. Test Seams

a. Test seams shall be made to verify that adequate conditions exist for field seaming to proceed.
b. Each seamer shall produce a test seam at the beginning of each shift and every four hours thereafter.
c. If a seaming operation has been suspended for more than one hour or if an equipment failure occurs for any reason, a test seam shall be produced prior to resumption of seaming operations.

2. Test seams shall be made in the field on pieces of the approved membrane. Each test seam shall be at least 4 ft. long by 1 ft. wide and with sufficient overlap in the seam for peel and sheer testing in the field tensiometer.

3. Pass/Fail Criteria: With the Engineer or his representative present, the Contractor shall cut six coupons 1" by 5" from the test seam for field testing. The coupons shall be cut in pairs from both ends and the center of the test seam. From each pair, one coupon shall be tested in the field tensiometer in peel and one in shear. 100% of samples shall pass.

a. Shear Strength: Both top and bottom of the coupon shall be tested in shear and shall register not less than 90% of the tensile strength at yield of the field parent material as determined in 4.01. B.3.d, and exhibit an acceptable location of break code as defined in 4.01 B.3.c. The shear percent elongation at break shall exceed 50% and is defined as follows:

$$E = L/L_o * 100$$

where

E = elongation %
L = extension at end of test
L_o = original average length (usually 1.0 in)

b. Peel Adhesion: Both sides of wedge welded seam coupons and one side of extrusion welded seams shall be tested in peel. Acceptable samples tested in peel shall register equal to or more than the greater of 60% of the manufacturer's specified minimum yield strength of the parent sheet or 60% of the tensile strength at yield of the parent material as determined in paragraph 4.01. B3c, and exhibit an acceptable location of break code as defined in 4.01.3.b. The peel separation (incursion) shall not exceed 25% and is defined as follows:

$$S = A/A_o * 100$$

where

S = separation %
A = average are of separation or incursion
A_o = original bonding area

c. As defined by GRI-GM13 and ASTM D6392 the following location of break codes are not acceptable and shall result in failure of the test:

Hot Wedge: AD, AD-BRK >25%
Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)

d. The parent material yield strength shall be determined as follows:

One 1" x 5" coupon will be cut from each sheet (both sides of seam) which makes up the "test seam" and "test sample." The coupons will be cut no less than 4 inches from the center line of the seam with the long dimension of the coupon perpendicular to the line of the seam. Each sample will be tested in tension to determine its yield strength. The minimum of the two yield strength value obtained will be used as the parent material yield strength.

For the laboratory testing required in paragraph 4.02.A.6, the testing laboratory will be required to record and document the two test coupon's yield strength results and the results of the five shear and ten peel test series required in paragraph 4.02.A.6.a. The test samples shall be of sufficient length to accommodate this testing.

As a result of this testing and as specified in paragraph 4.02.A.3, the CQA inspector may increase the amount of destructive testing at no additional cost to the Owner.

e. If the seam fails to pass, the welder and seaming apparatus shall not be used for field seaming until acceptable pre-weld tests are achieved.

4. Vacuum Testing

a. 100% of all vacuum testing shall be observed by the Engineer or his representative.
b. All extrusion welded and non-air channel seams of the 60-mil liner shall be evaluated using vacuum box testing. The seams of the 40-mil rub sheet shall not require non-destructive testing.
c. The solution shall be applied to the test section and the vacuum box placed over the section. The bleed valve is then closed and the vacuum valve opened.
d. Once a tight seal and a negative pressure of 2 - 3 psi has been established, the test section shall be visually examined for a period of not less than 10 seconds to determine whether bubbling of the soapy solution is occurring.
e. The vacuum box is then moved and the process is repeated on the next adjacent section. A minimum 3 inch visible overlap shall be provided between all test sections.
f. All locations where bubbling of the solution was observed shall be clearly marked for repairs with a high visibility marker and recorded by number on field test reports.
g. Any failed portion of seam shall be repaired in accordance with Section 3.03 and 3.04 and re-tested.

5. Air Pressure Testing

a. The air channel shall be sealed off at both ends.
b. If the end of a seam will be an integral part of the geomembrane, the sealing shall be done in such a way that it does not harm the geomembrane.
c. The pressure feed device shall be inserted into the air channel at one end of the seam and pressurized to 30 psi.
d. The feed valve shall be closed and the pressure sustained for a period of not less than 5 minutes. The pressure shall then be released by opening the air channel at the opposite end of the seam.
e. The drop in pressure on the manometer shall verify the continuity of the air channel. If there is no pressure drop, the seam shall be checked for air channel blockage(s). If more than three problem

areas are revealed, the seam shall be removed and a cap strip installed. The cap strip testing shall follow normal air channel test protocols.

f. If a pressure loss of greater than 2 psi is observed or if the required pressure cannot be reached then the seam shall be rejected.

g. All faulty areas along the seam shall be identified and repaired in accordance with Sections 3.03 and 3.04 and re-tested by non-destructive means.

h. Vacuum testing shall be allowed on split wedge welds only when the faulty area cannot be isolated using air pressure testing.

i. All holes created during air pressure testing shall be sealed on completion of the test and vacuum tested.

6. Spark Testing

a. Spark testing shall only be completed in areas where both air pressure testing and vacuum testing are not possible.

b. Conductive aluminum tape shall be placed beneath the seam prior to welding. Copper wire shall not be used.

c. Upon completion of weld, enable spark tester and hold approximately 1 inch above the weld and move slowly along the entire length of the weld. Spark will indicate a hole in the seam which shall be marked and repaired with an additional weld.

d. Spark testing shall not be completed if flammable gases are present in the area to be tested.

7. All liner seams shall be non-destructively tested by the Installer over their full length to verify the integrity of the seam.

a. Non-destructive testing shall be performed concurrently with field seaming.

b. Prefabricated field seams which will be inaccessible after installation, such as those under structures or fastened to penetrations, shall be tested prior to final installation.

c. All non-destructive testing shall be observed and documented by the Engineer or his representative.

8. Approved non-destructive testing procedure is as above. Alternate procedures shall be submitted for review to the Engineer prior to the commencement of non-destructive testing. Contractor shall notify the Engineer at least 48 hours prior to commencement of any field testing.

C. Destructive Testing

1. Destructive testing of field seams shall be performed at selected locations in order to verify the criteria given in Section 4.01.B.

a. All sampling and testing shall be done concurrently with field seaming so that verification of field seam properties is made as the work progresses and corrective action implemented.

2. Test samples shall be randomly selected with a minimum of one test location occurring within each 500 ft of seam. The Engineer may require a minimum of one destructive sample per day, and retains the option of increasing the number of samples in suspect areas.

   a. Sample locations shall be determined by the QC Representative and the Engineer, with consideration to the difficulty of subsequent repair and testing of the test site.
   b. The Installer shall not be informed in advance of the locations where the seam sample will be taken.

3. The Engineer may increase the amount of destructive testing if the results of previous testing indicate a failure rate of 10% or more, at no additional cost to the Owner.

   a. Additional samples may also be required when Installer or Engineer have reason to suspect the presence of excess crystallinity, contamination, faulty seaming or any other reason affecting seam quality.

4. The test sample shall measure a minimum of 12 in wide by 40 in long with seam centered lengthwise along the sample.

   a. Prior to cutting the laboratory sample, two (2) one inch wide sample strips shall be cut using an approved template from each end of the sample. Two additional sample strips will be cut to determine parent material yield strength.
   b. These strips shall be tested by the Installer in the field tensiometer. Parent, peel, and shear yield strength will be recorded in accordance with Section 4.01.B.
   c. If acceptable, the sample shall be cut into <u>three</u> 12 in lengths.

5. Samples shall be cut by the Installer, indelibly numbered and identified, and the locations recorded and submitted to the Engineer for laboratory testing.

6. The results of laboratory testing shall be faxed directly to the Engineer and Contractor not more than 48 hours after the samples have been received by the testing facility. Laboratory testing results shall determine the acceptability of a seam.

   a. Laboratory testing shall be performed in accordance with the methods given in ASTM D6693 or ASTM D6392-99 and meet the criteria given in Section 4.01.B.3. In addition to the 2 parent strength coupons, 10 test coupons shall be cut with from 5 coupons for shear and 5 coupons for peel tests. 100% of samples shall pass.

7. The area from which the destructive test sample was taken shall be repaired without delay in accordance with the procedures given in Section 3.03 and 3.04 and shall be non-destructively tested in accordance with Section 4.01.B.

D. Inspection and Acceptance

1. As the work progresses, the QC Representative shall document all locations requiring repair work and verify all repairs have been successfully made by the Installer.

2. The QC Representative shall field verify functional ability and accuracy of Installer's equipment on a daily basis.

3. A field seam shall only be considered acceptable when all destructive test locations on that seam have passed laboratory testing and acceptable non-destructive testing has been performed. The following procedures shall apply in the event that a seam fails field or laboratory testing.

   a. The Installer may reconstruct the seam between the previous passing test location and the next passing test location and retest, or

   b. The Installer may elect to trace the extent of an unacceptable seam to some intermediate location. This shall involve taking 1 inch template-cut cross-sections from the seam at a minimum distance of 10 feet in both directions from the failed test location.

      (1) These samples shall be tested in the field tensiometer in both shear and peel in accordance with Section 4.01.B.3.

      (2) If one or both of these samples fail the field test, tracing along the seam shall continue at minimum 10 feet increments until a passing result is recorded in both directions from the failed test location. If three additional tests fail on either side of the initial test site, the seam shall be rejected and either cap stripped or reconstructed. Further incremental testing shall be performed until acceptable test results are achieved. These additional tests may continue onto previous or subsequent seam work performed by the seaming technician, welding machine, or both.

   c. If more than one field seaming unit is employed, tracing of a failed weld shall only be done along seams welded by the same equipment used to weld the seam in question.

4. Reconstructed seams less than 150 ft in length shall be non-destructively tested in accordance with Section 4.01.B. Reconstructed seams greater than 150 feet in length shall be destructively tested in accordance with Section 4.01.B.3.

5. The entire geomembrane surface shall be examined continuously by the QC Representative to confirm that it is free of any defects, holes, blisters, undispersed raw materials, or contamination by foreign matter. Upon completion of the installation of each liner, and prior to covering the liner, a final review will be made by the Engineer and the QC Representative.

6. The geomembrane surface shall be cleaned by the Contractor prior to final review. The liner shall be free of dust, mud, debris or other material that would prevent examination of the surface.

7. Any defects or suspect areas shall be clearly marked by the Engineer or QC Representative. Such defects or suspect areas shall be repaired and non-destructively tested in accordance with Section 4.01.B by the Contractor.

8. As the work progresses, the Contractor's representative, Installation Supervisor and QC representative shall make continuous efforts to prevent the accumulation of waste materials on the liner surface and staging areas. Provision shall be made for containment of waste as the installation proceeds.

E. Submittal of Quality Control Documentation

1. Contractor shall provide written documentation regarding quality control results from each item specified in this section in a format(s) approved by Engineer.
2. Written documentation will be provided to Engineer on a regular basis as the installation proceeds, at a minimum once per week.
3. A separate report with all documentation will be submitted upon completion of the installation. A separate report with all documentation will be submitted upon completion of the leak location survey and leak repairs.

F. Drainage Geocomposite and Select Sand Placement

1. Prior to covering any portion of the liner system, the Contractor shall submit all QC documentation to the Engineer for review, comment and submittal as required to regulatory agencies.

2. The QC representative shall identify any wrinkles which may have been built into the geomembrane. Any wrinkle which may result in fold over of liner material upon placement of sand shall be cut, repaired and tested by the Contractor.

3. The QC Representative shall identify any slope toe, declivity, or other surface transitions which might result in bridging of the geomembrane during placement of the sand blanket. Any such area shall be cut, repaired and tested by the Installer.

4. The QC Representative shall coordinate with the installer, engineer and leak location contractor to create 0.25 in diameter test holes in the primary geomembrane to be used in calibration of leak location equipment.

5. Equipment used for placing and compacting the sand blanket shall not be driven directly on the geomembrane or composite. Such equipment shall be closely monitored during placement to ensure that no damage occurs to the geomembrane or composite.

6. A minimum thickness of 12 in of select sand cover shall be maintained between the geomembrane and drainage geocomposite and earth moving equipment. Only low ground pressure (LGP) tracked vehicles, having a maximum ground pressure of 4.7 psi shall be used at the minimum thickness.

7. For calculating equivalent ground pressure for non-LGP equipment operating on top of greater thicknesses, equivalent ground pressure shall be calculated at 12 in above the liner surface and shall meet LGP.

8. In all cases, the placement of sand blanket shall be done with caution and in a manner which is least likely to cause wrinkles in, or damage to, the geomembrane and composite. In order to eliminate wrinkles, significant methods must be employed including but not limited to use of hand labor and equipment to cast and place sand.

9. Drainage sand and topsoil materials shall be placed upslope or laterally on slopes greater than 5:1.

G. Electrical Leak Location Survey

1. Following the installation of the primary geomembrane and the placement of the geocomposite and select sand or stone (as applicable), the Contractor shall provide an electrical leak location survey of the entire primary liner. The survey will be conducted to detect leaks in the geomembrane caused during installation of the liner and cover materials.

   Electrical leak location survey services are considered subsidiary to the geomembrane installation and repair. The costs of the leak location survey, leak location documentation, repair of geomembrane leaks, replacement of cover materials, and re-survey of repaired leak locations, shall be the responsibility of the Contractor.

2. The Contractor shall coordinate with the geomembrane Installer, Engineer, and the Leak Location Contractor to position the leak location electrodes beneath the primary geomembrane. The electrodes and wiring shall be a permanent installation with wires left at the edge of the anchor trench with enough wire left to connect to in the future if necessary. Wiring shall exit from the anchor trench and be terminated in accordance with the requirements of the testing company.

3. A minimum of two (2) test holes with a diameter of 0.25 in shall be made in the geomembrane. The locations of these test holes shall be coordinated with the QC Representative, Installation Supervisor, Leak Location Contractor and Engineer.

   Test holes shall be made with a drill to remove, rather than displace, the HDPE material in the hole. All burrs from the edges and bottom side of the test holes shall be removed. Test holes shall be made in an area where the geomembrane has intimate contact with the underlying subgrade or GCL.

   Test holes shall be located at the farthest positions away from any electrode installed under the geomembrane, but at least 50 ft from the edge of the geomembrane.

   Locations of the test holes shall be included in the QC documentation and record drawing survey.

4. The Contractor shall provide electrical isolation at the perimeter of the drainage sand. Electrical isolation is achieved by leaving approximately a one-foot wide area of liner exposed around the perimeter of the landfill cell or leaving a minimum of six inches of bare liner protruding from the backfilled anchor trench.

5. Prior to conducting the leak location survey, the Contractor shall remove all standing water from the surface of the drainage sand.

6. Sufficient moisture must be available at the leak locations in the geomembrane surface for electrical leak detection to be performed accurately. Sufficient moisture shall be provided by the Contractor at least 24 hours in advance of the leak location survey by one of the following methods. Additional water shall be added if necessary during the testing to ensure successful results.
   - Rainfall of 0.1 in or greater on the bare geomembrane;
   - Uniformly wetting the earth materials covering the geomembrane with water to field capacity.

   Additional water may need to be applied shortly before and/or during the leak location survey to moisten the drainage sand materials.

7. A performance test shall be conducted at the test hole locations to verify operation and calibration of the leak location system and equipment.

   a. Leak location measurements shall be made and recorded along closely spaced parallel lines in the vicinity of the test holes. The lines shall be located in an area extending at least 20 ft before and beyond the test holes. This data is the leak signal plus noise signal (S+N).
   b. A line of data shall be taken and recorded directly over the test hole with the leak location excitation source turned off or

connected to an isolated load to measure the background noise level (BN).

The background noise level shall be defined as the difference between the maximum and minimum measured voltage with the excitation source turned off.

c. The recorded leak location data shall be examined to determine the peak-to-peak leak signal plus electrical noise signal to background electrical-noise ratio, R=(S+N)/BN , for each of the recorded data lines. The measured leak signals must have the characteristics of an electrical leak. Data points that deviate extremely from the theoretical leak signals shall not be used to determine R.

d. The farthest lateral lines of data with an R value greater than 3.0 shall be noted. The average of the lateral distance from the leak for the two lines is defined to be the leak detection distance for the 0.25 in diameter leak.

8. The leak location data shall be taken on survey lines spaced no further apart than twice the leak detection distance determined for a 0.25 in diameter leak as determined in the performance testing. The measurement electrode spacing shall be no less than that used for the performance test. The spacing between measurements shall be no more than that used for the performance test.

9. Leak location data shall be recorded, plotted, and analyzed for leak signals. The positions of the leak signals shall be located and the leaks excavated by the Contractor. The leaks shall be repaired or electrically isolated from the earth materials. Additional leak location survey data shall be collected near the located leak after the leak is repaired or electrically isolated to ensure that no additional leaks are present. The survey data shall be repeated on the two closest survey lines for a distance extending 20 ft before and beyond the leak. If another leak is detected, the process shall be repeated until no additional leaks are detected.

10. Daily results of the work shall be communicated to the Engineer. A report assembled by the Leak Location Contractor documenting the electrical leak location surveys shall be submitted within 14 days of the completion of each leak survey. The reports shall document the methodology used, the locations and descriptions of the leaks, and a diagram of the facility showing the approximate leak locations.

11. Copies of the installer's field QC documentation shall be submitted to the Engineer prior to covering repair locations following the leak location survey of the primary geomembrane. The Contractor shall not be allowed to replace soil materials over repaired geomembrane until full, written field QC documentation is submitted to the Engineer.

    Contractor shall provide written documentation regarding quality control results recorded during repair of located leaks. Documentation shall be

made according to each item specified in this section in a format(s) approved by Engineer.

12. Repair locations of leaks discovered during the leak location survey or the primary geomembrane shall be documented by field survey performed by a land surveyor licensed to practice in the project state. The survey shall be certified by the surveyor and submitted to the Engineer prior to covering the geomembrane.

PART 5 COMPLETION OF WORK

5.01 REQUIREMENTS

A. All required deployment, seaming, repairs, testing, records and site clean-up shall be completed by the Contractor.

B. Contractor shall submit a comprehensive quality control report, including all QC documentation specified in this section to the Engineer.

C. The Engineer shall be satisfied that the information provided by the Contractor indicates that the geomembrane has been installed in accordance with the above Specifications.

D. Contractor shall dispose of all trash, waste material and equipment used in connection with the work and shall leave the premises in an acceptable condition.

END OF SECTION

SECTION 02279
GEOSYNTHETIC CLAY LINER

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. This work shall consist of furnishing and installing geosynthetic clay liner beneath the primary liner as described or shown in the Contract drawings or specifications.

B. Panel Layout Plan.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Control/Quality Assurance
C. Section 02223 - Filling
D. Section 02234 - Select Sand
E. Section 02276 - High Density Polyethylene (HDPE) Liner

1.03 APPLICABLE STANDARDS, CODES AND REGULATIONS

A. American Society for Testing and Materials (ASTM):

1. ASTM D6496 - Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle Punched Geosynthetic Clay Liner.
2. ASTM D4643 - Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
3. ASTM D4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
4. ASTM D5199 - Test Method for Measuring Thickness of Geotextiles and Geomembranes.
5. ASTM D5261- Standard Test Methods for Measuring Mass per Unit Area of Geotextiles.
6. ASTM D5887 - Standard Test Method if Index Flux Through Saturated Geosynthetic Clay Liner Specimens using a Flexible Wall Permeameter.
7. ASTM D5890 - Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liner.
8. ASTM D5993 - Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liner.
9. ASTM D6768 - Standard Test Method for Tensile Strength of Geosynthetic Clay Liners.

10. ASTM D6243 - Standard Test Method for Determining Internal and Interface Shear Resistances of Geosynthetic Clay Liner by the Direct Shear Method.

1.04 QUALIFICATIONS

A. Installer:

The installer shall be trained and experienced in field handling, storing, deploying, and installing GCL. Alternatively, the Contractor shall engage an experienced Subcontractor who shall meet the experience requirements.

B. Contractor Responsible for Subcontractors - The roles of any subcontractor shall not relieve the Contractor of any responsibilities whatsoever under this contract. The Contractor shall be responsible for the actions and performance of the manufacturer and installer.

1.05 SUBMITTALS

A. Manufacturer's Certificate of Compliance shall be submitted and reviewed prior to installation.

B. The Contractor shall submit to the Engineer samples of the proposed GCL, and quality control certificates issued by the manufacturer for each roll of GCL. The certificates shall include roll number and identification. The certificates shall also include results of quality control tests completed at the minimum frequency specified, and at least one per lot, for the properties identified in Part 2.03. A lot is defined as a group of rolls manufactured from the same production line. The QC certificates shall be signed by the responsible Quality Assurance personnel employed by the manufacturer. This submittal shall be made at least 10 days prior to delivery of materials to the site.

C. The Engineer shall complete laboratory tests for Peel Strength of the on-site GCL in accordance with ASTM D6496, at a minimum frequency of one (1) test per 50,000 sf of GCL to be placed.

D. The Engineer shall also complete interface and internal shear strength testing of material proposed for use at the site in accordance with Part 2.02 B and 2.03 B.

1.06 MATERIAL HANDLING

A. Material shipping, storage, and handling shall be in accordance with the manufacturer's recommendations. The Contractor shall be responsible for the shipping, handling, storage, and care of the GCL from the time of delivery to the site until final acceptance of the completed work by the Owner and shall be liable for all damages to the materials during such time.

B. Inform Owner a minimum 72 hours before any delivery.

C. Roll Identification:

1. Provide GCL rolls wrapped in relatively impermeable and opaque protective covers and marked or tagged with the following information:
   a. Manufacturer's name.
   b. Product identification.
   c. Date of manufacture.
   c. Shipping lot - keyed to acceptable Certificate of Compliance.
   d. Roll number.
   e. Roll dimensions.
   f. Roll weight.

2. Indicate special handling marked on GCL itself, e.g., "This Side Up".

3. Conformance testing shall be conducted by the Manufacturer in accordance with Part 2.03 to indicate Conformance with the Specifications.

D. Handle GCL to ensure panels are not damaged.

E. Store GCL in a dry place under a roof or other protective cover; protect from moisture by placing on skids, pallets, or dry ground.

F. Any damaged packaging or rolls shall be cause for rejection, subsequent removal from the site, and replacement at no additional cost to the Owner.

G. The Engineer shall observe rolls upon delivery and prior to deployment at the site and report any deviations from the above requirements to the Contractor.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. BentoLiner; GSE

B. Bentomat; CETCO Lining Technologies

C. Or equal products.

2.02 GENERAL

A. Except when specifically authorized, do not furnish special run or value added products.

B. GCL:

1. Flexible, layered liner consisting of continuous layer of sodium bentonite sandwiched between two non-woven geotextile carrier layers, and reinforced with needle-punched fibers.

2. GCL shall be of type to maintain integrity during installation, placement, and covering procedures.

3. Bentonite adhesive shall be non-toxic and water soluble.

4. Refer to section 02234, Part 2.01C for GCL/Select Sand interface shear strength requirements.

2.03 GEOSYNTHETIC CLAY LINER (GCL)

A. The GCL shall have the following minimum physical properties as determined by the appropriate test method:

Material Property	Test Method	Frequency	Required Value
Non-Woven Carrier Layer			
Cap carrier sheet, non-woven polypropylene geotextile	ASTM D5261	1/200,000 ft^2	6.0 oz/yd^2
Bottom carrier sheet, non-woven polypropylene geotextile	ASTM D5261	1/200,000 ft^2	6.0 oz/yd^2
Bentonite			
Montmorillonite Content			90 Meq. min.
Bentonite Swell Index	ASTM D5890	1/100,000 lb	24 mL/2 g min.
Bentonite Fluid Loss	ASTM D5891	1/100,000 lb	18 mL max.
Bentonite Moisture Content	ASTM D4643	1/100,000 lb	12% max.
GCL			
Bentonite Mass/Area	ASTM D5993	1/40,000 ft^2	0.75 lb/ft^2
Nominal Thickness	ASTM D5199	1/40,000 ft^2	0.24 in. min.
GCL Grab Strength	ASTM D6768	1/200,000 ft^2	150 lb
GCL Grab Elongation	ASTM D6768	1/200,000 ft^2	100% Typ.
GCL Peel Strength	ASTM D6496	1/200,000 ft^2	3.5 lbs/in min.
Puncture Resistance	ASTM D4833	1/200,000 ft^2	220 lbs Typ.
GCL Hydraulic Conductivity	ASTM D 5084	1/week	5×10^{-9} cm/sec max.
GCL Index Flux	ASTM D 5887	1/week	1×10^{-8} $m^3/m^2/sec$ max.

GCL Hydrated Internal Sheer Strength	ASTM D 6243	Periodic	500 psf Typ.

B. Internal Shear Strength

1. The large displacement internal shear strength of the GCL shall be greater than a strength envelope of 26^0 when tested in accordance with ASTM D6243 at 1, 3, 10, 25, and 50 psi normal stresses. The strain rate of the test shall not exceed 0.004 inches per minute. The GCL shall be tested in the machine direction. After applying each normal load, the GCL shall be hydrated for 24 hours prior to shear testing. The tests shall be continued until residual shear strengths are achieved or to a maximum 2.4-inch displacement. The laboratory test reports shall include plots of shear strength versus normal stress for peak and large displacement values, and stress versus strain plots for tests run at each normal load application. A minimum of one (1) test shall be completed on the selected material

PART 3 EXECUTION

3.01 SUBGRADE

A. The bentonite mat shall be installed upon the geomembrane liner over a surface graded to the tolerances shown on the Contract drawings or geosynthetic materials fully installed as described in other specification sections.

B The underlying subgrade shall exhibit no ruts or other surface deformities.

3.02 ACCEPTANCE

A. The Contractor shall submit in writing the installer's certificate that the surface to be lined is acceptable. After submittal of written acceptance, the Contractor may proceed incrementally according to the installation schedule.

3.03 INSTALLATION

A. The GCL mat shall be placed over the prepared subgrade in such a manner as to minimize handling. Horizontal seams on the slopes shall not be acceptable. Only those sheets of material that can be covered in one day shall be unpackaged and placed in position. Seams shall be perpendicular to the toe of slope at all times.

B. Each panel of GCL shall be laid out and installed in accordance with the approved Shop Drawings. Any changes must be submitted to the Engineer in writing for approval prior to installation of liner.

C. Installation of the GCL shall be done in the presence of the Engineer or his designated representative.

D. Deployment:

1. No equipment or tools shall damage the mat by handling, traffic or other means.

2. No personnel working on the geomembrane shall engage in activities that could damage the mat.

3. The method used to unroll the panels shall not cause scratches or crimps in the liner and shall not damage the supporting soil or underlying liner.

4. Methods used to place panels shall minimize wrinkles, especially differential wrinkles between adjacent panels or sheets, while providing sufficient material to prevent bridging.

5. GCL must be covered by geomembrane by the end of the day.

6. Direct contact by machinery with the GCL shall be avoided. The mat shall be protected by geotextiles, extra geomembrane, or other suitable materials.

7. If the GCL panels do not include the Supergroove Technology: Overlap of adjacent panels shall be 6 in minimum at each side, 24 in at each end. Contacting surfaces shall be cleaned prior to installation of overlapping sheets. Seams shall receive additional granular bentonite at a minimum of 1/4 pound per linear foot. This strip of bentonite shall be 2 in wide (minimum), approximately 4 in from the edge. Additional fasteners or adhesives may be required to hold panels in place. These shall be reviewed by the Engineer prior to installation.

   If the GCL panels include the Supergroove Technology supplemental bentonite is not required on the longitudinal overlaps. Longitudinal seams should be overlapped a minimum of 6 inches. End-of-panel overlapped seams should be overlapped 24 inches for Bentomat. End of panel overlap seams shall receive additional granular bentonite at a minimum of ¼ pound per linear foot.

8. Installation shall be performed in a manner which protects underlying geosynthetics, and must meet the requirements for low ground pressure equipment, as applicable.

E. Penetrations: The GCL shall be installed around pipes as shown on the Drawings. Install to provide a watertight seal.

3.04 PROTECTION

A. A minimum of 12 in of soil cover shall be placed prior to operation of machinery.

B. Only low ground pressure (LGP) tracked equipment will be allowed on soil over liner covered surfaces. LGP is defined as equipment that distributes no greater than 4.7 psf.

C. Rips or tears shall be repaired with additional bentonite mat with a minimum of 12 in overlap on all edges. Additional bentonite powder shall be placed between the patch and original liner at a rate of 1/4 psf. This strip of bentonite shall be 2 in wide (minimum), approximately 4 in from the edge.

D. No GCL shall be placed in wet conditions. It is the Contractor's responsibility and sole risk to accurately assess the probability of rain or other precipitation in scheduling installation activities. Any GCL exposed to moisture prior to covering shall be removed and replaced at no additional cost to the Owner.

E. Prevent wind uplift by providing adequate temporary loading or anchoring (for example, sandbags, tires) that shall not damage GCL.

3.05 WRINKLES AND SHRINK COMPENSATION

A. All wrinkles shall be removed and patched (see 3.04.C) prior to placement of cover materials.

B. The Contractor shall allow for shrink compensation to avoid wrinkles and to assure the specified adjacent panel seam overlap.

END OF SECTION

SECTION 02541
GRAVEL ROADWAY

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Production from on site materials or procurement from off-site source and placement of crushed stone (fine and coarse) for roadways and roadbase as shown on the Plans.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance/Quality Control
C. Section 02222 - Excavation
D. Section 02223 - Filling

PART 2 PRODUCTS

2.01 GENERAL

A. Materials shall conform to NHDOT Specifications, Division 300, Section 304 "Aggregate Base Course".

B. The materials shall consist of hard durable particles or fragments of stone or gravel. Crushed stone and crushed ledge rock shall be made from rock from which the overburden has been stripped, and consist of clean, durable fragments of ledge rock of uniform quality reasonably free of elongated pieces.

C. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used.

2.02 GRADATION

A. Crushed stone (fine) and crushed stone (coarse) shall be free from injurious amounts of organic material, loam, snow, ice, frozen soil and other objectionable materials, and shall conform to the following gradations:

Item No.	304.4	304.5
Item	Crushed Stone (fine)	Crushed Stone (coarse)
Sieve Size	Percent Passing by Weight	
3 ½ in	--	100
3 in	--	85-100
2 ½ in	100	--
2 in	85-100	60-90
¾ in	45-75	40-70
#4	10-45	15-40
#200 (total sample)	0-5	0-5

2.03 QUALITY CONTROL

A. The Contractor shall provide certification that the gravel and crushed gravel used in construction of the roadway complies with the required gradations. Furnish the certification in accordance with Section 01300 "Submittals", and Section 01400 "Quality Assurance/Quality Control".

B. When materials are produced from processing of on-site boulders and rock, Contractor shall provide results of laboratory testing every 1,000 CY of materials to be installed, in order to demonstrate conformance with the requirements of Part 2.02 A.

PART 3 EXECUTION

A. Materials shall be furnished and placed in their final location with as little segregation as possible.

3.02 PLACEMENT AND COMPACTION

A. Placement and compaction of materials used in the construction of gravel roadways shall conform to NHDOT Specifications, Division 300, Section 304 "Aggregate Base Course".

B. A layer of woven geotextile (Section 02274) shall be installed over the base course (coarse crushed stone) materials, prior to installation of the fine coarse crushed stone.

END OF SECTION

SECTION 02542
BITUMINOUS PAVEMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Installation of bituminous pavement binder courses and surface courses, within the area shown on the Plans and as directed by the Engineer.

B. Backing edges of pavement with crushed gravel for shoulders.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance/Quality Control
C. Section 02541-Crushed Gravel Roadway

1.03 REQUIREMENTS OF REGULATORY AGENCIES

A. New Hampshire Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition, (NHDOT).

PART 2 PRODUCTS

2.01 MATERIALS

A. BINDER COURSE: The binder course of bituminous pavement shall be two (2) inches in thickness, NHDOT 3/4" mix, and shall conform to Division 400, Section 401 "Plant Mix Pavement - General" of NHDOT Specifications.

B. SURFACE COURSE: The surface courses of bituminous pavement shall be one (1) inch NHDOT ½"mix and shall conform to Division 400, Section 401, "Plant Mix Pavement - General" of NHDOT Specifications.

2.02 QUALITY ASSURANCE

A. MATERIALS: Use only materials furnished by a bulk bituminous concrete producer regularly engaged in the production of hot mixed, hot laid bituminous concrete.

B. EQUIPMENT: Provide, maintain and operate pavers, dump trucks, tandem, 3-wheel and pneumatic tired rollers well suited to the mixtures being placed. Provide, maintain and operate hand equipment as required. When applicable, provide, maintain and operate trimming equipment and materials.

PART 3 EXECUTION

3.01 MATCHING EXISTING PAVEMENT

A. GENERAL

1. Exercise extreme care in the removal of pavement so that the pavement will not be unnecessarily disturbed or destroyed.

2. Mechanically cut pavement shall be removed to a straight line, unless otherwise directed by the Engineer.

B. PAVEMENT REMOVAL

1. When removing pavement, strictly adhere to all the regulations controlling pavement openings.

3.02 INSTALLATION OF PAVEMENT

A. Sawcut edge of existing pavement to ensure proper matching up of new pavement and provide a smooth transition from existing pavement to new pavement.

B. The methods of construction shall be in accordance with Division 400, "Pavements", Section 403, "Hot Bituminous Pavement" of NHDOT Specifications.

C. Place the permanent pavement only when the underlying surface is dry, when the atmospheric temperature in the shade is above 40^0F, and when the weather is not foggy or rainy. However, the Engineer may permit, in case of sudden rain, the placing of the mixture then in transmit from the plant, if laid at the proper temperature and if the roadbed is free from pools of water. Such permission from the Engineer shall in no way relax the requirements for the quality of the pavement and smoothness of surface.

D. Any material delivered to the spreader having a temperature lower than 250^0F shall not be used.

E. Do not lay material upon a frozen base course or when wind conditions are such that rapid cooling will prevent satisfactory compaction.

F. If applicable, the edges of pavement shall be backed with crushed gravel for shoulders as specified in NHDOT Specifications, Division 300, Section 304 "Aggregate Base Course", to the full thickness of pavement, tapered out to the minimum distance as shown on the Plans.

END OF SECTION

SECTION 02555
TEMPORARY HDPE TARP

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing of scrim reinforced tarp
B. Quality Control for tarp
C. Field installation of the tarp

1.02 RELATED REQUIREMENTS

A. Section 01400 - Quality Assurance/Quality Control
B. Section 02220 – Selective Demolition
C. Section 02222 – Excavation
D. Section 02273 - Drainage Geocomposite
E. Section 02619 – HDPE Pipe and Fittings

1.03 QUALIFICATIONS

A. Liner Manufacturer:

The manufacturer of the temporary HDPE tarp shall have manufactured and fabricated not less than 15,000,000 square feet of temporary HDPE tarp.

A. Liner Installer:

The installer shall have demonstrated, by previous experience, the ability to do the work, and shall be approved and/or licensed by the temporary HDPE tarp material supplier. The installer shall provide the services of a competent English-speaking field superintendent throughout the installation of the liner and all appurtenant structures. Personnel performing seaming operations shall be qualified by experience. All field seams shall be inspected over their full length by the Installer Specifications.

1.04 SUBMITTALS

A. The manufacturer shall furnish complete written instructions for the storage, handling, installation, seaming, repair, and inspection of the temporary HDPE tarp material in compliance with this Specification and conforming to the conditions of his warranty. A copy of all manufacturer literature shall be submitted to the ENGINEER upon request.

B. The manufacturer or his designated representative shall furnish panel layouts as required for the temporary HDPE tarp installation.

C. Brand of temporary HDPE tarp to be used, and a statement from the supplier detailing its properties and composition.

D. Warranties regarding quality of workmanship, materials, and performance of the synthetic material.

E. Make, model, year, total weight(s), and tire pressure(s) of deployment vehicle(s) [All Terrain Vehicle(s)].

F. Panel layout drawings showing the installation layout, identifying panel identification numbers and field seams, as well as any variance or additional details which deviate from the project Drawings or Specifications. The layout shall be adequate for use as a construction plan and shall include dimensions and details as appropriate.

G. Shop Drawings, showing extent, sizes, panel identification numbers, and details of the temporary HDPE tarp, including recommendations for terminating the tarp and proposed methods of sealing around penetrations if different than shown on the Drawings, shall be submitted prior to the start of temporary HDPE tarp installation. Except for special requirements due to configuration and/or termination of the temporary HDPE tarp, maximum use of large size panels shall be made. Previous experiences at the facility should be taken into consideration when evaluating the panel placement layout with regards to deployment methods and weather concerns.

H. QC plans detailing proposed QC procedures shall be submitted prior to the start of the temporary HDPE tarp installation.

I. Samples of all materials and certificates of specifications shall be submitted to the Engineer

J. During the course of the work, the INSTALLATION CONTRACTOR shall maintain As-Built Drawings showing, but not limited to, panel layout and identification, seam type and identification, and repair locations and identifications. The INSTALLATION CONTRACTOR shall submit working copies of the As-Built Drawings to the ENGINEER upon request, and shall submit a final copy to the ENGINEER prior to moving off the site.

1.05 PRE-CONSTRUCTION MEETING

A. A pre-construction meeting is required between the Owner, Engineer, Contractor, and Installer prior to the start of any work on-site. The intent of the meeting is to discuss the requirements of these Contract Documents to ensure that all parties involved are familiar with their respective responsibilities.

PART 2- PRODUCTS

2.1 TEMPORARY HDPE TARP

A. Temporary HDPE Tarp shall be black four (4) layer reinforced polyethylene extrusion laminate film containing carbon black. The reinforcement shall be a minimum 1,000 denier scrim laid in a diagonal pattern spaced 3/8-inch apart with an additional machine direction scrim every 3 inches across the width. Individual plies shall be laminated together with molten polyethylene.

B. Temporary HDPE Tarp shall be Dura-Skrim 12BBR 12-mil thick material as manufactured by Raven Industries of Sioux Falls, South Dakota, or equivalent approved by the ENGINEER.

PART 3- EXECUTION

3.1 INSTALLATION

A. Temporary HDPE Tarp shall be installed in accordance with the manufacturers recommendations, and as shown on the Drawings and specified herein.

B. As indicated on the Contract Drawings, an anchor trench shall be excavated around the area to be lined at the edge of the tarp, except where noted on the Drawings. The trench shall be constructed according to the specifications of the Drawings. Care shall be taken when constructing the trench to avoid construction equipment from coming in direct contact with the cover material.

C. A proper ballasting system is required for the majority of cover applications. The ballast system may incorporate an anchor trench.

D. The entire subgrade surface should be inspected prior to placement of the cover panels. Observation and/or approval by the Engineer and Owner may be required.

E. Project panel layouts must be completed for reference during panel layout. The layout should specify panel configuration and seam location. The design should minimize the number of both field seams and seams oriented across (horizontal) the slope.

F. Panels are to be placed in their respective locations as specified by the layout drawings. In the event the panels are misplaced or moved, a revised layout diagram must be completed indicating the change.

G. Unacceptable conditions for panel installation include the presence of any excessive standing water, high winds, or extreme temperatures. Installation temperatures should range between 0°F and 100°F. During extremely warm

temperatures it is recommended that installation and seaming take place in early mornings or evenings to avoid unnecessary membrane damage or unacceptable seams.

H. The method, personnel, and equipment used for panel installation must not damage the cover membrane or the supporting subgrade surface. Proper repair procedures must be followed should any damage occur.

I. No individuals will be allowed on the liner surface wearing improper footwear that may damage the cover membrane in any way. This also includes smoking or any action that may result in damage.

J. Proper ballasting must be provided to protect against wind uplift. Ballasting systems shall be minimum 25 pound polyethylene sandbags placed every 10 feet on center and fastened to minimum 5/8"diameter (Tensile strength 3500 lbs min.) polypropylene rope spaced at 10 feet on center in two directions.

K. Panels should be positioned to minimize handling and to allow enough slack to compensate for shrinkage.

L. All holes and tears in the Temporary HDPE Tarp shall be noted and repaired as specified by the manufacturer and approved by the Engineer.

3.2 FIELD SEAMING REQUIREMENTS

A. The Temporary HDPE Tarp, especially the seaming area, should be kept clean, dry and free of any contaminants or debris.

B. Individual Temporary HDPE Tarp panels should be deployed per the panel layout configuration and overlapped a minimum of four (4) inches before seaming.

C. Field seaming of Temporary HDPE Tarp panels shall be in accordance with the Federal Seam Type SSN ("J" seam) and performed in accordance with the manufacturers methods and recommendations.

END OF SECTION

SECTION 02614
CULVERTS AND STORM DRAINS

PART 1 GENERAL

1.01 SUMMARY

This work shall consist of furnishing and installing, or removing and relaying, pipes, pipe end sections, and pipe sleeves at the locations shown or ordered, including the necessary joints, fittings, and connections as required. All excavation, bedding, backfill, compaction, and site restoration required to complete the pipe installation shall be included in this work.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance/Quality Control
C. Section 02222 - Excavation
D. Section 02223 - Filling
E. Section 02232 – Stone Fill

1.03 QUALITY ASSURANCE

A. All drainage pipe and fittings shall conform to the requirements of NHDOT Specifications, Division 600, Section 603 "Culverts and Storm Drains".

1.04 SUBMITTALS

A. Submit shop drawings in conformance with Sections 01300 "Submittals" and 01400 "Quality Assurance/Quality Control".

B. Submit the manufacturer's Certificate of Compliance with specified ASTM Standards.

PART 2 PRODUCTS

2.01 MATERIALS

A. Corrugated polyethylene pipe shall be ADS or equivalent and smooth polyethylene storm water pipe shall be ADS N-12 or equivalent. Equivalent products shall conform to AASHTO M 294.

B. To facilitate field jointing or corrugated metal piping, the ends of individual pipe sections shall meet the requirements of Section 7.7/1 of AASHTO M 36 and Section 18.3 of AASHTO M 191.

C. Section 9.1.3 of AASHTO M 36 and Section 19.3 of AASHTO M 196 do not apply.

D. Joining of polyethylene pipe shall be completed in accordance with the manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall provide for the temporary diversion of water in order to permit the installation of the culvert in a dry trench.

B. Where soft or other unsuitable material is encountered, all such unsuitable material shall be removed and replaced with acceptable 1 ½ inch crushed stone bedding material. Soft or unsuitable excavation and backfill replacement up to 12 inches below the proposed pipe invert grades is subsidiary work; unsuitable excavation and back fill replacement greater than 12 inches below pipe invert grades shall be paid for under alternate bid items for additional authorized excavation and filling. Where bedrock or other rock material is encountered, it shall be removed to a point 12 inches below design pipe invert grades.

C. Granular backfill or other approved material shall be used to backfill the spaces left by the excavation of material removed in accordance with 3.01 B. The material shall be uniformly compacted to 95 percent of its maximum density as determined by ASTM D-1557 Method "C".

D. The width of trenches shall be held to a minimum consistent with the space required to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Trenching below the top of the pipe shall be kept to a minimum of three times the diameter of the pipe. The width of the trench above the pipe may be at the Contractor's option.

E. The pipe shall be placed at the designated location on a prepared foundation so that the flow line of the pipe will conform to the required grade.

F. Where the top of the pipe would lie above the natural ground, sufficient compacted fill shall be constructed at pipe locations to ensure that the pipe is placed in a trench equal in depth to at least the height of the pipe. The fill shall be constructed on each side of the pipe for a distance equal to at least 5 times the diameter of the pipe.

3.02 BEDDING

A. Bedding for pipes less than 48 inches in diameter or span shall consist of preparing and shaping the bottom of the trench and installing a minimum of 6 inches of crushed stone bedding (Section 02232) beneath the pipe and up to the spring line of the pipe as indicated on the Drawings with reasonable closeness and with uniform density and stability. Recesses shall be excavated for the bells of pipe.

B. Bedding for all pipes 48 inches or more in diameter or span shall consist of bedding the pipe on a carefully prepared bed of 6 inches of 1 ½ inch crushed stone (Section 02232) material, shaped by means of a template to fit the lower part of the pipe exterior. Bedding shall be installed up to the spring line of the pipe as indicated on the Drawings.

3.03 LAYING AND JOINING PIPE

A. Proper facilities shall be provided for lowering the sections of pipe into the trench. Each section shall be securely attached to the adjoining section by the approved method for the type of joint used.

B. Sections of corrugated and smooth polyethylene pipe shall be joined with hinged split couplings.

C. Joints between dissimilar pipes shall be made in accordance with the recommendations of the pipe manufacturer.

3.04 END SECTIONS

A. End sections shall be installed in accordance with the recommendations of the manufacturer or as directed.

B. Necessary excavation shall be made to the required depth and contour for the section. Where ledge is encountered, the trench shall be excavated 12 inches below the bottom of the end section and the area refilled to grade with suitable material, thoroughly tamped, and carefully shaped.

C. Connections between concrete end sections and pipe culverts shall be by standard tongue and groove joints or as ordered.

3.05 BACKFILLING

A. Select sand shall be backfilled from the top of the bedding material to 12 inches above the top of the pipe.

B. Backfill from the top of select sand to proposed subgrade of roadways or other fill shall be completed with common borrow or excavated materials, with all rocks, lumps or clods larger than 3 inches removed.

C. All backfill material shall be compacted at near optimum moisture content, in layers layers not exceeding 6 inches in compacted thickness, by pneumatic tampers, vibratory compactors, or other approved means. Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to ensure that the compacted backfill material is in direct contact with the sides of the pipe. Fill at the sides of the pipe may be compacted by rolling or operating heavy equipment parallel with the culvert, provided care is taken to avoid displacement or damage of the pipe. Material in the vicinity of pipes shall be compacted to not less than 95 percent of ASTM D1557, Method C.

D. The Contractor shall place an adequate protecting cover of earth or other approved material over the structure before allowing equipment or traffic to pass over it.

3.06 MANHOLE CONNECTIONS

A. Pipes shall be grouted into manhole wall using non-shrink grout.

3.07 WORKMANSHIP

A. Any pipe which is not true to alignment and grade or which shows any undue settlement after laying or is damaged, shall be removed and relayed or replaced without extra compensation.

END OF SECTION

SECTION 02617
POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

PART 1- GENERAL

1.1 SCOPE OF WORK

A. Supply polyvinyl chloride (PVC) Schedule 40 and 80 pipe and fittings as shown on the Drawings.

1.2 SUBMITTALS

A. CONTRACTOR shall submit manufacturer's technical product data and installation instructions for PVC pipe and fittings to ENGINEER in accordance with Specification Section 01330.

PART 2- PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe and fittings shall be manufactured from a PVC compound which meets the requirements of Cell Classification 12454-B polyvinyl chloride as outlined in ASTM D 1784. Pipe and fittings materials shall be specially formulated with sufficient UV inhibitors to provide for longer term outdoor exposure with no deleterious effects.

B. PVC piping used in the construction of LFG collection and control systems shall meet the requirements of ASTM D 1784 and ASTM D 1785 for Schedule 80 PVC pipe.

C. PVC fittings used in the construction of LFG collection and control systems shall meet the requirements of ASTM D 2464 and ASTM D 2467.

D. All PVC cements shall meet the requirements of ASTM D 2564 for solvent cemented PVC joints.

E. clean rework or recycle material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this Section.

F. Fittings shall be industrial, heavy duty, hub style.

G. Socket fittings shall be pressure rated the same as the corresponding size pipe prescribed by ASTM D 1785. Threaded fittings shall be pressure rated to at least 50 percent of the rating for socket fittings.

2.2 FLANGES

A. Flanges shall be one piece solid design or two-part Van Stone type that use the tapered, serrated face and full face gasket technique for joining, and are compatible with ANSI B16.5 Class 150 metal flanges.

B. Flanges shall be pressure rated at 150 psi for water service at 73°F, non-shock and have a minimum burst requirement of 3.3 times the rated pressure.

C. Bolts shall be zinc-plated ASTM Al93, Grade B8M hex head and nuts shall be zinc-plated ASTM A194, Grade 8m hex head.

D. Gaskets shall be ¼-inch thick, full-face viton with a Shore A durometer rating between 60 and 80.

PART 3- EXECUTION

3.1 PVC PIPE HANDLING

A. PVC pipe and pipe fittings shall be handled carefully in loading and unloading. They shall be lifted by hoists and lowered on skidways in such a manner as to avoid shock. Derricks, ropes, or other suitable equipment shall be used for lowering the pipe into well borings. Pipe and pipe fittings shall not be dropped or dumped.

3.2 PVC PIPE INSTALLATION

A. PVC pipe installation shall conform to the requirements of this Section, the manufacturer's recommendations, and as outlined in ASTM D 2774V.

3.3 JOINING OF PVC PIPES

A. Pipes shall be joined in accordance with ASTM D 2855.

B. All pipe shall be inspected for cuts, scratches, or other damages prior to installation. Pipe with imperfections shall not be used.

C. All buns, chips, etc., shall be removed from pipe interior and exterior.

D. All loose dirt and moisture shall be wiped from the interior and exterior of the pipe end and the interior of the fitting.

E. All pipe cuts shall be square and perpendicular to the center line of pipe.

F. Pipe ends shall be beveled prior to applying primer and solvent cement so that the cement does not get wiped off during insertion into the fitting socket.

G. A coating of CPS primer, as recommended by pipe supplier, shall be applied to the entire interior surface of the fitting socket, and to an equivalent area on the exterior of the pipe prior to applying solvent cement.

H. The solvent cement shall comply with the requirements of ASTM D *2564* and shall be applied in strict accordance with manufacturer's specifications.

I. Pipe shall not be primed or solvent welded when it is raining, or when atmospheric temperature is below 40°F, or above 90°F when under direct exposure to the sun.

J. After solvent welding, the pipe shall remain undisturbed until cement has reached initial set. As a guideline for joint setting time, use 1 hour for ambient temperatures between 60 and 100°F, or 2 hours when ambient temperature is between 40 and 60°F.

K. Pipe and pipe fittings shall be selected so that there will be as small a deviation as possible at the joints, and so that inverts present a smooth surface. Pipe and fittings that do not fit together to form a tight fitting joint shall be rejected.

3.4. PIPE TESTING

A. Before any section of a PVC pipe system is put into service, it shall be carefully tested to assure that it is gas tight. Prior to testing, the system shall be blown out, cleaned and cleared of all foreign material. Each joint shall be tested by means of soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed or concealed. All testing of pipe systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Solvent-cemented pipe shall be allowed to cure for the minimum time recommended by the solvent-cement manufacturer, but not less than 4 days (96 hours), prior to initiating pressure tests.

B. Pressure Tests: Before the equipment is connected, piping systems shall be tested in accordance with the requirements in Section 02619.

END OF SECTION

SECTION 02619
HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Quality assurance of pipe and fittings.
B. Delivery and storage of piping.
C. Installation of the piping.
D. Testing of installed piping.

1.02 RELATED REQUIREMENTS

A. Section 01400 - Quality Assurance/Quality Control
B. Section 02222 - Excavation
C. Section 02223 - Filling
D. Section 02276 - High Density Polyethylene (HDPE) Liner

1.03 SERVICE AND TYPE REQUIREMENTS

Except as otherwise specified or authorized, high density polyethylene pipe and fittings shall be of the type, grade, schedule, or pressure rating indicated on the Plans and as approved by the Engineer for its service function.

1.04 QUALITY ASSURANCE

A. Provide all required manufacturer's certifications and test results in accordance with Section 01400 prior to delivery of the pipe on site.

B. Provide all test results of the HDPE piping system prior to substantial completion of the Project.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Performance Pipe
B. ISCO pipe
C. Approved equal

2.02 MATERIALS

A. PIPE:

1. ASTM D1248 Type III, Class C of the standard dimensional ratio (SDR) indicated on the Plans. All leachate and landfill gas piping shall be of IPS pipe size.

2. Piping shall be manufactured in accordance with ASTM F 714. Provide manufacturer's certification that the piping has been tested in accordance with ASTM D2837.

3. The HDPE pipe shall have the following minimum physical properties as determined by the appropriate test method.

Physical Property	Test Method	Required
Density	ASTM D1505	0.955 g/cm^3
Tensile Yield Strength	ASTM D638	3200
Tensile Modulus of Elast.	ASTM D638	130,000 psi
Flexural Modulus	ASTM D790	135,000 psi
Melt Index	ASTM D1238	0.10 gm/10 min

B. FITTINGS:

1. Butt fusion molded and fabricated fittings shall be pressure rated to match the system piping to which they are fused, and manufactured in accordance with ASTM D 3261.

2. Provide factory fabricated dual containment fittings from the same manufacturer as the pipe materials.

3. Fittings shall have the same or higher pressure rating as the pipe.

4. The Drawings may not show all the fittings required and the Contractor shall provide all fittings required to complete the work.

C. GASKETS AND HARDWARE

1. All gaskets shall be Viton. Joint hardware shall be 304 stainless steel.

D. SUPPORT SPACERS FOR DUAL CONTAINMENT PIPE

1. Support spacers shall be manufactured from non-metallic, corrosion resistant material.
2. Supports shall have broad, smooth bearing surfaces.
3. Support spacers shall be manufactured to maintain the specified annulus between the carrier and containment pipes.

4. Supports shall allow unrestricted passage of monitoring or alarm system cables, possible flow of liquid from the carrier, and leak testing.

PART 3 EXECUTION

3.01 PIPING DELIVERY AND STORAGE

A. Piping delivered on site shall be clean, new, and bear the manufacturer's identification and SDR designation. Piping shall be unloaded and stored on site on pallets in accordance with the manufacturer's recommendations.

B. Piping damaged en route to the site or during the unloading will be rejected and shall be removed from the site and replaced with new piping meeting specification.

3.02 INSTALLATION OF PIPING

A. GENERAL:

1. Lay out piping as shown on the Plans. Any deviation from the layout shown must be approved by the Engineer.

2. Piping shall be cut from measurements taken at the site and not from the Plans. All necessary provisions shall be taken in laying out piping to provide for expansion and contraction.

3. Contractor shall provide the Owner with two additional stainless steel wrap around repair couplings and two additional HDPE end caps per leachate collection piping changeover for future use.

B. INSPECTION OF PIPING:

1. Carefully inspect all pipe and fittings before installation, removing all dirt. The pipe should be installed with the markings up for visual inspection and verification.

2. All pipe shall have smooth exterior and interior surfaces, be first quality, be free from cracks, blisters, and other imperfections, and be true to shape or form throughout each length. Piping judged by the Engineer to be unacceptable shall be removed from the site and new undamaged pipe shall be provided at no extra cost to the Owner.

3. The interior of the pipeline shall be kept free from all dirt, joint material, and other foreign materials as the work progresses. Tight fitting stoppers or bulkheads shall be securely placed at the ends and any other openings

of the pipe when work is stopped temporarily, or at the end of the days work to prevent dirt or trash from entering the pipe.

C. PIPE JOINTING:

1. Pipe joints and fittings shall be butt fused at 440 or 500°F and shall be socket or sidewall fused at 500°F. Fusing shall be performed using manufacturer approved equipment and shall be in accordance with the manufacturer's recommendations. When shown on the Plans, piping shall be joined using the stainless steel repair clamps equivalent Dresser Style 364 with Viton.

2. Flanged connections shall be completed with fabricated flange adapters and, convoluted stainless steel back-up rings on installations below ground, and epoxy coated carbon steel backup rings shall be used above grade. Use Viton full face gaskets only. All fasteners shall be Type 18-8 or Type 304 stainless steel below grade, and zinc plated steel above grade. Hot dipped galvanized fasteners are not permitted.

3. Protect below grade bolts and flanges by covering with 6-mil thick polyethylene wrap. Duct tape wrap to HDPE pipe.

4. Electrofusion couplings, where used, shall be installed per manufacturer's recommendations. The outside diameter of the HDPE pipe and face shall be prepared in accordance with the manufacturers recommendations prior to installing the coupler.

D. CARRIER PIPE/FITTING SUPPORT SPACERS PLACEMENT

1. Support spacers shall be secured at a minimum of 4-foot intervals to align pipe for fusion welding adjacent to fittings and bends.
2. Support spacers shall not restrict longitudinal movement between the carrier and containment pipe.
3. If dual walled pipe is not manufactured with internal spacers, Contractor shall install a least three spacers on either side of all simultaneous butt fusion joints to maintain correct alignment of the carrier pipe within the containment pipe.

E. PIPE PENETRATIONS:

Penetrations of the HDPE piping through the HDPE liner membrane shall be sealed between the exterior surface of the piping and the edge of the liner penetration as shown on the Plans. The method of sealing shall be an approved procedure by both manufacturers of the HDPE piping and HDPE liner. The seals at all penetrations shall be inspected and approved by the Engineer prior to backfilling with Select Sand.

3.03 PIPE EMBEDMENT AND BACKFILL

A. The HDPE pipe and fittings shall be installed in full compliance with the manufacturer's recommendations.

B. The pipe shall be embedded with bedding, haunching, and initial backfill materials that provide stable and permanent support to the pipe. These materials shall be as shown on the Plans.

C. Care should be taken to ensure that the haunching of the pipe is performed without disturbing the pipe. Initial backfill shall be placed in 6-inch layers and hand tamped to assure compaction.

D. Leachate force main piping shall be insulated with waterproof, closed-cell foam insulation when the top of the pipe is less than 5-feet below ground surface or within 5-feet of a stormwater drainage pipe.

3.04 TESTING OF GRAVITY, SOLID WALL PIPELINES

Testing of a section of pipe shall be performed using the below stated equipment according to stated procedures and under the observation of the inspecting Engineer.

A. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.

B. Pneumatic plugs shall be braced or blocked when installed in the test section.

C. All air used shall pass through a single control panel.

D. Three (3) individual hoses shall be used for the following connections:

1. From control panel to pneumatic plugs for inflation.

2. From control panel to sealed line for introducing the low pressure air.

3. From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

Procedures: All pneumatic plugs shall be seal tested before being used in the actual test installation. One (1) length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The sealed pipe shall be pressurized to 5 psig. The plugs shall hold against the pressure without bracing and without movement of the plugs out of the pipe.

After a reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psig. Low pressure air shall be introduced until internal pipe pressure reaches 4 psig greater than the average back pressure of any ground water that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize.
After the stabilization period (3.5 psig minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of the line being tested shall be termed "acceptable" if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any ground water that may be over the pipe) shall not be less than the time shown for the given diameters in the following table:

Pipe Diameter In Inches	Minutes
4	2.0
6	3.0
8	4.0
10	5.0
12	6.0
15	7.5
18	9.0
21	10.5
24	12.0
30	14.0
36	17.0

For purposes of determining test pressure in areas where ground water is known to exist, the Contractor shall install sumps or monitoring wells adjacent to the pipeline to be tested.

A measurement from the top of ground water to top of pipe in the test section in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings. (For example, if the height of water is 11½ feet, then the added pressure will be 5 psig, and the 2.5 psig will then be 7.5 psig. The allowable drop of one pound and the timing remain the same.)

If installation fails to meet the above requirements for the air test, the Contractor shall correct the pipeline until an acceptable test is achieved.

The Contractor shall provide as required the proper plugs, bracing, and other equipment required to perform all tests. Testing of each section of HDPE installed shall include the portions of service connections that are to be installed under the Contract.

Where ground water is confirmed to be high, the Engineer, at his option, may elect to accept infiltration measurements in lieu of air testing.

These tests shall be conducted at all times in the presence of the Engineer. Should a pipe section which has previously been tested indicate any water infiltration, or otherwise

appear suspect to the Engineer, the Contractor shall conduct confirmation air tests on the line at no additional cost.

3.05 PRESSURE TESTING OF FORCE MAINS

Testing of the polyethylene force mains shall be performed using the below stated procedures under the observation of the inspecting Engineer:

A. Water will be used to hydrostatically pressure test the force main.

B. All free air must be removed from the line.

C. The pressure in the section shall be measured as close as possible to the lowest point of the test section.

D. Prior to testing, the pipe shall be covered at intervals and curves to hold the pipe in place. Flanged connections shall be left exposed for visual leak inspection.

Procedure:
Pressure in the line shall be raised at a steady rate to 1.5 times the rated operating pressure of the pipe or the lowest rated component of the system. The initial pressure test shall be applied and allowed to stand without make up pressure for 2-3 hours to allow for diametric expansion or pipe stretching to stabilize.

After the equilibration period, the test section can be returned to the 1.5 times operating pressure and the final test pressure held for 3 hours. If there are no visual leaks or significant pressure loss during the final test period, the section of force remains passes the test.

Pressure drop will not only occur due to pressure expansion but also due to temperature fluctuations. As temperatures increase, gauge pressure will decrease. Make up water for expansion during the test which exceeds 0.25 gallons/100 feet of pipe is not acceptable.

END OF SECTION

SECTION 02751
PRECAST VALVE VAULTS AND CHAMBERS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Furnishing and installation of valve chambers and leak detection and air release chambers. Commercially available precast concrete products shall be utilized.

1.02 RELATED REQUIREMENTS

A. Section 02222 - Excavation
B. Section 02223 - Filling
C. Section 02850 - Testing Precast Vaults and Manholes

1.03 QUALITY ASSURANCE

A. PRECAST CONCRETE PRODUCTS

1. Minimum strength of 5,000 psi at 28 days. The cover is to be designed for AASHTO HS20-44 loading.

2. Steel Reinforcement:

   a. Conform to ASTM A -615, Grade 60.
   b. 1" minimum cover.

3. Acceptable Manufacturers:

   a. Superior Concrete
   b. American Precast Corp.
   c. Approved equal

1.04 SUBMITTAL TO THE ENGINEER

A. Submit shop drawings and manufacturer's literature in conformance with Section 01300 "Submittals".

B. Base, Risers and Tops:

1. Submit concrete strength certificate of compliance prior to delivery of the tank components to the site.

PART 2 PRODUCTS

2.01 GENERAL

A. PRECAST CONCRETE VAULTS AND CHAMBERS

1. Commercially available precast concrete structures designed for H20 wheel loading shall be used. Dimensions shall be as shown on the drawing or as directed by the Engineer.

B. JOINTS

1. Asphaltic Butyl Rubber Sealant shall be used at each joint to assure watertightness.
2. Seal wrap shall be applied on the outside of all joints as indicated on the drawings.

C. OPENINGS

1. All concrete wall penetrations shall be Link-seal or equal.

2. Each valve chamber shall have a frame and cover as shown on the Drawings.

D. SEALANTS

1. Apply sealant to the floors and walls of all vaults and chambers as indicated on the Drawings and in accordance with Section 09900 Coatings.

PART 3 EXECUTION

3.01 PERFORMANCE

A. PRECAST MANHOLES AND CHAMBERS

1. Perform jointing in strict accordance with the manufacturer's recommendations.

2. Install structures level and plumb to the elevations and in the locations shown on the Plans.

3. Do not permit water to enter the structures.

4. Make sure all joints are watertight.

5. Solidly fill joints around tanks with non-shrink grout.

6. When necessary, cut openings carefully to prevent damage. Replace damaged sections at no additional cost to the Owner.

B. ADJUST TO GRADE

1. Adjust the hatch covers to grades as shown on the Plans.

C. PIPE CONNECTIONS

1. Connect piping to structures with joint design and materials approved by the Engineer.

D. FRAMES AND COVERS

1. Install frames and covers as indicated on the Drawings.

3.02 TESTING

A. GENERAL

1. Perform exfiltration tests on the concrete manholes and chambers in accordance with Section 02850.

2. All testing must be performed in the presence of the Engineer.

3. Suitably plug all pipes entering the tank and brace plugs to prevent blow out.

B. VAULT/CHAMBER REPAIRS

1. Correct leakage by reconstruction, replacement of gaskets and/or other methods as approved by the Engineer.

2. The use of lead-wood and/or expanding mortar will not be permitted.

END OF SECTION

SECTION 02930
LOAMING AND SEEDING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Produce loam from on-site materials or procure from off-site source, test, amend, and place loam, seed, lime, fertilizer, and mulch on all areas disturbed during construction, where shown on the Plans, and as directed by the Engineer.

1.02 RELATED REQUIREMENTS

A. Section 02223 - Filling
B. Section 02270 - Erosion Control

1.03 SUBMITTALS

A. The Contractor shall furnish all materials to be used in performing the work under this Contract. Prior to use, the Contractor shall be required to furnish the following information to the Engineer.

1. Copies of delivery tickets showing the net weight of materials delivered to the job site.

2. Certification from the suppliers of ground limestone showing:

a. Magnesium oxide content
b. Total calcium oxide neutralizing equivalent, and
c. Gradation of the ground limestone

3. Certification that the fertilizer meets the requirements of NHDOT Specifications, Division 600, Section 643 "Fertilizer for Grasses".

4. The bag tag for each variety of mix and bag of seed showing test results and the date of test.

1.04 CERTIFICATE OF PROVISIONAL ACCEPTANCE

A. The Owners Representative will inspect all work upon the written request of the Contractor received at least ten days before the anticipated date of inspection.

B. Seeded areas shall be reviewed for acceptance only after all areas have a close stand of grass with no bare spots greater than two inches in diameter, at least 90%

of the grass established shall be permanent grass species and the lawns have been maintained for a minimum of ninety (90) days prior to inspection.

C. Furnish full and complete written instructions for maintenance of all lawns to the Owner at the time of provisional acceptance.

E. Owner's Representatives inspection shall determine if the seeded areas are acceptable and whether maintenance shall continue in any part.

F. After all necessary corrective work and clean-up has been completed, and maintenance instructions have been received by the Owner, the Owner's Representative will certify in writing the acceptance of the seeded areas. The Contractor's responsibility for maintenance of seeded areas shall cease on receipt of the Certificate of Provisional Acceptance.

1.05 EXAMINATION OF CONDITIONS

A. All areas to be seeded shall be inspected by the Contractor before starting work and any defects, such as incorrect grading, drainage problems, etc., shall be reported to the Owner's Representative prior to beginning this work. The commencement of work by the Contractor shall indicate his acceptance of the areas to be seeded, and he shall assume full responsibility for the work of this Section.

PART 2 PRODUCTS

2.01 TOPSOIL

A. Existing stockpiled topsoil materials at the site shall be processed to meet the requirements of NHDOT Specifications Division 600, Section 641 "Loam"

B. The topsoil shall be screened to remove all particles greater than one (1) inch in any diameter, and be reasonably free from subsoil, clay lumps, stones, brush, objectionable stumps, roots, litter, toxic substances, and other material or substances which may be harmful to plant growth or be a hindrance to grading, planting and maintenance operations.

C. A sample of the processed topsoil materials shall be provide to the Engineer for laboratory testing, to determine recommended fertilizer application rates and whether any additives are required. Contractor shall treat the topsoil to meet the specifications.

E. Topsoil shall be applied to areas disturbed during construction, where shown on the Plans, and as directed by the Engineer to a depth of four (4) inches after spreading and rolling.

2.02 LIME

A. Lime shall conform to NHDOT Specifications Division 600, Section 642 "Limestone".

2.03 FERTILIZER

A. Fertilizer to be used must be the equivalent of a standard 15-15-15 mixture and shall be approved by the Engineer. Fertilizer shall be a standard commercial grade fertilizer conforming to all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists. The analysis shall represent respective percentages of nitrogen, phosphoric acid, and potash.

2.04 SEED

A. All seed shall be certified as to mixture, germination, and purity, and as being in conformity with the NHDOT Specifications, Division 600, Section 644 "Grass Seed".

B. The Contractor shall use approved slope erosion resistant seed mix for erosion control of sloped areas and use grass mix for level areas.

2.05 MULCH

A. Only hay or straw shall be used. The materials shall not be musty, moldy, caked, or of otherwise low quality. If the seed is applied hydraulically, a suitable wood fiber mulch may be used in place of hay or straw.

B. Mulch application shall be at a minimum rate of 1½ to 2 tons hay/acre.

C. Bonded Fiber Matrix, as described in Section 02270, shall be applied on seeded areas with slopes steeper than 3:1.

PART 3 EXECUTION

3.01 SEEDING PERIODS

A. Unless otherwise authorized, the Contractor shall do all seeding during the following periods:

1. April 1 and July 1
2. August 15 and October 15
3. If seeding is done beyond October 15, the Contractor shall apply mulch at a rate of 2 to 2½ tons per acre, but no more than 3 tons/acre.

Seeding shall not be done during windy weather or when the ground is frozen, excessively wet, or otherwise untillable.

3.02 SEED BED PREPARATION

A. Seed will be applied to a well-conditioned smooth firm seedbed, prepared to a depth of three (3) inches. Clods or other obstructions generally larger than two (2) inches in diameter of thickness that will prevent uniform seeding shall be removed or reduced in size.

B. Hard or caked seed bed shall be reconditioned before the seed is applied.

C. Care must be taken by the Contractor to see that ruts or ridges are not created on the graded areas.

3.03 LIMING, FERTILIZING, AND SEEDING

A. Lime, fertilizer and seed may be applied by any of the methods described in NHDOT Specifications, Division 600, Section 644 "Grass Seed". The rates of application shall conform NHDOT Specifications, Division 600, Section 642, 643, and 644 "Limestone", "Fertilizer for Grasses", and "Grass Seed".

B. Lime and fertilizer shall be applied based upon nutrient availability of the soil and worked into the soil at the time of seed bed preparation.

3.04 MULCHING

A. MULCH:

Immediately after the area has been seeded, it shall be uniformly covered by a mulch of hay or straw at the rate of 1½ to 2 tons per acre.

3.05 MAINTENANCE AND PROTECTION

A. Maintenance shall begin immediately after any area is seeded and shall continue for ninety (90) days or until final written acceptance by the Owner's Representative, whichever is longer.

B. Maintenance shall include reseeding, mowing, watering, weeding, liming and fertilizing.

C. Watering of Seeded Areas:

1. First Week: The Contractor shall provide all labor and arrange for all watering necessary to establish an acceptable lawn. In the absence of an adequate rainfall, watering shall be performed daily or as often as

necessary during the first week and in sufficient quantities to maintain moist soil to a depth of at least two inches.

2. Second and Subsequent Weeks: The Contractor shall water the lawn as required to maintain adequate moisture, in the upper two inches of soil, necessary for the promotion of deep root growth.
3. Watering shall be done in a manner which will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment. The Contractor shall furnish sufficient watering equipment to apply one complete coverage to the seeded areas in an eight (8) hour period.

D. Protection:

1. Seeded and sodded areas shall be protected by a three foot high barrier constructed of two-by-four stakes or iron pipes set eighteen inches in the ground at ten foot intervals and connected by No. 10 wire. Flags of white cloth shall be secured to the wire at center points between stakes.
2. Barriers must be raised immediately after seeding or sodding and shall be maintained until acceptance.

E. Reseeding: After the grass in seeded areas has appeared, all areas and parts of areas which, in the opinion of the Owner's Representative, fail to show a uniform stand of grass, for any reason whatsoever, shall be reseeded and such areas and parts of areas shall be seeded repeatedly until all areas are covered with a satisfactory growth of grass. Reseeding together with necessary grading, fertilizing, and trimming shall be done at the expense of the Contractor.

F. Mowing:

1. Seeded Areas: The Contractor shall keep seeded areas mowed until written acceptance of the seeding by the Owner's Representative by cutting to a height of two inches (2") when growth reaches three inches (3") or as directed by the Owner's Representative .
2. Mowing shall include removal of clippings.

G. Fertilizing: A second application of fertilizer, as specified herein, shall be applied after one (1) season of growth of a minimum of two (2) months duration, but only during the months of April, May, August or September. Fertilizer shall be applied at the rate of thirty (30) pounds per one thousand (1,000) square feet.

H. Liming: If more than one initial application of limestone is required by the soils analysis to bring the pH of the stockpiled topsoil/loam borrow to a specified range, the Contractor shall be responsible for all additional required lime applications.

3.05 GUARANTEE PERIOD

A. The Contractor shall guarantee all seeded areas for a period of one (1) year following the date of Provisional Acceptance. During the guarantee period, the Contractor shall make periodic inspections of seeded areas and to determine if any remedial actions are necessary to prevent erosion or damage to seeded areas.

B. At the end of the guarantee period, the Engineer and Owner shall observe the vegetation, at the written request of the Contractor, at least ten (10) days before anticipated date. Seeded area not demonstrating satisfactory vegetation, as determined by the Engineer and Owner, shall be repaired, reseeded, and maintained to meet all requirements specified herein.

C. After the completion of all necessary corrective work, the Engineer shall issue a certificate of final acceptance, which shall terminate the Contractors responsibility for the seeded areas.

END OF SECTION

SECTION 02850
TESTING CONCRETE VAULTS AND CHAMBERS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Testing of Precast Pipe Vaults and Chambers.

B. Testing of manholes.

1.02 RELATED REQUIREMENTS

A. Section 02751 - Precast Valve Vaults and Chambers.

1.03 SCOPE

A. Under this section the Contractor shall furnish all labor, materials, tools, equipment and related items required to test concrete structures for integrity and leakage. This section does not waive testing requirements outlined in other sections of the Contract Documents. All structures shall be tested under the observation of the Engineer and successful completion and passing of the specified test for a specific material or product must be achieved prior to acceptance by the Engineer. Passage of a test does not relieve the Contractor of his responsibilities to construct the Project in full compliance with the Contract Documents.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.01 LEAKAGE TESTS

A. Leakage tests shall be made and observed by the Engineer on each structure. The test shall be an exfiltration test made as described below.

B. Test structures prior to backfilling, mortaring joints, and installing the bench and inverts.

C. When the groundwater is below the bottom of the structure, perform an exfiltration test by plugging all pipes and other openings. Fill structure with water to the 3 feet above lowest wall seam. After 12 hours, if there is no visible leakage (no water visibly moving down the surface of the structure) and if there has been no drop in water level, shall be considered watertight and backfilling may proceed.

D. When the groundwater is above the bottom of the structure perform an infiltration test on that portion of the manhole or vault below the groundwater shall be considered watertight. After the infiltration test has been completed, fill the manhole or vault with water as described in paragraph 3.01C and perform an exfiltration test on that portion of the structure above the groundwater.

E. Any visible or other leakage into and out of structures shall be considered unsatisfactory.

F. All labor and equipment shall be furnished by the Contractor. The Contractor shall furnish equipment and/or necessary piping as required to transport water used in testing from source to test location.

G. Water for testing shall be furnished by the Contractor without additional cost to the Owner. Water for testing structures shall be free from any pollution and shall not deposit any appreciable amounts of silt in the bottom of the structures. Water sources must be approved by the Engineer. Should a source of testing water be judged to be unacceptable, the Contractor at his expense will be directed to find and submit another source for Engineer approval.

H. Correct all leakage by reconstruction using new materials, at no additional cost to the Owner. The use of leadwool, expanding mortar, and other repair methods, shall not be permitted.

END OF SECTION

SECTION 02960
DECOMMISSIONING/EXTENSION OF MONITORING WELLS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The proper decommissioning and extension of monitoring wells within the work area of the Contract.

B. The Contractor shall engage a licensed New Hampshire water well contractor, familiar with the installation, extension and decommissioning of monitoring wells and the NHDES guidelines and policy regarding this work.

1.02 RELATED REQUIREMENTS

A. Section 02222: Excavation.

1.03 QUALITY ASSURANCE

A. Powdered bentonite and Portland cement shall be of the type appropriate for the work.

B. Monitoring wells shall be designed, installed, and decommissioned in accordance with the practices described in NHDES Groundwater Management and Groundwater Release Detection Permits, Env-Or-610.04.

1.04 SUBMITTALS

A. Manufacturer and specification data on bentonite.

B. Specific work plan, with descriptions of pumping equipment, for use in the specified work.

1.05 INSPECTION ON TESTING

A. All work completed under this section shall be done in the presence of the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bentonite shall be of type appropriate for the intended use.

2.02 EQUIPMENT

A. The pumps for the grouting operation shall be specifically suited for the intended use.

PART 3 EXECUTION

3.01 DECOMMISSIONING

Existing monitoring wells and piezometers will be abandoned as follows:

1. Each well will be sounded to determine the total depth of the well prior to abandonment procedures.

2. The well will be sealed by injecting cement/bentonite grout from the bottom of the well to 5.0 feet below ground surface with a tremie pipe. The tremie pipe will be placed near the bottom of the well installation. Continue to pump the grout into the well installation while removing the tremie pipe and any remaining casing. The grout level will be maintained at a depth of 5.0 feet below existing ground surface.

3. The grout will consist of approximately 5 lbs. of granular bentonite mixed with 7.5 gallons of water per bag of Portland cement (94 lbs.) Pumps for grouting operations shall be of the screw-feed or non-piston type, which will deliver an even, continuous flow. The grout will be allowed to set for 48 hours. The abandoned well will be checked for grout settling.

4. The existing cement grout surface seal and protective casing will be removed to a depth of 5.0 feet below ground surface with a hand held pneumatic jack hammer or backhoe powered hoe ram.

5. The remaining borehole annulus will be backfilled with native soils and hand compacted and mounded in a fashion to promote surface drainage away from the abandoned well. Several days after completion of the abandonment procedures, the surface grade will be checked and, if necessary, completed as described above.

3.02 EXTENSION

A. Any monitoring wells requiring extension through soil fill shall be performed without using a solvent seal. The PVC riser shall be extended to 2.8 feet above proposed grade.

B. A protective casing with locking cap shall also be installed from the existing grade to three (3) feet above closure grade. The casing shall be sealed with cement grout below the existing grade to prevent movement during filling operations.

C. The Contractor shall use caution during the filling process, so that the extended well is not disturbed. Any damages to the extended wells shall be repaired at no additional cost to the Owner.

3.03 SHORTENING

A. Depths of any monitoring wells requiring shortening shall be confirmed prior to excavations around the monitoring wells.

Excavation should be performed in a manner which avoids damage to the wells. Any damage to the wells shall be repaired at no additional cost to the Owner.

B. No monitoring well shall be shortened to a height below five feet above the top of the well screen.

C. Excavation shall proceed to remove the existing well to the required grade. The PVC riser shall be cut at an elevation 2.8 feet above final grade.

D. A protective casing with locking cap shall be installed to an elevation three (3) feet above final grade. The casing shall be sealed with cement grout below the final grade to anchor the casing.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUBMITTALS

A. Submit the following:

1. Product data for reinforcement, forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Engineer.

2. Shop drawings for fabricating, bending, and placing concrete reinforcement.

3. Laboratory test reports or evaluation reports for concrete materials and concrete mix designs.

4. Written report to Engineer for each proposed concrete mix at least 15 days prior to start of concreting. Do not begin concrete production until mixes have been reviewed by Engineer.

B. Quality Control: Comply with provisions of ACI 301, "Specifications for Structural Concrete for Buildings," ACI 318, "Building Code Requirements for Reinforced Concrete," and CRSI "Manual of Standard Practice," except where more stringent requirements are indicated.

1. Concrete Testing Service: The Owner shall engage a testing agency to perform materials evaluation testing.

a. Materials certificates signed by concrete producer and Contractor may be submitted in lieu of materials laboratory testing when acceptable to Engineer.

1.02 PRODUCTS

A. Form Materials: Furnish form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection.

1. Forms for Exposed Concrete Surfaces: Suitable panel-type material to provide continuous, straight, smooth, exposed surfaces.

B. Reinforcing Materials: As follows:

1. Deformed Reinforcing Bars: ASTM A 615, Grade 60, unless otherwise indicated.
2. Welded Wire Fabric: ASTM A 185

C. Concrete Materials: As follows:

1. Portland Cement: ASTM C 150, Type 1
2. Fly Ash: ASTM C 618, Type F
3. Aggregates: ASTM C 33, except local aggregates of proven durability may be used when acceptable to Engineer.
4. Water: Potable
5. Fiber Reinforcement: Engineered polypropylene fibers designed for secondary reinforcement of concrete slabs.

D. Admixtures: Provide admixtures that contain not more than 0.1 percent chloride ions.

1. Air-Entraining Admixture: ASTM C 260
2. Water-Reducing, Retarding, and Accelerating Chemical Admixtures: ASTM C 494

E. Related Materials: As follows:

1. Vapor Barrier: 10 Mil polyethylene.
2. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
3. Moisture-Retaining Cover: Waterproof paper, polyethylene film, or polyethylene-coated burlap, complying with ASTM C 171.
4. Membrane-Forming Curing Compound: ASTM C 309, Type I. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq. ft./gal.
5. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

F. Mix Proportions and Design: Proportion mixes complying with mix design procedures specified in ACI 301.

1. Limit use of fly ash to not exceed 25 percent of cement content by weight.

2. Design mixes to provide normal weight concrete with the following properties with mid range water reducers used:
   A. 4000-psi, 28-day compressive strength; water-cement ratio, 0.45 maximum with mid range water reducers (MRWR) used.
   B. 3000-psi, 28-day compressive strength; water-cement ratio, 0.5 maximum with MRWR.

3. Water cement ratios for 3,000 psi concrete in footings shall be a maximum of 0.53 without the use of MRWR.

4. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows: (slumps may be

increased only with mid-range or high-range water reducers). Maximum concrete slump shall be 4 inches without MRWR and 6 inches with MRWR.

5. Adjust mix designs when material characteristics, job conditions, weather, test results, or other circumstances warrant. Do not use revised concrete mixes until laboratory test data and strength results have been submitted to and reviewed by Engineer.

G. Use air-entraining admixture in exterior exposed concrete, providing not less than 4.5 percent and not more than 7 percent entrained air for concrete exposed to freezing and thawing, and from 2 percent to 4 percent for other concrete.

H. Use water-reducing, accelerating, and retarding admixtures that have been tested and accepted in mix designs in strict compliance with manufacturer's directions.

I. Job-Site Mixing: Not permitted.

J. Ready-Mix Concrete: ASTM C 94.

1.03 EXECUTION

A. Formwork: Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position. Select form materials to obtain required finishes.

1. Maintain formwork tolerances and surface irregularities within ACI 347 limits, Class A tolerances for concrete exposed to view and Class C tolerances for other concrete surfaces.

2. Provide openings in formwork to accommodate work of other trades. Accurately place and securely support items built into forms.

3. Clean and adjust forms prior to concrete placement. Apply form-release agents or wet forms as required. Retighten forms during concrete placement, if required, to eliminate mortar leaks.

B. Vapor Retarders/Barriers: Place vapor retarder/barrier membrane where indicated on the Drawings.

C. Reinforcement: Accurately position and support reinforcement, and secure against displacement. Locate and support reinforcement to maintain minimum cover with metal chairs, runners, bolsters, spacers, and hangers as required. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

1. Install welded wire fabric in lengths as long as practicable; lap at least one full mesh and lace splices with wire.

D. Joints: Locate and install construction, isolation, and control joints as indicated or required. Locate construction joints so they do not impair strength and appearance of structure. Place isolation and control joints in slabs-on-ground to stabilize differential settlement and prevent random cracking.

E. Installation of Embedded Items: Set and build anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting diagrams, templates, and instructions provided by others for locating and setting.

F. Concrete Placement: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," for placing concrete in a continuous operation within planned joints or sections. Do not begin concrete placement until other affected work is completed.

1. Consolidate placed concrete using mechanical vibrating equipment with hand rodding and tamping so that concrete is worked around reinforcement and other embedded items and into forms.

2. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placing, and curing.
   a. In cold weather comply with ACI 306.
   b. In hot weather comply with ACI 305.

G. Finish of Formed Surface: As follows:

1. Smooth-Formed Finish: Provide a smooth finish for concrete surfaces exposed to view and surfaces to be covered with a coating or covering material applied directly to concrete. Repair and patch defective areas, with fins and other projections completely removed and smoothed.

H. Slab Finishes:

1. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish when surface water has disappeared and when concrete has stiffened sufficiently to permit operation of power-driven floats. Consolidate surface with power-driven floats or by hand-floating.

   a. Check and level surface plane to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness). Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

2. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, paint, or other thin film-finish coating system.

   a. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of F(F) 20 (floor flatness) and F(L) 17 (floor levelness). Grind smooth surface defects that would telegraph through applied floor covering system.

3. Nonslip Broom Finish: Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

   a. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route.

I. Curing: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, apply an evaporation-control compound according to manufacturer's instructions after screening and bull floating, but before power floating and troweling.

1. Begin initial curing as soon as free water has disappeared from exposed surfaces.

2. Continue curing unformed concrete surfaces by water ponding, continuous fog spraying, continuously wetted absorptive cover, or by moisture-retaining cover curing. Cure formed surfaces by moist curing until forms are removed. Keep concrete continuously moist for not less than 72 hours for high-early strength concrete and 7 days for all other concrete.

3. Apply membrane-forming curing compound to exposed interior slabs and to exterior slabs, walks, and curbs as soon as final finishing operations are complete. Apply uniformly according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. Use membrane-curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

J. Field Quality Control: The Contractor shall employ a testing agency to perform tests and to submit test reports to the Engineer. Sampling and testing for quality control during concrete placement shall include the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
   a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
   b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
   c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
   d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
   e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

3. When total quantity of a given class of concrete is less than 50 cu. yd., Engineer may waive strength testing if adequate evidence of satisfactory strength is provided.

4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

6. Test results will be reported in writing to Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive

strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

7. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

8. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION

SECTION 09900
COATINGS

PART 1- GENERAL

1.01 SUMMARY

A. This specification describes the coating to be used for the concrete within the pump station building and interior surfaces of the concrete manholes and vaults.

1.02 QUALITY ASSURANCE

A. Manufacturing qualifications: The manufacturer of the specified product shall be ISO 9001 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

B. Contractor qualifications: Contractor shall be qualified in the field of concrete repair and protection with a successful track record of 5 years or more. Contractor shall maintain qualified personnel who have received product training by a manufacturers representative.

C. Install materials in accordance with all safety and weather conditions required by manufacturer or as modified by applicable rules and regulations of local, state and federal authorities having jurisdiction. Consult Material Safety Data Sheets for complete handling recommendations.

1.03 DELIVERY, STORAGE, AND HANDLING

A. All materials must be delivered in original, unopened containers with the manufacture's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

B. Store all materials off the ground and protect from rain, freezing or excessive heat until ready for use.

C. Condition the specified product as re commended by the manufacturer.

1.04 JOB CONDITIONS

A. Environmental Conditions: Do not apply material if it is raining or snowing or if such conditions appear to be imminent. Minimum application temperature 40°F *(5°C)* and rising.

B. Protection: Precautions should be taken to avoid damage to any surface near the work zone due to mixing and handling of the specified material.

1.05 SUBMITTALS

A. Submit copies of manufacturer's literature, to include: Product Data

Sheets and appropriate Material Safety Data Sheets (MSDS).

1.06 WARRANTY

A. Provide a written warranty from the manufacturer against defects of materials for a period of five (5) years, beginning with date of substantial completion of the project.

PART 2- PRODUCTS

2.01 MANUFACTURER

A. Sikagard 62, as manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio, 43302 is considered to conform to the requirements of this specification. No substitutions will be allowed.

2.02 MATERIALS

A. Epoxy resin coating:

1. Component A shall be an epoxy resin of diglycidilether of bisphenol A containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.

2. Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents, pigments, and accelerators.

3. The ratio of Component A: Component B shall be 1:1 by volume

B. Granules for slip-resistance shall be supplied by the manufacturer of the specified product and shall be able to be mixed into the coating and shall not settle during application. Granules shall be used for the floor coating of the side riser building.

2.03 PERFORMANCE CRITERIA

A. Typical Properties of the mixed epoxy resin coating:

1. Application Life: Approximately 20 .25 minutes

2. Tack Free Time: Approximately 4 hours

3. Color: grey

4. Solids: 100% VOC g/l: 0.00 Max.

5. Immersion & Chemical Exposure: mm. Cure 3 Days

B. Typical Properties of the cured epoxy resin coating:

1. Water Absorption (ASTM D-570) at 7days: 1.0% max. (2 hour boil)

2. Elongation (ASTM D-522) at 14 days: *5%* mm.

3. Abrasion Resistance (ASTM D-968) at 14 days: 51 liters/mu

4. Adhesion classification (ASTM 3359) at 14 days: 4A mm.

5. Abrasion (Taber Abrader) at 7 days: Weight loss: 0.65 gin. max. (H-22 wheel; 1000 gm weight; 1000 cycles)

6. Tensile Properties (ASTM D-638) at 14 days: Tensile Strength 6400 psi (44.1 Mpa) / Elongation at Break 2.7%

7. Bond Strength (ASTM C-882) Hardened Concrete to Hardened Concrete

   a. 2 Day (dry cure): 2000 psi mm.

   b. 14 Day (moist cure): 1500 psi mm.

8. The coating shall have United States Department of Agriculture approval.

PART 3- EXECUTION

3.01 SURFACE PREPARATION

A. Substrate must be clean, sound, and free of surface contaminants. Remove dust, laitance, grease, oils, curing compounds, form release agents and all foreign particles by mechanical means. Substrate shall be in accordance with ICRI Guideline No. 03732 for coatings.

3.02 MIXING AND APPLICATION

A. Mixing: Premix each component. Proportion equal parts by volume of Component A and Component B into a clean, dry mixing pail. Mix thoroughly for 3 minutes min. with a jiffy paddle on a low-speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its pot life (35 minutes at 73F). To minimize color difference, blend two complete Component B's together. Use only one of the blended Component B's to mix with a Component A. After the first Component B has been used, blend the second Component B with a new Component B and repeat the above procedure for the entire application.

B. Placement Procedure: The epoxy resin coating shall be applied only to approved, prepared surfaces with high-quality brushes, rollers, or spray equipment. Coating shall be applied at ambient and substrate temperatures between 50 and 90°F. Application thickness shall be between 4-7 mils per coat. Subsequent coats shall be applied within 48 hours of the previous coat. Care is to be taken on vertical and overhead surfaces to avoid sags or runs. If this occurs, it must be sanded out and the area re-coated. If coating of horizontal surfaces that will receive traffic is

specified, a slip-resistant aggregate, Sikagard 62 Granules, shall be incorporated into the mixed epoxy resin coating at 1/2 lb. /gallon.

C. When applying the coating, if possible never stop the application until the entire surface has been coated. If possible always discontinue at an edge, corner, or joint. Never let a previously coated film dry. Always coat into wet film. Always apply the coating at a 45° angle to an edge, corner, or joint.

D. Adhere to all limitations and cautions for the epoxy resin as stated in the manufacturers printed literature.

3.03 CLEANING

A. The uncured epoxy resin coating can be cleaned from tools with an approved solvent. The cured epoxy resin coating can only be removed mechanically.

B. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

SECTION 11310
LEACHATE PUMP STATION PIPE & ACCESSORIES

PART 1- GENERAL

1.1 SCOPE OF WORK

A. Furnish and install all pipe, valves, and appurtenances in Pump Station I, including:

1. Polyvinyl chloride (PVC) pipe and fittings.
2. Check valves, regulating valves, shutoff valves, air release/vacuum relief valves.
3. Labels.

B. Furnish and install blind flanges to sideslope risers.

C. Furnish and install vent piping.

D. Perform hydrostatic testing.

1.2 PRODUCT HANDLING

A. Ship, store, and install material and equipment in a manner that does not degrade quality, serviceability or appearance. Store in clean, dry location.

B. Do not spill or cause release of any chemicals used to clean or bond pipe materials.

1.3 SUBMITTALS

A. Manufacturers' product data, including catalog cuts, specifications, and dimensions in accordance with Section 01330.

1.4 WORKMANSHIP

A. All pipe shall be installed by qualified workers, with minimum 5 years experience in industrial process plumbing.

PART 2- PRODUCTS

2.1 PVC PIPE FITTINGS

A. PVC pipe for pressure applications shall be Schedule 80, ASTM D-1785, Type 1, Grade 1. Fittings shall be socket type, ASTM D-2467.

B. Solvent Cements: conform to ASTM D-2564.

C. Pipe and fitting sizes shall be as indicated on the Plans.

D. PVC valve bodies and fittings shall be Schedule 80, ASTM D-1785, Type 1, Grade 1. Fittings shall be socket ends, ASTM D-2467.

E. All flange hardware shall be zinc-plated steel. Flange gaskets shall be 1/8-inch Viton, full face, 60-80 Shore A durometer.

2.2 VALVES

A. PVC ball valves shall be true union design.

B. Butterfly valves shall be wafer/flange type, constructed of stainless steel or PVC. Valves shall have Viton seats and packing. Pressure rating shall be at least 150 psig at 75° F.

C. Check valves shall be ANSI Class 150, wafer style, with Type 316 stainless steel body, valve plates, spring and trim. Seals shall be Viton. Check valves shall provide leak-tight seal at 2 psig back pressure. Acceptable Manufacturer: Techno Corporation of Erie, PA.

D. Gate valves shall be flanged or wafer style.

2.3 VACUUM, AIR, AND PRESSURE VALVES

A. Air release/vacuum relief valve shall be Crispin Model USL-20B or Val-Matic Model 3OIBW designed for domestic sewer use.

B. Air release and vacuum relief valves shall allow entry of air when operating pressure is below atmospheric pressure. The valve shall also allow release of air from the pipe when the pipe is filling, and under pressure. The valve shall close leak-tight when the pipe is full, and provide a drip-tight seal at 2 psig to 20 psig (max. normal operating pressure). Provide suitable seat material to assure drip-tight seal.

C. Valve body shall be constructed of cast iron. Float rod, float guide, and float shall be stainless steel. Furnish valve body with factory applied epoxy lining.

D. Valve shall be equipped with 125 psig 2-inch NPT inlet, 1-inch NPT outlet.

E. Valve pressure rating shall be from 0 to 150 psig.

2.4 QUICK CONNECT COUPLINGS, CLAMPS

A. Couplings shall be quick connect type. Couplings shall be constructed entirely of stainless steel and use a cam mechanism to secure the adapter to the coupler,

providing a leak-tight connection. No springs, ball bearings, or snaps shall be used. Engagement levers shall be stainless steel. Couplings shall be designed to operate at working pressure of 200 psig. If installed on hose, use non-reusable stainless steel, "Band-It" type hose clamps.

B. Couplings shall be fitted with recessed Viton gaskets.

C. Dry Connect Type: Internal mechanism shall prevent accidental release of fluid when coupling is disconnected. Size as indicated on the Drawings. Acceptable Manufacturer: Civacon "Kamvaloks".

D. Standard Type: Size as indicated on the Drawings. Acceptable Manufacturer: Civacon "Kamloks".

2.5 PIPE SUPPORTS

A. Pipe supports shall conform to requirements of Chapter 1, Section 6 of the ANSI Code for Pressure Piping (B-3 1.1).

B. All concrete and masonry anchors shall be drilled expansion bolt type; power driven fasteners will not be allowed. Expansion bolts shall be stainless steel. Acceptable Manufacturers: Rawl-Bolt.

C. Pipe supports shall be fabricated from stainless steel. Supports shall generally conform to the typical details shown on the Plans. The dimensions shall be modified as required to accommodate specific conditions.

2.6 LABELS

A. Label text and materials shall be as indicated on the Drawings and in accordance with the Attached Label Schedule.

2.7 SIDESLOPE RISER BULKHEAD AND HARDWARE

A. Fabricate sideslope riser bulkhead from a standard HDPE blind flange.

B. Sideslope Riser Pipe Connection: Provide HDPE flange adaptor fusion welded to the sideslope riser pipe. Provide convoluted ductile iron flange back-up ring.

C. Fasteners: Provide zinc-plated bolts, flat washers, and nuts with proper diameter and length for flange size. Hot-dipped galvanized fasteners will not be allowed.

D. Bulkhead Gasket: Provide 1/8-inch thick, full face Viton gasket with 60 to 80 Shore A durometer.

2.8 VENT ASSEMBLY

A. Schedule 80 PVC, sizes as indicated on the Drawings.

B. Vent Seal: PVC roof boot.

C. Provide screened mushroom vent cap of same nominal size as vent pipe.

D. Flame Arrestor

1. Aluminum bank and housing construction.

2. Acceptable Manufacturer: Varec 5200 Series.

2.9 PITLESS DISCHARGE ADAPTORS

A. Discharge adaptors shall be manufactured from Type 304 stainless steel, provide a liquid-tight 0-ring seal for the pump discharge pipe, provide a gas-tight seal at the leachate sideriser pipe penetration, and provide a male NPT nipple for attachment of pipe external to the sideriser.

B. Discharge adaptors shall be the same nominal size as the pump discharge pipe unless otherwise noted.

PART 3- EXECUTION

3.1 GENERAL

A. Do not damage pipe, valves, gauges, or other equipment during loading, hauling or handling. Provide all lifting and loading equipment required.

B. Furnish all tools and materials required to join pipes in accordance with manufacturer's instructions.

C. Install all pipe and appurtenances in a neat and workmanlike manner. Pipe shall be aligned true to line and grade and rigidly supported. Pipe shall be installed at constant slope, and in alignment with fittings, equipment and structures.

D. Install adequate unions and flanges to allow convenient removal of valves, meters, and other equipment from the pipe system.

E. Pipe and fittings shall be cleaned before being installed to remove foreign material.

F. Threaded connections shall be made with thread compound applied to male thread only. Teflon® tape or compound may be used for PVC, steel, or copper.

G. Proper fittings shall be used for changes in direction. Piping shall be installed at right angles and parallel to walls and floors. Provide low points and union connections where needed to allow drainage.

H. All penetrations through structures shall be sealed weather-tight inside and outside.

I. Check layout of pipe prior to final installation, and verify that adequate clearance between valves, fittings, instruments, and structural components will be achieved.

3.2 JOINING PVC PIPE

A. Join PVC pipe in accordance with Section 02617 of these Specifications.

B. All PVC female NPT fittings that are connected to a male NPT fitting of a material other than PVC shall be stainless steel reinforced PVC fittings.

3.3 VALVES

A. Locate and orient valves and flow meters to allow unobstructed manual operation, and access for maintenance.

B. Verify correct orientation of check valves and flow direction specific devices with flow direction.

3.4 PIPE SUPPORTS

A. Pipe supports shall be independent of equipment that is connected tb the pipe. Equipment shall be removable without affecting pipe supports.

B. At a minimum, pipe supports shall be spaced to conform to the Manufacturers Standardization Society (MSS) Standard of Practice SP-69.

C. Install pipe supports within 4 inches both sides of all valves and flow meters. Pipe supports shall be located so that access in the leachate vault, and removal of equipment from the sideslope risers is not restricted.

D. Install pipe supports at maximum 4-foot intervals along straight runs of pipe.

E. Pipe shall be supported and restrained to prevent excessive stress on pipe, fittings, or equipment to which pipe is connected. Supports shall provide required pitch for proper drainage. Supports shall prevent excessive variation in supporting force. Supports shall allow free expansion and contraction.

3.5 LABELING

A. Place labels as shown on the Drawings.

3.6 TESTING

A. General

1. Pipes shall be pressure tested in presence of ENGINEER. Provide minimum 7-day notice to ENGINEER before performing test.

2. Provide necessary pipe connections between section of pipe being tested and nearest available source of water or air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to perform test.

3. OWNER will provide water for testing.

4. Provide bulkheads, flanges, valves, bracing, blocking, or other temporary sectionalizing devices required.

B. Sections to Be Tested

1. Test all PVC pipe and fittings, and flexible hose inside the leachate sideriser building.

C. Test Procedure

1. Perform test in accordance with requirements in Sections 02617 & 02619.

END OF SECTION

SECTION 11310 ATTACHMENT

LABEL SCHEDULE
STAGE IV PHASE II LANDFILL EXPANSION

NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.
BETHLEHEM, NEW HAMPSHIRE

Type and/or Location	Quantity	Text	Font Color	Font Size	Sign Size	Sign Color	Material	Fastening	Location
Pump Station I	1	PUMP STATION I	Black	3/4"	10"x 7"	White	Alum	4 Holes	Man Door, Outside
Atmospheric Hazard Potential	1	DANGER, POTENTIALLY HAZARDOUS ATMOSPHERE	OSHA STD	OSHA STD	10"x 7"	White	Alum	4 Holes	Man Door, Outside
Flow Meters									
Comined Leachate Flow Meter	1	COMBINED FIT-PSI	Black	1/4"	1-1/2"	Brass	Brass	Chain	Flow Transmitter
Secondary Leachate Flow Meter	1	SECONDARY FIT-PSI	Black	1/4"	1-1/2"	Brass	Brass	Chain	Flow Transmitter
Overlay Secondary Leachate Flow Meter	1	OVERLAY SECONDARY FIT-PSI	Black	1/4"	1-1/2"	Brass	Brass	Chain	Flow Transmitter
Light Switch for Interior Light	1	LIGHTS	Black	1/4"	3"x 2"	White	Acrylic	2 Holes	At Switch
Vent Fan Switch	1	FAN	Black	1/4"	3"x 2"	White	Acrylic	2 Holes	At Switch
Leachate Riser Bulkheads									
Primary	2	PRIMARY, 3 HP	Black	3/4"	4"x2"	Yellow	Al	4 Holes	Riser Bulkhead
Explosion-Proof Junction Box for Pump	2	240 VAC	Black	3/4"	4"x2"	Yellow	Al	4 Holes	At Junction Box
Secondary	1	SECONDARY 2 HP	Black	3/4"	4"x2"	Yellow	Al	4 Holes	Riser Bulkhead
Explosion-Proof Junction Box for Pump	1	240 VAC	Black	3/4"	4"x2"	Yellow	Al	4 Holes	At Junction Box
Overlay Secondary	1	OVERLAY SECONDARY, 2HP	Black	3/4"	4"x2"	Yellow	Al	4 Holes	Riser Bulkhead
Explosion-Proof Junction Box for Pump	1	240 VAC	Black	3/4"	4"x2"	Yellow	Al	4 Holes	At Junction Box
Cleanout	1	CLEANOUT	Black	3/4"	4"x2"	Yellow	Al	4 Holes	Riser Bulkhead
Piping									
Primary Leachate Pipe Labels	3	COMBINED LEACHATE	Black	3/4"	4" Pipe	Yellow	Vinyl	Adhesive	Pipe
Secondary Leachate Pipe Labels	2	SECONDARY LEACHATE	Black	3/4"	3" Pipe	Yellow	Vinyl	Adhesive	Pipe
Vent Pipe Labels	4	VENT	Black	3/4"	1" Pipe	Yellow	Vinyl	Adhesive	Pipe
Flow Control Valves									
Combined Leachate, downstream of flow meter	1	FCV-PSI-C1	Black	1/4"	1-1/2"	Brass	Brass	Chain	Valve Stem or Handle
Secondary, upstream of flow meter	2	FCV-PSI-S1	Black	1/4"	1-1/2"	Brass	Brass	Chain	Valve Stem or Handle
Common Forcemain	1	FCV-PSI-C2	Black	1/4"	1-1/2"	Brass	Brass	Chain	Valve Stem or Handle
Leachate Recirculation	1	FCV-PSI-R1	Black	1/4"	1-1/2"	Brass	Brass	Chain	Valve Stem or Handle

SECTION 11312
LEACHATE PUMPS AND CONTROLS

PART 1 GENERAL

1.01 DESCRIPTION

A. Furnish and install leachate sump pumps and related accessories, including:
   1. Two (2) Primary Leachate Sideslope Riser Pumps.
   2. Two (2) Secondary Leachate Sideslope Riser Pumps.
   3. Level control, flow meters, and appurtenances as shown in the plans and specified herein and as required for a complete operating system.

B. The duplex and simplex control of the pump will be controlled by the pump control panels, to be provided by the Owner and installed by the Contractor.

C. The interior of the leachate pump station building is classified as Class 1, Division 1, Group D environment. All instrument wiring and controls shall be intrinsically safe or rendered intrinsically safe through the use of barrier devices, or shall be rated explosion proof and installed in a manner that preserves that rating.

1.02 QUALITY ASSURANCE

Qualifications of Manufacturers: The pumps shown and specified are based on the products manufactured by EPG Companies, Inc. Catalog numbers and references are given only as an indication of the quality of materials and workmanship to be used. Equal products by other manufacturers, approved by the Engineer and Owner, will be acceptable in accordance with the terms outlined in the Contract Documents.

1.03 QUALITY CONTROL

A. The pumps shall conform to all applicable requirements of NEMA, IEEE, NEC, FM, SWPA and Hydraulic Institute. For purposes of this specification, the revision and/or version of the referenced standards in effect on the date of bid shall apply.

B. The Pumps specified shall be the products of reputable manufacturers who have been regularly engaged in the design, manufacture and furnishing of Water/Wastewater Pumping Equipment for at least ten (10) years. The manufacturer of the pump shall assume full responsibility for the compatibility of all the components of the pump station. The motor and pump shall be manufactured by one company providing sole source responsibility for the warranty of the unit. Manufacturers who do not manufacture the submersible motor and who limit their warranty to that of the motor manufacturer shall not be acceptable. Additionally, the products of third party packagers, assemblers or distributors shall neither be considered equal, nor shall they be acceptable.

C. The flow meters shall be the products of reputable manufacturers who have been regularly engaged in the design, manufacture and furnishing of Water/Wastewater Flow Monitoring Equipment at least ten (10) years

1.04 SUBMITTALS

A. Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with Section 01300. Submittals shall be submitted within thirty (30) days after the award of the Contract and shall include at least the following:

1. Certified shop and erection drawings showing important details of construction, wiring diagrams, and dimensions.

2. Descriptive literature, bulletins and/or catalogs of the equipment.

3. Certified factory test data on the characteristics and performance of the pumps. Data shall include guaranteed performance curves based on actual shop tests of similar units which shows that the pump meets the specified requirements for head, capacity, and horsepower. The curves shall be submitted on an 8-1/2 inches by 11-inch sheet.

4. All data and assumptions used to size and/or select the equipment.

5. The weight of each component.

6. A complete, total bill of materials for all equipment.

7. A list of the manufacturers recommended spare parts with the manufacturer's current price of reach item. Include gaskets and bearings on the list. List bearings by bearing manufacturer's numbers only.

8. Complete description of surface preparation and shop prime painting.

9. Operation and Maintenance Manuals of the equipment and components.

B. In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

1.05 EQUIPMENT FURNISHED BY OTHERS

A. Control panels for the pump station, leachate consolidation vault, and the above ground storage tank will be furnished by the Owner and installed by the Contractor.

1.06 DESIGN CRITERIA

A. The system shall be complete with submersible pumps, motor controls, electrical wiring and conduits, piping and valves, liquid level sensors, lift out assemblies, and all other necessary appurtenant items.

B. The primary and secondary pumps shall be suitable for installation into a 24-inch diameter HDPE SDR 17 side slope riser pipe on a 3:1 slope with a 24-inch diameter HDPE SDR 17 perforated pipe at the bottom of the sump as shown on the Drawings.

C. The operating conditions for the primary leachate pumps at Pump Station I shall be 83 gpm at 96 feet TDH with 230 VAC, single phase motors. The pumps shall be EPG Series 17 SurePump Model VSDPT 17-3, 5 hp, 304 stainless steel construction with solids handling impeller as manufactured by EPG Companies, or approved equal.

D. The operating condition for the simplex secondary leachate pumps at Pump Station I shall be 30 gpm at 54 feet TDH with 230 VAC, single phase motor. The pump shall be EPG Series 8 SurePump Model WSDPT 8-2, 0.75 hp, 304 stainless steel construction, with solids handling impeller as manufactured by EPG Companies, or approved equal.

PART 2 PRODUCTS

2.01 PUMPS AND CARRIAGE SYSTEM

A. The submersible sideslope riser pumps shall be self contained, squirrel cage induction type designed to operate at continuous full load either submerged or non-submerged without the need for any external cooling devices or water jackets. The wheeled sump drainer pumps shall pump down to within 8 inches of the sump bottom without any loss of performance or damage to the pump. External priming or pump down systems shall not be acceptable.

B. The pump bowls, impellers, shaft, guide vanes, housing and filter screen shall be stainless steel.

C. Seals, bushings and diaphragms shall be Viton.

D. The power cables for the primary and secondary pumps in Pump Station II shall be 100 feet in length. The cables shall be furnished with a pigtail 12 inches above the pump, and made from type SO extra hard usage cord from the pigtail to the receptacle with fittings suitable for Class I, Division I, Group D environment. Conductor size shall be as specified on the Drawings.

E. All exposed metal parts of the pump/motor shall be cleaned, primed and finished with the manufacturer's standard paint system.

F. The primary and secondary leachate pumps shall be mounted in a stainless steel carriage that is designed for sideslope leachate riser applications. All wheels of the carriage must remain in contact with the inside diameter of the riser pipe to assure a straight path of travel of the pump to the base of the riser pipe and shall prevent the pump from twisting movement due to the starting torque of the motor. The carriage must provide for easy removal of the pump in the field shall the pump require service. The pump and carriage shall be capable of entry into the riser pipes described above in Part 1.06 B and must be able to travel over welding beads and perforations in the leachate collection riser pipe fabrication as shown in the Drawings.

G. The carriage shall be equipped with a cable lug and connector welded to the outside of the bottom of the carriage. Lug and connector shall not interfere with the movement of the carriage. A 3/16" stainless steel wire rope shall be provided from the lug to.the pump station for retrieval of the pump.

H. The pump in the storage tank shall be mounted on stainless steel guide rails and disconnect system. The guide rails shall be equipped with an upper stand off bracket and a foot which rests on the bottom of the storage tank. The pump shall be fitted with a sufficient length of stainless steel lifting cable to raise and lower the pump unit. The configuration of the pumps, guide rails, and discharge force mains shall be as shown on the Drawings.

I. The leachate pump discharge piping shall be polyethylene meeting the requirements of ASTM D-1428 and ASTM D-2737, 160 psi rating. The discharge piping connectors shall be Buna-N gasket "T" compression style with stainless steel beveled gripper ring and split clamp, sized to match discharge piping and meeting AWWA C-800. A metal insert shall be used inside the end of the discharge pipe.

2.02 PRESSURE GAUGES

A. Pressure gauges shall be 2.5-inch diameter, glycerin filled stainless steel case, satin finish.

B. Window shall be polycarbonate or laminated glass. Dial shall be white with black markings. Accuracy shall be ±1 percent of full scale.

C. Gauge shall be bottom outlet, flush mounted style, with ¼-inch NPT stainless steel connection. Pressure range shall be 0 . 100 pounds per square inch gauge (psig).

D. Provide each pressure gauge with a plug type, isolation valve as indicated on the Drawings to allow removal of the gauge under operating pressure.

2.3 LEVEL SWITCH AND HOLDER

A. The level switch shall be float type, with reed switch.

B. Level switch shall indicate discrete fluid level by buoyancy of the float, which closes the reed switch. Switch shall be installed in normally open position.

C. Each level switch assembly shall include a single reed switch and single float. Switch location shall be as indicated on the Plans.

D. Float diameter shall be 2 inches. Float shall be buoyant in liquids of specific gravity greater than 0.70.

E. Float and guide tube shall be stainless steel.

F. Extension pipe and fittings shall be stainless steel. Dimensions shall be as indicated on the Drawings.

G. Float switch installed inside the pump station building shall be intrinsically safe. Circuit shall be rendered intrinsically safe by zener barrier (to be provided by OWNER) in the control panel.

H. Support brackets shall be galvanized steel or stainless steel.

I. Acceptable Manufacturer: Madison M5600-PR

2.4 FLOW METERS

A. Flow meters shall be .

B. Acceptable manufacturers: Sparling Instruments, Inc., or Krohne, Inc., or Data Industrial.

2.5 LEVEL TRANSMITTERS

A. Level transmitters for leachate sumps shall be submersible piezoresistive pressure sensing type, with Type 316 stainless steel construction, welded stainless steel diaphragm, 24VDC excitation, 2-wire 4-20mA output, and integral sealed signal cable with vent tube.

B. Install aneroid bellows assembly for atmospheric pressure reference in the junction box on the leachate sump side riser pipes, unless otherwise noted. Use manufacturer-supplied vented cable full length to bellows.

C. Level transmitters shall be intrinsically safe. Circuit shall be rendered intrinsically safe by zener barrier (to be provided by OWNER) in the control panel.

D. Acceptable Manufacturer: WIKA Instrument Corporation LS-10 transducer with

Pressure Systems, Inc. Series 815 Aneroid Bellows.

PART 3 EXECUTION

3.01 INSTALLATION

A. The configuration of the pumps, discharge force mains, disconnects, valves, flow meters, control panel and level sensors shall be as shown on the Drawings. The installation of the pumping system shall be completed in accordance with written instructions provided by the manufacturer.

B. All electrical wiring shall be as specified in applicable NEC and NEMA standards.

C. Prior to start up and field testing, all foreign matter shall be removed from the perforated sump pipes, risers and pumps. Any lubricants or other materials used in servicing the system shall be cleaned from al equipment and concrete surfaces.

3.02 TESTING

After installation, a minimum 15-minute field test shall be performed on each pump with clean water. The test shall demonstrate to the satisfaction of the Owner that the equipment meets all specified performance criteria, is properly installed, and operates smoothly without exceeding the full load amperage rating of the motor or excessive motor heating. Additionally, the submersible Sump Drainer Pumps shall operate within the acceptable Field Vibration limits as established by the Hydraulic Institute for this class of equipment.

3.03 WARRANTY

A material and workmanship warranty shall be provided by the Contractor and/or manufacturer for a period of one year from the date of the Owner's final inspection and acceptance of the installed equipment. This warranty shall cover the cost of labor and materials, including removal and reinstallation costs, required to correct any defect.

3.04 FIELD SERVICE

The Contractor shall provide a minimum of two days of field service by an authorized, factory trained representative of the Pump Manufacturer for installation and start up. Services shall include, but not necessarily be limited to, inspection of the completed installation to ensure that it has been performed in accordance with the manufacturer's instructions and recommendation, supervision of all field testing and activation of the Manufacturer's Warranty. A minimum of 1–day of field training of Owners personnel shall also be provided by the manufacturer.

The Contractor shall be responsible for coordinating the required field services with the Pump Manufacturer.

3.05 GENERAL

A. Install components to allow access for maintenance. Care shall be taken in the installation to ensure sufficient space is provided between instruments and other equipment for ease of removal and servicing.

3.06 FLOW SENSORS AND LEVEL SWITCHES

A. All instrumentation shall be installed in accordance with the manufacturer's installation requirements.

B. Flush chips and other debris from pipe before installing flow sensors.

C. Install flow sensors to allow minimum 10 pipe diameters in uninterrupted straight pipe upstream and 5 pipe diameters downstream from any valves or fittings. Verify this requirement has been met prior to installation of the flow meter.

D. Installation hardware shall include all details including special brackets and mounting hardware which may be necessary to properly install the instruments. Brackets and mounting hardware shall be stainless steel.

E. All mechanical fasteners such as bolts, nuts, screws, cinch anchors, clamps, etc. shall be stainless steel, unless otherwise specified.

F. Install level switches in accordance with distances indicated on the Drawings. Switches shall be installed in a manner that does not interfere with unobstructed vertical movement of the float. Switches shall be installed in normally open position, raising of the float shall cause switch closure.

3.07 LEVEL TRANSMITTERS

A. Level transmitters shall be installed in accordance with the manufacturer's installation recommendations.

B. Level transmitters in landfill leachate sumps shall be securely fastened to pump carriage such that transmitter is located beneath the pump and near the discharge end of the pump body when the pump is installed in the sump.

3.08 SIGNAL WIRING

A. All signal wiring shall be installed by the OWNER's electrical contractor. CONTRACTOR shall provide excavation, bedding and backfill for conduit runs installed by OWNERs electrician, as shown on the Drawings.

B. OWNERS's electrical contractor shall make all wiring connections between Control Panels and field instrumentation. Install signal wiring conduit to right hand bottom of Control Panels, power wiring to left-hand bottom.

C. OWNERS's electrical contractor shall install Class I, Division I sealing glands at conduit penetrations through building wall.

D. OWNERS's electrical contractor shall install signal wiring from terminal to terminal with no intermediate splicing. Connect signal wire ground to control panel ground.

E. OWNERS's electrical contractor shall loosely coil, securely cap and tape ends of unused signal wire pairs.

3.5 TELEPHONE SERVICE

A. Provide excavation, bedding and backfill for the installation of communication by OWNER from network interface on the utility pole to the control panel, as shown on the Drawings. Coordinate service with OWNER and their representatives.

END OF SECTION

SECTION 13001
SITE SAFETY AND CONTINGENCY WORK PLAN OUTLINE

PART 1 GENERAL

1.01 DESCRIPTION

A. The North Country Environmental Services landfill site is located off Trudeau Road in the Town of Bethlehem. The existing landfill occupies approximately 34 acres of site. Elsewhere on the site are located the landfill gas and leachate management facilities, and truck scale.

The lined landfill was first permitted by NHDES in 1987 to accept municipal solid waste, construction and demolition debris, and non-hazardous special wastes including industrial wastes, wastewater sludge, and ash materials. Prior to the lined landfill operation, an unlined landfill was operated at the site. Waste materials from this landfill have been incorporated into the lined landfill, and the unlined area has been constructed over by portions of the lined landfill.

B. The Stage IV – Phase II expansion of the landfill will require excavation and relocation and regrading of waste materials to provide access to existing liner materials, and management of existing leachate generated from the landfill. Air quality degradation, potentially flammable gas, gas emissions, and noxious odors, and nauseating odors may occur during the execution of the Work due to the decomposition of waste.

C. Facility personnel and commercial haulers will be accessing the operating landfill disposal of solid waste during the expansion construction. The Contractor shall employ practices that ensure health and safety of others. Most of the landfill expansion and waste excavation work is not in the general vicinity of the operating area, however site access roads will be shared by the Contractor and the facility operators and commercial haulers.

D. The purpose of the Site Safety and Contingency Work Plan (SSACWP) outline is to assist the Contractor in assessing specific site hazards which may be encountered, to suggest safety procedures which will reduce personnel exposure to hazardous conditions, and to outline emergency response procedures. The Contractor shall prepare the final SSACWP for Contractor's work. The SSACWP shall be submitted to the Engineer for review and submittal to NHDES within two weeks following Notice of Award and prior to beginning site work. All comments from Engineer and NHDES must be addressed prior to commencing activities that disturb waste. The SSACWP will provide for the identification of hazardous site conditions and shall provide for discontinuance of the work in the area identified and notice to the Engineer of the location, time, type of waste and action taken.

E. This Contract anticipates that the Work will be performed in Level D personal protective equipment (PPE), supported by health-and-safety monitoring and appropriate response actions.

F. The Contractor shall be fully responsible for liabilities, claims, or damages, which are the result of the Contractor's negligence, willful misconduct or failure to comply with any part of this Contract.

G. The Contractor shall be solely responsible for the safety of employees and subcontractors. The Contractor shall comply with all applicable provisions of National and Local safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. The Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all necessary safeguards and barricades for the protection of employees on the Work and the safety of others employed near the Work and the public, and shall post danger signs and warning lights clearly indicating potential hazards created by features of the construction.

H. The Contractor shall provide the developed SSACWP and shall coordinate safety requirements for all representatives visiting the site, including the Engineer (including resident engineer), the Owner, the NHDES, and all other visitors to the site.

I. The Contractor shall immediately report in writing, giving full details to the Engineer, Contractor shall immediately report the accident by telephone or messenger whether the accident occurs on or adjacent to the site, causes death, serious personal injury or substantial property damage. If a claim is made or suit is filed by anyone against the Contractor or any subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Engineer giving full details of the claim.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. The Contractor is required to maintain appropriate health and safety equipment on-site for the use of personnel at times during excavation of waste materials, or when the potential exists for exposure to noxious or hazardous conditions.

B. The Contractor shall maintain at the site, at a minimum, a combustible gas indicator, oxygen meter, and hydrogen sulfide detector for the duration of the work.

C. In addition, the Contractor shall maintain fire extinguishers, first aid kits, eye wash and other related safety equipment on-site for the duration of the Work.

D. All safety equipment shall be inspected periodically by the Contractor and maintained in good working order. The Contractor shall clearly tag and/or remove from the site, any equipment that does not pass the Contractor's inspection, and replace such equipment immediately.

PART 3 EXECUTION

3.01 SITE SAFETY AND CONTINGENCY WORK PLAN - GENERAL

A. The Contractor shall prepare a SSACWP in accordance with 29 CFR 1910.120. The plan will include at a minimum, the following for each phase of the Work: identification of specific site hazards, risk analysis, personal protection program, and an air monitoring plan. In addition, the plan shall include a comprehensive work plan and also outline emergency contacts and response actions. The Contractor's SSACWP shall include the elements described in the SSACWP Required Elements Outline, Part 3.05 of this section.

B. The Contractor's SSACWP shall be prepared by a certified industrial hygienist or a person certified as a safety professional experienced with similar types of projects. The Plan shall include a signed statement from the preparer attesting the adequacy of the Plan.

C. The Contractor shall submit the prepared SSACWP to the Engineer within 2 weeks after Contract award and before initiating any site activities. Any comments provided by the Engineers and NHDES must be addressed prior to commencing work that will disturb waste. The Engineer's review does not relieve the Contractor of responsibilities for SSACWP completeness, accuracy, and implementation.

D. All Work shall be consistent with the applicable provisions of Federal, State, and Local laws, including 29 CFR 1926. The Contractor shall comply with all applicable OSHA requirements.

E. The Contractor shall provide copies of the Contractor's SSACWP to all emergency contacts, including the Engineer, Owner, Local Fire Department, Police Department, NHDES-Waste Management Division and Hospital identified in the Plan. The Contractor shall also provide notification of scheduled SSACWP meetings and provide briefings to the emergency contacts and agencies listed in this section.

3.02 SAFETY PERSONNEL - GENERAL

A. The Contractor's SSACWP shall identify a primary Site Manager who will be available on-site at all times while construction work is in progress. The Site Manager shall be responsible for site activities related to the performance of Work. The Site Manager shall also serve as the Contractor's representative and point of contact for all on-site communications. All communication with the Site

Manager shall be considered to be communication with the Contractor. An Alternate Manager shall also be designated to carry out the responsibilities of the primary Site Manager when the primary Site Manager is not available.

B. The Contractor shall designate a site Safety Officer for the duration of the project. The Safety Officer shall be experienced with work similar in nature to this project along with hazardous materials identification and monitoring. The Contractor may designate an alternate Safety Officer having qualifications meeting this section, to carry out the responsibilities of the primary Safety Officer when the primary Safety Officer is unavailable.

C. The Safety Officer shall be trained according to the requirements of CFR 29 1910.130 and shall maintain certification throughout the duration of the project.

D. The Safety Officer shall be present on-site during all on-site activities that may potentially involve hazardous material, including waste excavation, or other intrusive activity.

E. The Safety Officer shall be responsible for the SSACWP implementation.

3.03 ADDITIONAL CONSIDERATIONS FOR SSACWP DEVELOPMENT

Reports on the landfill operation and waste materials received at the facility will be made available to the Contractor. The Contractor is provided the following additional considerations for SSACWP development.

A. Physical Hazards: The Contractor should recognize construction physical hazards. Physical hazards include the following: heavy equipment operation during excavation of solid waste, falling trees during clearing and grubbing, steep and potentially unstable slopes, bulky waste materials, boulders, or other objects which may become dislodged and move downslope during excavations, obscured vision due to dust or other obstructions, sharp objects and unstable footing on waste.

B. Air: Decomposition of MSW organic materials may generate landfill gases such as methane, carbon dioxide and hydrogen sulfide. Landfill gas may migrate through the waste surface at the face of waste excavation. Excavating and regrading waste may also create dust which may contain trace concentrations of metals or organic compounds.

Excavation and relocation of waste is anticipated to result in the release of potentially obnoxious and nauseating odors. The SSACWP shall include provisions in the event of nauseating odors.

C. Leachate: Landfill leachate will also be encountered during the waste excavation work and liner system construction.

E. Storm Water: Storm water runoff may contain residual compounds resulting from contact with wastes in the landfill.

3.04 SITE SAFETY AND CONTINGENCY WORK PLAN REQUIRED ELEMENTS OUTLINE

The requirements for the Contractor's SSACWP shall be as described in the following outline. The order of the Contractor's SSACWP sections may be modified by the Contractor. The Contractor may also include additional sections or provisions as needed or required based on the Contractor's approach to completing the Work. The absence of particular provisions in the outline does not relieve the Contractor of developing appropriate sections or procedures for site work in accordance with applicable OSHA standards. The Contractor shall ensure that all subcontractors engaged to perform work for Contractor either adopt the Contractor's SSACWP provisions or develop a SSACWP consistent with the following outline.

A. Introduction: This section shall describe the Contractor's SSACWP purpose. This section shall describe the health and safety responsibilities of the Contractor and subcontractors in performing the Work. This section shall describe the general OSHA training requirements for personnel involved in site field work.

B. Site Description/History: This section shall briefly describe relevant physical site features including the following: location, size, layout, topography, surface water and ground water. The site history shall briefly describe relevant previous site activities which may assist site workers in understanding the nature of wastes anticipated during construction activities.

C. Project Description and Work Plan: This section shall briefly describe the general tasks to be conducted by Contractor. The project description and work plan section shall include categories of site work such as excavation, grading, liner placement and methane vent pipe installation.

D. Personnel, Responsibilities and Training Requirements: This section shall include the Contractor personnel names, company affiliation, responsibility and whether the individual will be on-site during specific tasks. This section shall name a Site Manager, Alternate Site Manager, Safety Officer, and an Alternate Safety Officer. Contractor's construction foreman, heavy equipment operators and laborers may be listed as "VARIOUS". All site personnel shall read and sign the Contractor's SSACWP. This section should also list Engineer representatives, municipal emergency response representatives and appropriate regulatory agency officials. The training and medical monitoring requirements specified in 29 CFR 1910.120 for each individual or class of individuals shall be specified in this section. The level of training and medical monitoring per individual shall be appropriate for the tasks assigned.

E. Hazardous Material Summary: This section shall include the general categories of the waste physical and chemical characteristics which may be encountered during site work.

F. Hazards of Concern: This section shall include the applicable general hazards of concern for consideration during site work. Example hazards of concern include the following: heat stress, cold stress, explosive or flammable substances, oxygen deficiency, radiological, biological, noise, toxicity, corrosivity and physical hazards.

G. Overall Hazard Evaluation Per Task: This section shall include a qualitative assignment of risks as high, medium, low or unknown to health and safety resulting from site work per task. This section shall include justification of the PPE level used for each site task based on the qualitative risk designation. Justification for selection of PPE may include: the hazards of anticipated wastes, the nature of the task, and selection of air monitoring procedures and/or frequency to evaluate that the proper level of PPE is maintained.

H. Protective Clothing: This section shall establish the anticipated task-specific levels of PPE (such as A, B, C or D) based on the task-specific hazard evaluation. This section shall include a task-specific description of the levels of PPE including the anticipated respiratory and protective clothing requirements for each task.

I. Environmental Monitoring Equipment and Procedures: This section shall establish the task-specific environmental monitoring equipment and monitoring procedures to be employed during site work. This section shall include the instrument type and the monitoring parameter (for example methane) for each monitoring device employed during site work and a description of calibration procedures to be followed for the instrument. This section shall establish task and instrument specific monitoring frequencies to be employed during site work. This section shall establish the task-specific conditions under which levels of PPE shall be upgraded in response to environmental monitoring.

J. Mitigation of Physical Hazards: This section shall include a description of mitigating procedures for task-specific physical hazards that will be employed during site work. This section may include a description of mitigating procedures for fall prevention, fire and explosion hazards, electrical hazards and heavy equipment operation hazards.

K. Personnel Decontamination Procedures: This section shall establish personnel decontamination procedures for each level of PPE (such as A, B, C or D) anticipated during site work, including personnel and equipment washing and rinsing procedures. This section shall include a description of the on-site storage method to be employed during site work for used disposable and reusable protective clothing pending final off-site or on-site disposal.

L. Equipment Decontamination Procedures: This section shall establish procedures to decontaminate equipment that contacts hazardous material, if applicable.

M. Site Control: This section shall establish procedures to reduce contact of site personnel and equipment with contaminated or potentially contaminated materials, including procedures for reducing site access to non-project personnel or non-essential vehicular traffic.

N. Heat/Cold Stress Monitoring: This section shall establish procedures to monitor site personnel and site weather conditions to control heat and cold stress. Monitoring may include ambient air temperature, cloud cover and site personnel heart rates and oral temperatures.

O. Emergency Procedures: This section shall establish mitigation procedures to be followed for potential emergencies during the Work. Potential emergencies may include personnel chemical exposure through potential exposure pathways, personnel injury, fire or explosion and spills of hazardous or potentially hazardous materials. Mitigation procedures may include assessing personnel exposure pathways and vital signs, rendering appropriate first aid measures, contacting fire and/or ambulance units and spill assessment and containment measures. This section shall also establish emergency evacuation procedures if Work area evacuation is necessary during site work. Emergency evacuation procedures may include evacuation signals, evacuation routes and staging areas for the assembling of evacuated personnel.

P. Emergency Equipment: This section shall designate emergency or safety equipment required on-site during the Work. Emergency equipment may include extra protective clothing, first aid kits, fire extinguishers, portable telephones, air horns, and air purifying respirators with suitable cartridges.

Q. Emergency Contacts: This section shall include a listing all personnel or agencies that require notification during an emergency. The listing should include the contact name and phone number and where the contact can be located. The listing should include the Project Manager or supervisor, the Safety Officer, the Owner, the Engineer, the local fire and police departments, NHDES Waste Management Division, and appropriate State of New Hampshire and federal agencies. The listing should also include medical emergency contact information including the nearest hospital with emergency services with the hospital address and telephone number, the telephone number of the nearest ambulance service and directions with a map showing the most direct route to the hospital. The Emergency Contact list shall also be posted at the job site trailer.

3.05 RESPONSE PROCEDURES

A. It is anticipated that materials encountered in the landfill will consist of household garbage, some construction/demolition waste, ash materials, and unclassified wastes. However, if potentially hazardous materials are encountered during the progress of the Work, the Contractor shall immediately implement the following:

1) All work in the immediate area will be suspended, and site personnel will be evacuated to a safe zone.

2) All materials suspected of being hazardous shall immediately be reported to the Engineer and Owner.
3) The Contractor's Safety Officer and the Engineer will assess if the material is hazardous by observation, screening, or if necessary, by sampling and analysis by the Contractor.
4) The Contractor shall maintain a log of all incidents related to the discovery of potentially hazardous materials which shall be available to the Owner and Engineer at all times.

B. If the material is assessed to be a hazard, the Contractor will notify the Engineer and Owner. The notification must include the following:

1) The name and telephone number of the person reporting.
2) The landfill location where the material was observed.
3) Identification and approximate quantity of materials discovered.
4) The extent of on-site hazards and personnel injuries, if any.
5) An assessment of hazards to health and safety of on-site personnel, and nearby people, if applicable.
6) Recommendations to control or remove the site hazard.

END OF SECTION

SECTION 16402
ELECTRICAL WORK

PART 1 GENERAL

1.01 GENERAL

A. Include Conditions of the Contract and applicable parts of Division 1.

B. Examine all other sections of the specifications for requirements which affect the work of this Section, whether or not such requirements are particularly mentioned herein.

C. Coordinate the work of this section with the related work of other trades, and cooperate with such trades to assure the steady progress of all work of this Contract.

D. Where the National Electrical Code appears in this specification, it shall be interpreted to mean the latest edition.

1.02 SCOPE

A. The work covered by this Section consists of furnishing all labor, materials, equipment, supplies, devices, electrical apparatus, stand-by power connections, power service, connections to alarm/control panels, disconnects, and the performance of all operations necessary for the installation and/or modification of electrical facilities in and about the structures and around the grounds, as indicated on the Contract Documents.

B. This work shall include all costs involved in providing power service and distribution and new telephone service and distribution at the facilities and any costs involved with any other special utilities on the project. Without limiting the work required under this specification section, the following is included:

1. Provide new electric power and telephone underground services at pump Station I.

2. At pump station I provide conduit and wire for high level alarm in leak detection chamber or other pit remote from pump station.

3. All conduit and wire for sump pumps, process pumps, level control transducers, float switches, lighting, etc.

4. Provision and installation of panel boards, motor starters, disconnects, manual transfer switches, switches, etc.

5. Provision and installation of terminal box for portable stand-by power connection.

6. Provision of all conduits and wires for connection to control panels by EOS Research. Coordinate with vendor and providing Contractor.

7. All other electrical installations required to provide complete, functioning facilities operating as per design and specifications.

8. Obtain all electrical permits, etc. required.

1.03 WORK OF OTHER SECTIONS

A. Refer to other Sections in this specification as appropriate and/or required.

1.04 SUBMITTALS

A. Shop Drawings:

1. Within thirty days after award of the Contract, submit shop drawings in accordance with the requirements of the General Conditions and in the manner described therein. Shop drawings shall indicate specifications section and paragraph requiring equipment indicated.

2. Shop drawings are required on all major pieces of equipment in the following list, but not necessarily limited thereto: breakers; motor starters; panel boards; contactors; relays of all types involved; push button stations; pull, junction, and terminal boxes; disconnect switches; lighting fixtures; wiring devices; etc.

B. Samples:

1. Within thirty days after award of the Contract, submit samples of all materials requested by the Engineer. Samples shall be prepared and submitted in accordance with the requirements of General Conditions, all postage and transportation costs being paid by the Contractor submitting same.

C. Record Drawings:

1. In accordance with requirements of the Supplementary General Conditions, the Subcontractor shall furnish and keep on the job at all times one complete set of blackline prints of the electrical work, on which shall be clearly, neatly and accurately noted, promptly as the work progresses, all architectural and electrical changes, revisions, and additions to the work. Wherever work is installed otherwise than as shown on the Contract Drawings, such changes shall be noted.

2. The Subcontractor shall indicate on these prints the daily progress by coloring in the various apparatus and associated appurtenances as they are installed.

3. No approval of requisition for payment for work installed will be given unless supported by record prints as required above.

4. At the conclusion of work, prepare record drawings in accordance with the requirements of the Supplementary General Conditions.

D. Operating Instructions and Maintenance (O&M) Manual:

1. The Subcontractor shall instruct, to the Owner's satisfaction, such persons as the Owner designates in the proper operation and maintenance of systems and their parts.

2. Parties indicated above sign affidavits stating that the above instructions were given by the Electrical Subcontractor.

3. Furnish in accordance with General Conditions operating and maintenance manuals and forward same to the Engineer for transmittal to the Owner.

4. The operating instructions shall be specific for each system and shall include copies of posted specific instructions.

5. For maintenance purposes, provide shop drawings, parts lists, specifications and manufacturer's maintenance bulletins for each piece of equipment. Provide name, address and telephone number of the manufacturer's representative and service company, for each piece of equipment so that service or spare parts can be readily obtained.

E. Manufacturers' Data:

1. Within thirty days of award of Contract, the Subcontractor shall submit for Engineer's approval a complete list of manufacturers' names of all materials and equipment proposed for the project.

2. After approval of the above list, the Subcontractor shall submit for Engineer's approval complete detailed manufacturers' data consisting of bulletins, shop drawings, and parts lists of the materials and equipment to be furnished, as required.

3. Shop drawings and manufacturers' data submitted must bear the Electrical Subcontractor's stamp stating that the shop drawings and data have been checked and meet the plans and specifications before being submitted for Engineer' s approval, or they will not be considered and will be returned for resubmission. If the shop drawings and data show proposed variations from the requirements of the plans and specifications because of standard practice or other reason, specific mention shall be made of such variations in the letter of transmittal.

4. The Electrical Subcontractor shall assume the entire cost and responsibility for any changes in the work, which may be occasioned by approval of materials other than those specified.

5. Errors, omissions, and coordination of shop drawings shall be the sole responsibility of the Subcontractor whether or not the shop drawings are approved.

6. In the event that any specified manufacturer's number has been superseded by a new number since the writing of this specification, the new manufacturer's number shall be immediately submitted to the Engineer for approval. It shall be the responsibility of the Subcontractor to notify the Engineer of any superseded manufacturers' numbers mentioned in these specifications.

1.05 QUALITY ASSURANCE

A. Applicable Standards, Permits and Codes:

1. The installation shall comply with all laws applying to electrical installations in effect in Bethlehem, New Hampshire, and with regulations of any other governmental body or agency having jurisdiction, including OSHA; with regulations of the National Electrical Code where such regulations do not conflict with those laws, with the regulations of the company involved, with the telephone utility, and with ASHRAE Standard 70, as amended.

2. File all required notices and plans. Obtain and pay for all permits, inspections, licenses, and certificates required for work under this Section.

3. If any portion of the electrical plans or specifications conflict with any laws or ordinances with regard to type of materials, equipment, or fixtures to be used, the Electrical Subcontractor shall bring it to the Engineer's attention at least seven days before submitting the bid. Otherwise the cost of all work necessary to make the installation comply with said laws or ordinances shall be paid by the Electrical Subcontractor and shall become a part of this Contract.

1.06 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which an examination of site conditions and Contract Documents prior to executing the Contract would have revealed.

1.07 DRAWINGS

A. The Subcontractor shall refer to the electrical drawings and civil plans and details for a full comprehension of the extent and detail of the work to be performed. These drawings are intended to be supplementary to the specifications, and any work indicated, mentioned, or implied in either is to be considered as specified by both.

B. All work shown on the drawings is intended to be approximately correct to the scale of the drawings, but figured dimensions and detailed drawings are diagrammatic and are not intended to show every detail of construction or the exact location of equipment. Where building construction makes it advisable or necessary to change the location of equipment, the Subcontractor shall perform such work without cost to the Owner or written request of the Engineer. Any doubt as to the intended location of equipment shall be resolved by the Engineer before proceeding with the installation.

C. The intent is to obtain an electrical installation of all systems, complete in every detail within and about the structures, and with all facilities properly interconnected with power and telephone. The Electrical Subcontractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best trade practice and to the satisfaction of the Engineer. Upon completion, the electrical systems and all equipment throughout the structures shall operate properly and adequately and function as intended.

D. In any discrepancy between requirements of any Section, between notes on the drawings, between drawings, between details in the specifications, or between drawings and specifications, that which is in the best interest of the Owner shall apply.

1. Testing by Contractor: Provide equipment and personnel for operating test of electrical system.

2. Changes by Contractor: The Contract Drawings indicate the extent and schematic arrangement of the conduit and wiring systems. If changes from the drawings are deemed necessary by the Contractor, submit details of such changes within 30 days of award of Contract. Make no changes without written authorization of Engineer. Where conduit routings are not indicated, coordinate with Engineer, General Contractor, and other Subcontractors to insure no conflicts result from routings selected.

1.08 ELECTRICAL REFERENCE SYMBOLS

A. Standard symbols have been employed where such will meet the need. These are augmented and modified to illustrate as necessary. The chart on the Contract Drawings is intended to illustrate all symbols and explain the function and installation method of the device represented. When not clear, or where one has been inadvertently omitted, it shall be the responsibility of the Electrical Subcontractor to obtain a ruling on the intent before proceeding with any work.

1.09 TEMPORARY POWER

A. The Contractor or Electrical Subcontractor shall furnish and install temporary feeders of proper capacity power required for construction. Contractor is responsible for providing an adequate source of power at no added cost to Owner. Sufficient outlets shall be installed at convenient locations so that extension cords of not over 50 feet will reach all areas requiring power.

B. The General Contractor and all subcontractors shall furnish their own extension cords and such lamps as may be required for their work, and shall pay for the cost of temporary wiring of construction offices or shanties used by them and any temporary wiring of a special nature for light and power required other than that mentioned above.

C. All temporary wiring shall be completely removed as its use is no longer required. No temporary wiring shall remain at completion of the project.

1.10 GUARANTEE

A. Contractor's guarantee for items furnished covers and includes:

Faulty or inadequate design
Improper installation
Defective workmanship and materials

B. Warranties of Manufacture:

Not less than one year
As specified
As normally supplied if greater than one year

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. All materials, devices, and equipment, unless specifically accepted, shall be new.

2.02 IDENTIFICATIONS

A. All materials shall bear UL labels where such have been established for the particular device.

B. All devices shall show make, type, serial number (where applicable), voltage, amperage, wattage, motor ratings, and all other pertinent data.

C. All wire shall have make, type of insulation, size, and voltage rating clearly marked upon it.

2.03 SLEEVES/JUNCTION BOXES/ANCHORS

A. The Subcontractor shall advise the Contractor of locations for all sleeves, openings, anchors, supports, conduits, and boxes, and shall provide same so that they may be built into the job wherever feasible.

2.04 ACCESS PANELS

A. Furnish, for installation by the General Contractor, all metal access panels required for access to services provided under this Section.

B. Coordinate locations and sizes of all such panels with the Contractor, subject to the Engineer's approval.

2.05 CONDUITS

A. Exterior:

1. Buried conduit shall be Schedule 80 PVC or PVC coated rigid galvanized steel. Conduits below concrete slabs, and to five feet outside of foundation walls shall be rigid galvanized steel, PVC coated. Where PVC is used, all elbows and/or offsets shall be PVC coated rigid galvanized steel. Only PVC coated rigid galvanized steel shall be used above grade.

B. Exterior Above Grade:

1. PVC rigid galvanized steel only. PVC may be utilized at utility poles for risers in accordance with the utility company's standards.

C. Interior:

1. Interior conduits shall be PVC coated rigid galvanized steel or rigid aluminum. Conduits for lighting in the load out building may be rigid

galvanized steel, PVC coated rigid galvanized steel or rigid aluminum. Fittings, boxes, and related items for interior work shall be manufactured by Crouse Hinds, Appleton, or approved equal.

2. Minimum size conduit for light and power wiring shall be 1/2".

D. General:

1. The use of nonmetallic conduit or raceway within a structure or below floor slabs is not permitted.

2. Rigid galvanized conduit shall be manufactured by Youngstown Sheet and Tube Company, Republic Steel, or equivalent.

3. In non-classified locations, liquid-tight flexible metallic conduit shall be used to tie in all motors or similar equipment. Provide minimum 2 ft. diameter loop at all locations. In classified areas, Class 1, Division 1, Group C and rated flexible conduit with corrosion resistant overall jacket shall be used.

4. PVC conduit shall be Type II by Carlon Products or approved equal.

5. PVC coated rigid galvanized conduit shall be approved equal to Rob Roy "Plasti-Bond Red" with 40 mil PVC exterior coating and with urethane (red) interior coating.

6. Aluminum conduit may be used on this project.

7. All terminations of conduits shall have smooth, rounded bushings. All conduit 1" and larger shall have insulation which may be integral with the bushing connector, or an insulated bushing may be added.

8. All rigid conduit joints shall be threaded. Do not use any type of clamp on fittings. All plastic joints shall be cemented or heat welded.

9. All bends for telephone/data conduits or ducts shall be 36" minimum radius.

10. Provide expansion joints on all conduits rising from below grade at utility poles and/or any other structure, and at all other locations required by codes/ordinances. In classified areas, provide Class 1, Division 1, Group C and D seal fittings on conduit before expansion fitting and after expansion fitting.

2.06 WIRE AND CABLE

A. All cable and wire shall comply with the latest requirements and specifications of the NFPA and/or the Insulated Power Cable Engineers Association (IPCEA) and shall be as manufactured by General Cable, General Electric, Anaconda, Phelps Dodge, or approved equal, unless otherwise specified or indicated.

B. All conductors used in the wiring system shall be soft-drawn copper wire having a conductivity of not less than 98% of that of pure copper, unless otherwise indicated or specified. All conductors shall be stranded. Solid conductors are not acceptable. Aluminum conductors are not permitted.

C. All wire and cable shall be stamped approximately every two feet to indicate voltage, type, temperature rating, UL listing, manufacturers' name, size, etc.

D. All underground conductors shall be installed in conduits. All underground conductors shall enter manholes, building walls, or termination points through a protective galvanized steel conduit sleeve of appropriate size.

E. All cable and wire shall be: 600 volt; installed in approved raceways or conduit; not less than No. 12 AWG (except that No. 14 AWG may be used for control wiring).

F. Insulation for cable and wire shall be as follows:

Wet or Moist Locations	XHHW-2
Feeders to Panels, other	XHHW-2

G. All internal wiring to fixtures shall be minimum No. 14 AWG, silicon rubber insulated (150°C) with minimum 300 volt insulation.

H. All branch circuit wiring from panelboards to any outlet on the circuit over 50' but under 100' shall be No. 10 AWG for the first half of the circuit, over 100' but under 175', use No. 8 AWG for the first half, or as otherwise required to provide no greater than 3% voltage drop at the most remote device on the circuit.

I. The following color code shall be used for all conductors. The colors must be fast, fadeless, and capable of withstanding cleaning.

	120/240 Volt (Single Phase)
Phase A	Black
Phase B	Red
Phase C	-
Neutral	White
Bond	Green

J. Multi-conductor control cables shall be approved equal to GE SI-58779, Flame resistant.

K. Multi-conductor shielded cables shall be approved equal to GE SI-58760, #16 AWG, with individual grouping shielded.

L. All circuit wires shall be tagged in cabinets, etc., with 1/16" thick tags securely fastened to the conductors with a heavy type of linen wrap at time wires are pulled in and tested. Circuit numbers shall be indicated on the tags. Tags shall not be removed for any reason.

M. At least 8" loops or ends shall be left at each outlet for the installation of devices or fixtures in the future. All wires in outlet boxes not for the connection to fixtures at that outlet shall be rolled up, connected together, and taped.

N. Wires and cables shall be carefully handled during installation.

O. When a lubricant is necessary for pulling wires, it must be listed by UL and be of such consistency that it will leave no obstruction or tackiness that will prevent

pulling out old wires or pulling in new wires or additional wires. No soap flakes or vegetable soaps will be permitted.

P. Conductors shall be continuous from panelboard to outlet and from outlet to outlet. No splices shall be made except within junction or outlet boxes.

Q. Splices and taps in wires No. 8 AWG and larger shall be made with crimp-on type connectors designed for the purpose. All connections between wires at fixtures and boxes shall be made with UL approved 600 volt pressure connectors equal to Ideal "Wire-Nut" or "Wing-Nut" (on lighting or general purpose receptacles and only in dry locations).

R. Type NM, NMC, AC, MC, or similar cables shall not be permitted on this project. All wiring is to be installed in conduit.

S. All conductors and connections shall be free of grounds, shorts and opens.

T. Telephone wiring/cables shall conform to requirements of the local telephone company.

2.07 OUTLET BOXES

A. All boxes shall be held to wood surfaces by wood screws. On metal surfaces, boxes shall be held by metal-to-metal screws or by machine bolts.

B. Any outside boxes or boxes mounted exposed in the structures shall be cast metal type with integral threaded hubs (style similar to Crouse Hinds FS or FD) where not in classified locations. Bell style boxes will not be accepted.

2.08 PULL BOXES AND JUNCTION BOXES

A. Pull boxes, cabinet boxes, and junction boxes shall be constructed of code gauge sheet metal to match the conduits involved of not less than the minimum size recommended by the National Electrical Code. Boxes shall be furnished with screw-fastening covers. Where several feeders pass through a common pull box, they shall be tagged to indicate clearly their electrical characteristics, circuit number, and panel designation. Where pull boxes must be used in finished areas, the Engineer shall be consulted for the location, style of cover, and finish of box. The location shall always be as inconspicuous as possible. Where shown on the drawings, sizes of pull boxes, terminal boxes and junction boxes shall be followed or next larger standard trade size shall be used. Add pull boxes when such are deemed advantageous.

B. Boxes in classified areas shall be Class 1, Division 1, Group C and D labeled and of a material that matches the conduits involved.

2.09 PULLING CABLES

A. All raceways are to be equipped with conductors. Swab all conduit before cable is drawn into them. Any crushed raceways shall be replaced before drawing in cable. Where cable pulling compounds are required, materials specifically intended for that purpose may be utilized.

2.10 DISCONNECTS (if any)

A. Where shown on the Drawings, or when NEC required whether or not shown, install disconnect switches appropriate for the application. When serving motors, they shall be motor rated. Those for equipment (if any) outdoors shall be in NEMA 4X SS enclosures, or as otherwise indicated on Contract Drawings. Those for use in classified locations shall be Class 1, Division 1, Group C and D labeled.

B. Switches shall be heavy duty, quick make and break type. They may be non-fused by a solid copper bar, silver-plated, heavy duty on motors over 2 HP. For small motors (1/8 HP and less), a toggle switch, motor rated, may be used; otherwise, they shall be approved equal to Square D Type HU (where not in classified areas). Manual starters with overload protection built in are approved when NEC acceptable.

C. Where multiple equipment items are supplied from a common circuit or where otherwise required by code, disconnects shall be fused type.

D. Manual transfer switches shall be NEMA 4X SS enclosed, 2 PDT, padlockable in either "ON" position and in the "OFF" position. Switches shall be UL listed for use on NEC Article 702 "Optional Standby Systems".

2.11 OVERCURRENT PROTECTION SERVICES

A. Overcurrent protection for motors is to be in the starters. There is to be protection in each phase wire. Overcurrent protection of conductors is by thermal and magnetic molded case circuit breakers in the panelboards. Where combination starters are used, the breaker is to be a motor circuit protector with only magnetic trips. These must be supplied from a branch circuit protected by a thermal and magnetic trip breaker.

2.12 WIRE CONNECTORS AND DEVICES

A. All wire joints shall be made with a pressure squeezed connector such as T & G Stakon and Ideal, or bolted clamp such as made by Dessert. Twist-on type wire nuts are also permitted for general lighting and receptacle circuits in dry locations only. Make up to terminals shall be mechanical squeeze connector. Wherever only a screw connector is available, install a conductor terminal like T & G Stakon spade or donut and designed for the application and compression set to the conductor.

B. Cover all joints made with non-insulated clamp devices with Scotch brand plastic electrical tape. Type #88 may be used at any joint and shall be used whenever the temperature of joint or the room is below 50°F. In the summer, or when temperature is above 60°F, new type #33 plus may be used. Triple wrap joints, each wrap having a 50% overlay.

2.13 SWITCHES AND PLATES (if any)

A. Switches shall be industrial specification grade, 20 amperes at 120/277 volts, with ivory handle, such as Bryant 4901-I, for SPST applications. For three-way use

No. 4903-1, and for four-way use 4904-1. All switches shall have clamp type terminals screw set.

B. Mount all switches vertically, wall-flush, and at a height of 4'-0", surface mounted.

C. All switches must have machine screw held wire and be back wired. Automatic grips will not be permitted. All switches must be classed as heavy duty.

D. All flush plates (if any) are to be smooth-line nylon, one piece construction for all grouped switches, or Mulberry equivalent. On surface boxes they shall match the box style for the device installed.

E. Switches and plates shall be a product of Bryant, General Electric, or Hubbell.

F. Provide Class 1, Division 1, Group C, D enclosed switches in all locations.

2.14 CONVENIENCE AND OTHER OUTLETS AND PLATES

A. Where "GFI" receptacles are indicated on drawings, it is the intent that ground fault protection be provided by individual Class A, 20 Ampere, 120 volt, GFI receptacles for each device shown, equal to Bryant GFR53FT-1.

B. Outdoors and elsewhere as shown, use weatherproof covers conforming to NEC Article 406.8 (B) for use while not attended.

C. Automatic grip set outlets are not permitted.

D. On exposed FS and FD boxes in non-classified areas, use cast feraloy covers matching the box or stainless steel as above, if styled for the box. In corrosive areas, outdoors and in damp locations, use device plate that is weather proof with the attachment plug inserted or removed, in full conformance with NEC Article 406.8 (B), so the load may be plugged in and not attended while in use. Enclosures shall be UL listed and must include a gasket between the hinged cover and mounting/base plate, and between the enclosure and the mounting surface. These devices shall be as manufactured by Tay Mac Corp., Tempe, AZ; 1-888-440-9045.

E. Outlets and plates shall be a product of Bryant, Hubbell, or General Electric.

F. There are not to be any convenience receptacles installed in any classified areas. All buildings and pits are classified as Class 1, Division 1.

2.15 MOTORS

A. These specifications relating to motors and motor control apply to all motors and controls furnished by this section or any other section.

B. Each section supplying motor drive apparatus will be responsible for supplying an electric motor of sufficient size for the duty performed. These shall not be oversized beyond a normal safety factor, except that standard design ratings for next above motor size required will be used. Unless otherwise specified, all motors shall have open frames, Class A insulation and continuous duty classification based on a 40°F ambient temperature of reference.

C. Motor Control: Each motor or group of motors, requiring a single control shall be provided with a suitable controller and devices, which shall perform the functions specified for the respective motors in other sections of these specifications. All controllers shall conform to the adopted standards and recommended practices of the industrial control standards for the National Electrical Manufacturers Association and the standards for industrial control equipment of Underwriters' Laboratories, Inc.

D. All motors utilized with VFD drives shall be premium efficiency, inverter duty rated. All motors shall be in conformity with serving utility efficiency requirements to permit OWNER to obtain rebate.

E. Thermal Overload Protection. Each motor shall be provided with an overload protective device, integral with either the motor or controller. Unless otherwise specified, the protective device shall be of the manually reset type. Manual controllers for motors shall be specifically designed for the purpose, and shall have an HP rating adequate for the motor. Automatic control devices such as thermostats or floats are satisfactory, for direct control provided they are designed for that purpose and have an adequate HP rating.

F. Provide all motor starters. All motors are single phase. Starters shall be NF Disconnect Combination type, Size 1 minimum. Overload relays shall have a N.O. Auxiliary Contact (close on overload trip), for field wiring to alarm system. All starters shall have a 2-N.O. and 2-N.C. auxiliary contacts for Owner's field wiring. Control voltage shall be 120 Volts AC. Provide control power transformers in all starters for 240 volt motors, with both primary and one secondary lead fused. Start/stop controls shall be outputs from EOS Research control panels.

G. Provide Class 1, Division 1, Group C and D push button station at leachate loading platform for "pump start/stop" and for "leachate overfill reset". Provide separate Class 1, Division 1, Group C and D enclosure with LED Pilot Light for "pump run" indication.

2.16 PRIMARY AND SECONDARY SERVICE

A. A new 240/120 volt, single phase, 3 wire service shall be provided underground from the utility to each of the pumping station sites by this CONTRACTOR. A single power feed conduit and a spare conduit shall be installed.

2.17 ELECTRICAL SERVICE AND DISTRIBUTION SYSTEM

A. The Subcontractor shall furnish all labor, materials, etc. necessary for a complete approved electrical service as required by the structure, including inspection and approval by the utility and local inspection departments.

B. The Subcontractor shall notify the utility company in writing, with a copy to the Engineer, no later than ten days after signing construction contracts, as to when the power service will be required.

C. Overhead utilities on the site are the Owner's. Existing utilities (power, telephone, etc.) are being relocated under the site contract and are not part of the

electrical work under this specification. Any required pole mount transformers are provided under the site contract.

D. The word "utility" here-in refers to overhead and communication lines.

2.18 UNDERGROUND ELECTRICAL SERVICES

A. Underground service shall comply with all requirements of the National Electrical Code, National Electrical Safety Code, local utility company, and local enforcing authority.

B. Furnish and install secondary lugs on transformer as required.

C. It may be run in PVC coated rigid galvanized conduit (as indicated in item 2.05 Conduits, this specification section) approved for electrical use. Conduit shall be 36" below grade and pitched to drain.

D. Install yellow plastic marking tape 12" above all buried distribution.

2.19 METERING

A. This site is primary metered at the public utility service point. There is no metering on the new services within the Owner's high voltage distribution.

2.20 HAND HOLES (if any)

A. Hand holes shall be as specified on the plans.

2.21 PANELBOARDS

A. Panelboards shall be provided with main lugs or main breakers and branch circuit breakers, according to the schedule on the Drawings.

B. The general requirements for the panels are shown on the Drawings including mounting and gutters. Mount the panels 6'-6" up to top of roughing cabinets. Gutters shall not be less than 5". Breaker frame size is shown on the Drawings. Handle ties will not be permitted anywhere. Multi-pole breakers shall have common trip and one handle.

C. All breakers shall be trip-free, suitable for switching, and thermal magnetic. All breakers shall be bolted to bus type secured in place by holding bolt. "Space" means provisions for adding breakers. Breakers or busses shall contain terminations or tappings designed for these attachments. All points of contact between bus and sub-bus shall be of copper full silvered between all contact surfaces. All breakers shall have an interrupting capacity for 22,000 amperes at 240 volts AC (symmetrical RMS amperes).

D. Note that the breakers supplying outdoor receptacles are not the ground fault interrupter type. Design requires GFI receptacles, specifically.

E. Provide a type written tabulation indication fixture outlets, devices, machines, or apparatus served by each breaker and their room location. This shall follow coding on the Drawings with breakers numbered from top to bottom. Mount tabulation inside the door in a frame for the purpose, with a transparent plastic cover.

F. Panelboards shall be NEMA 4X SS with cover-in-cover design if available. Provide Alternate Bid if NEMA 3R is acceptable to Owner.

G. Panelboards provided under this Contract shall be Square D.

2.22 BALANCING OF LOADS

A. The Contractor shall balance all loads between phases in all panels, etc., around the neutral. Neutral conductors shall be the same size as phase conductors unless specifically noted otherwise. No Common neutrals will be permitted.

B. All circuits shall be distributed among the phases so as to restrict any phase load imbalance to less than 10% at any panelboard.

C. After completion of the installation, record under full load conditions, the current flow in each phase feeder. Submit four copies to the Engineer giving name and location of each panel, etc.

D. Circuit members assigned to home runs and devices on the Drawings are for purposes of indicating individual circuits and are intended to correspond with the circuit numbers in the panels. The panelboard directory shall designate each circuit and its associated load. If numbers deviate from the drawings, the as-built drawings shall reflect this.

2.23 TELEPHONE

A. Provide new underground telephone service conduit 2" minimum at each site. Provide wiring to EOS research panel at each pump station.

B. Provide telephone surge arrestor on each service.

C. Overhead telephone wiring and its relocations are provided under the Site Work Contract and not this specifications section.

2.24 EMERGENCY LIGHTS, EXIT SIGNS

A. Provide per fixture schedule (if any).

2.25 WIRING OF MECHANICAL AND OTHER EQUIPMENT

A. The Electrical Subcontractor shall wire all power to, providing and installing local disconnects for, all mechanical equipment and equipment by other trades or this section per Contract Drawings. This shall include but not be limited to:

Pumps, level transducers, float switches, etc.

NOTE: Review plans and specifications for all sections providing equipment to be wired to determine special wiring or control requirements to be provided for such under this specification section.

2.26 TRANSFORMERS (if any)

A. NEMA ST20, general purpose, dry-tape, self-cooled, ventilated. Provide transformers in a NEMA 1 enclosure. Transformer shall have 220°C insulation system with a temperature rise not exceeding 150°C under full rated load in a maximum ambient of 40°C. Transformer shall be capable of carrying

continuously 115% of the nameplate KVA without exceeding the insulation rating.

2.27 INSTRUMENTATION

A. The subcontractor under this section shall provide all conduit for and provide and install all signal cables for instrumentation provided under all Sections of these specifications, including provision of all required 120 volt power wiring and interconnections of signal cables. Review other Specification Sections for equipment requirements. Float switches, flow meters, transducers, etc. are provided under other specification sections.

2.28 STAND-BY POWER PROVISIONS

A. Provide all conduit, wire and connection/terminal box for stand-by generator connection at pump station #1 and pump station #2.

2.29 EOS RESEARCH CONTROL PANELS

A. Coordinate installation of control panels by EOS Research at Pump Station I. Panels and enclosures are provided by EOS and installed by Contractor. Contractor shall install required conduit, cabling and signal wires into the panel enclosure provide by EOS, and leave a pigtail for connection by EOS.

B. Provide all conduits and interconnecting wires between various field devices, telephone services, pump starters, remote push buttons and pilot light(s), etc.

C. Communication lines between EOS Panel at Pump Station I and between EOS Panel at existing Stage IV Side Riser Building shall include a network cable and signal wires installed in a 2" conduit and connected to the existing conduit outside the limits of the berm.

1. Network cable shall be Belden #9842 *(2 pair). The wire shall be tinned copper, polyethylene insulated, twisted pairs and include an Overall Beldfoil aluminum-polyester shield and 24 AWG stranded tinned copper drain wire, Overall tinned copper braid shield (90% coverage) and a chrome PVC jacket.
2. Communication lines shall be Belden #9556 12-conductor (6-pair) 18 AWG wire with overall Beldfoil shield and drain wire and chrome PVC jacket.

D. Coordinate with EOS as to cable types required for all field instruments.

E. Coordinate with EOS for their connections of the cables to their panels.

F. EOS Research is responsible for any programming, etc. of controls within their panels and for provision of all required outputs and acceptance of all inputs.

2.30 ELECTRIC HEATERS

A. Provide, install, wire and connect electric heaters in Pump Station #1. Heaters shall be approved equal to those noted in the schedule on the Contract Drawings.

2.31 MAIN SERVICE BREAKERS/OVERCURRENT PROTECTIVE UNITS

A. Provide new main service breakers for utility at each pump station.

2.32 DIALERS

Not applicable to this Specification Section.

2.33 NAMEPLATES

Provide nameplates for all items of equipment on all panelboards, controllers, selector switches, starters, safety switches, push-button stations, feeder switches and relay and equipment enclosures.

Nameplates shall be black laminated plastic or bakelite, approximately 3/4" x 2-1/2" x 1/16", with four edges neatly beveled. Lettering shall be engraved, white, with a height of approximately 3/16" x 1/4".

Provide two holes in nameplate and secure to equipment with non-ferrous screws. If adequate space is not available on item to which nameplate is to be affixed nameplate may be installed adjacent to and as close to the item as possible, and in a position where it is readily visible.

Notations on nameplates shall be exactly the same as corresponding notations that appear on the Drawings. Submit proposed engraving list for approval before obtaining.

2.34 EQUIPMENT SUPPORTS

Provide all structural supports required for proper attachment of all equipment. Wall mounted equipment shall be installed to maintain at least 1½" air space between equipment and supporting walls. Groups or arrays of equipment may be mounted on adequately sized stainless steel channels, angles or bars. Prefabricated stainless steel channels equal to those manufactured by Unistrut or Kindorf are acceptable. All fasteners shall be stainless steel.

Equipment suspended from ceilings shall be supported by adjustable threaded stainless steel rods of adequate strength. No hangers may be secured to furred or suspended ceilings or attached to or carried through ductwork.

Supports shall be orientated vertically behind starters, panelboards, and other electrical enclosures.

2.35 DELIVERY, STORAGE AND PROTECTION

A. The Subcontractor shall be responsible for the work and equipment until finally inspected, tested and accepted. Carefully store materials and equipment, which are not immediately installed, after delivery to the site. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material.

B. Each Subcontractor shall protect work and material of other trades from damage that might be caused by that Subcontractor's work or workers and shall make good a damage thus caused.

PART 3 INSTALLATION

3.01 GENERAL

A. The entire work provided in this specification shall be constructed and finished in every respect in a workmanlike and substantial manner.

B. The Subcontractor shall obtain detailed information from the manufacturer of apparatus as to the proper method of installing and connecting same. The Subcontractor shall also obtain all information from the Contractor and other Subcontractors that may be necessary to facilitate the work and the completion of the whole project.

C. Before installing any of the work, the Subcontractor shall see that it does not interfere with the clearances required for finished columns, pilasters, partitions, walls, and ceilings, as shown on the Contract Drawings and details.

D. Work installed by the Subcontractor which interferes with or modifies the architectural design as shown on the Contract Drawings shall be changed as directed by the Engineer, and all costs incidental to such changes shall be paid by the Subcontractor.

E. In any and all cases of discrepancy in figures, plans or specifications the matter shall be immediately submitted to the Engineer for decision.

3.02 SITE VISITS

A. The Subcontractor will be required to visit the site as the work progresses and to carefully investigate the structural and finished conditions affecting all details of the work, and shall arrange such work required to meet such conditions.

3.03 CUTTING AND PATCHING

A. It is the duty of the Subcontractor to furnish and install all sleeves required in the performance of this Contract and to furnish to the Contractor the size and location of all openings required on the performance of this contract, and it shall be the duty of the Contractor to provide the required openings during construction.

B. If this Subcontractor fails to provide for all sleeves and openings as required in the performance of this Contract, the Subcontractor shall instruct the Contractor, who shall do such cutting, drilling, patching and grouting and so forth necessary for the proper installation of this Subcontractor's work. The Contractor is to charge this Subcontractor for this work and it shall be done at no additional expense to the Owner.

C. Should the Contractor, after having been fully advised by the Subcontractor, fail to arrange for this work, the Subcontractor shall promptly notify the Engineer in writing of such failure. In the event of any disagreement between the Electrical Subcontractor and the Contractor over the foregoing, and in the absence of any written requests or agreements between the two, the decision of the Engineer shall be final.

3.04 ALUMINUM CONDUITS

Aluminum conduits may be installed.

3.05 INTERIOR CONDUIT SYSTEMS

A. Electrical Subcontractor shall coordinate with Engineer as to locations, sizes and number of conduit sleeves to be installed through cast concrete.

B. Exposed runs of conduit shall have supports not more than 6' -0" apart and shall be installed with runs parallel or perpendicular to walls, structural member, or intersections of vertical planes and ceilings with right angle turns consisting of cast metal fittings or symmetrical bends. Conduit bends and offsets shall be avoided where possible, but where necessary, shall be made with an approved hickey or conduit bending machine. Conduit which has been crushed or deformed in any way shall not be installed. Expansion fittings shall be used to provide for expansion joints. Wooden plugs inserted in masonry or concrete shall not be used to secure conduits or boxes. Conduits shall be supported on approved types of stainless steel wall brackets, ceiling trapeze, straphangers or pipe straps, secured by means of toggle bolts in hollow masonry units, expansion bolts in concrete or brick, machine screws on metal surfaces, and wood screws on wood construction. Provide stainless steel hardware for stainless steel support systems. Conduit shall be installed in such a manner as to insure against trouble from the collection of condensation, and all runs of conduit shall be so arranged as to be devoid of traps wherever possible. The Contractor shall exercise the necessary precautions to prevent the lodgment of dirt, trash, or plaster in conduits, fittings, or boxes during the course of installation. A run of conduit which has become clogged shall be entirely freed of the accumulation or shall be replaced.

C. In corrosive/damp areas, all clamps, fasteners, etc. shall be stainless steel with stainless steel fasteners. (All areas on this project are considered corrosive/damp.)

D. Conduits shall be securely fastened to all junction boxes, pull boxes, and panelboards with galvanized locknuts and bushings, care being taken to establish a firm mechanical and electrical contact between the box and the conduit.

E. Flexible conduit shall be installed only where necessary to overcome vibration at motor connection, and shall be as short as possible between the motor terminal box and the junction box on the branch circuit rigid conduit.

F. All rigid metallic conduit shall utilize threaded fittings.

G. Conduit shall conform to item 2.05, this specification section.

H. Pull boxes, junction boxes and cabinet boxes shall be per item 2.08, this specification section.

3.06 CONDUCTORS

A. A complete system of conductors shall be installed in the raceway system, except where otherwise noted. Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes. Compression type connectors properly taped shall be utilized for all splices

3.07 OUTLETS

A. Outlets shall be installed in locations as indicated on the Contract Drawings. The Subcontractor shall study the general construction plans in relation to the spaces surrounding each outlet in order that the work may fit the other work required by these specifications. Where necessary, the Subcontractor shall relocate outlets so that installed fixtures will not interfere with other work or equipment.

3.08 DEVICE PLATES (non-classified areas)

A. Device plates shall be installed on each outlet to suit the device installed therein. Plates shall normally be installed vertically, with an alignment tolerance of 1/16".

3.09 GROUNDING

A. The conduit system and the neutral conductor of the wiring system shall be grounded. The grounded connection between the electric system neutral and the conduit system shall be made at the main electrical service panel. A bare copper conductor sized per NEC shall be installed in non-metallic conduit from the breaker enclosure to 3 driven ground rods ¾" diameter X 10 ft. long, copperweld, spaced in a triangular pattern with rods 10 ft. on center.

B. In addition, the ground electrode conductor shall be connected by a process approved equal to "Cadweld" process to ground rods and also to reinforcing steel in any associated building foundation, to steel columns in any building with a steel frame, and to any metallic waterline (if any). Provide certified test of recognized testing agency that ground resistance does not exceed 25 ohms.

C. Ground wires shall be grouped and bonded to panel boxes, not to system neutrals. The ground terminal or receptacles shall be bonded to outlet boxes with No. 12 AWG bare or green insulated wire, or other suitable means per the National Electrical Code.

D. All electric equipment shall be grounded.

E. Conduit and/or raceway shall not be utilized as the bonding conductor.

3.10 EXPLOSION PROOF REQUIREMENTS

A. Where encountered, equipment shall be Class 1, Division 1, Group C, D rated. Interior of pump stations are so rated, as is the interior of the leachate loading building and work outdoors and adjacent to the above ground storage tank and the leachate concentrating tank.

3.11 PULLING CABLES

A Cables shall be installed utilizing pulling equipment designed for the types of wireways or conduits installed. Where lubricating material is required, it shall be a material manufactured for and designated by UL label as suitable for the types of insulation involved on the conductors. Care shall be taken during cable pulling not to cause kinks or sharp bends in the conductors. If insulation on conductors is cut or nicked during pulling, the conductors involved shall be removed and replaced at no added cost to the Owner. During pulling, the maximum strain

applied to the conductors shall not exceed 50% of the ultimate strength of the conductors.

3.12 FIELD TESTS

A. As an exception to requirements that may be stated elsewhere in the Contract, the Engineer shall be given 5 working days notice prior to each test.

B. Distribution Conductors 600 Volt Class: Test all 600 volt class conductors to verify that no short circuits or accidental grounds exist. Make tests using an instrument which applies a voltage of approximately 500 volts to provide a direct reading in resistance.

C. Ground Rods: Test ground rods for ground resistance value before any wire is connected. Use a portable ground testing meggar to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground electrode under test. Provide one copy of the meggar manufacturer's directions for use of the ground meggar indicating the method to be used.

D. Test Report:

600 volt cables (identify each cable & test result).

Grounding Electrodes & Systems (identify electrodes and systems, each test).

3.13 EXAMINATION AND APPROVAL OF WORK

A. No work shall be covered before examination and approval by the Engineer and by all inspectors and authorities having jurisdiction. Replace any imperfect or condemned work with work conforming to requirements and satisfactory to the Engineer, without extra cost to the Owner. If work is covered before due inspection and approval, the Subcontractor shall pay all costs of uncovering and reinstating work.

3.14 CLEAN UP AND REPAIR

A. At the completion of the work, the work area shall be left clean. Any damage caused to work of other trades by electrical installation shall be repaired at the expense of the Electrical Subcontractor.

3.15 GUARANTEE

A. Attention is directed to provisions of the General Conditions regarding guarantees and warranties for work under this Contract.

B. Manufacturer shall provide standard guarantees for work under this Section. However, such guarantees shall be in addition to and not in lieu of all other liabilities, which the manufacturer and Subcontractor may have by law or by other provisions of the Contract Documents.

C. All materials, items or equipment and workmanship furnished under this Section shall carry the standard warranty against all defects in material and workmanship for a period of not less than one year from the date of final acceptance of the

work. Any fault due to defective or improper material, equipment, workmanship or design which may develop within that period shall be made good, forthwith by and at the expense of the Subcontractor, including all other damage done to areas, materials and other systems resulting from this failure.

D. This Subcontractor shall guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as are set forth herein or as indicated.

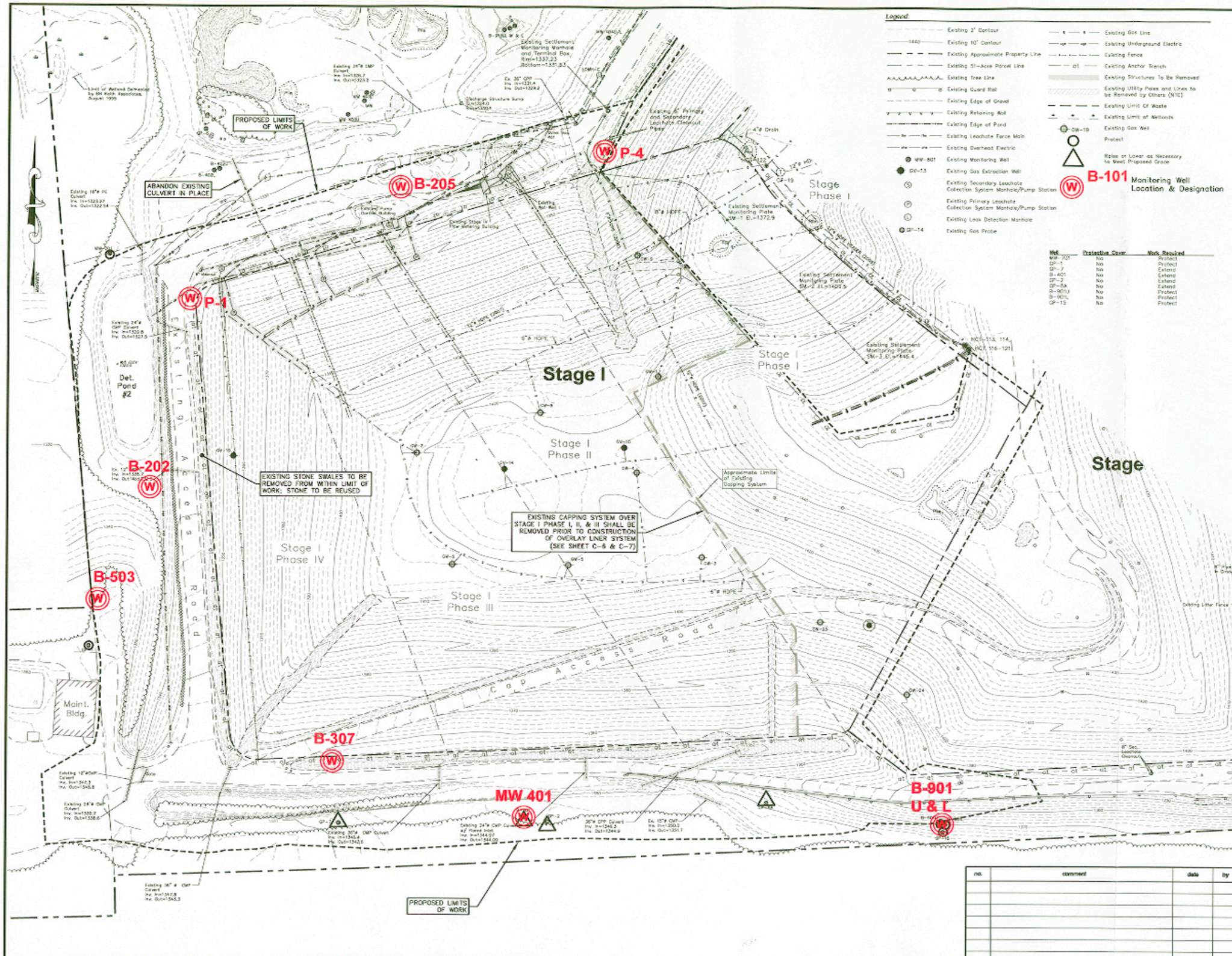
E. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the Subcontractor.

F. This Subcontractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

END OF SECTION

Appendix A

BORING LOGS



Legend

- Existing 2' Contour
- Existing 10' Contour
- Existing Approximate Property Line
- Existing 51-Acre Parcel Line
- Existing Tree Line
- Existing Guard Rail
- Existing Edge of Gravel
- Existing Retaining Wall
- Existing Edge of Pond
- Existing Leachate Force Main
- Existing Overhead Electric
- Existing Monitoring Well
- Existing Gas Extraction Well
- Existing Secondary Leachate Collection System Manhole/Pump Station
- Existing Primary Leachate Collection System Manhole/Pump Station
- Existing Leak Detection Manhole
- Existing Gas Probe
- Existing Gas Line
- Existing Underground Electric
- Existing Fence
- Existing Anchor Trench
- Existing Structures To Be Removed
- Existing Utility Poles and Lines to be Removed by Others (NTC)
- Existing Limit Of Waste
- Existing Limit of Wetlands
- Existing Gas Well
- Protect
- Raise or Lower as Necessary to Meet Proposed Grade
- B-101 Monitoring Well Location & Designation

Well	Protective Cover	Work Required
MW-701	No	Protect
GP-1	No	Protect
GP-7	No	Extend
B-401	No	Extend
GP-2	No	Extend
GP-5A	No	Extend
B-901U	No	Protect
B-901L	No	Protect
GP-15	No	Protect

Notes:

1. Topography was developed by Eastern Topographics based upon aerial photos dated November 4, 2008. Horizontal and vertical ground control was provided by Alpine Land Surveyors, company of Littleton NH. Horizontal datum is based on NAD83(1996) NH State plane coordinates system. Vertical datum is based on NAVD88 conversion of elevation from previous plans based on local datum to NAVD88 accomplished by adding 6.83 ft. Active grades within Stage IV, Phase I will vary due to operation of active landfill.

2. Contractor shall salvage any useable equipment to Owner. Any equipment not kept by the Owner shall become property of Contractor.

3. All features required to be removed shall include all pumps, associated wiring, piping, and equipment. These features shall be decommissioned, removed and disposed of by the Contractor. Contractor shall excavate existing capping system materials over Stage I and segregate and stockpile materials for future reuse at locations designated by Owner. Materials will include topsoil, select sands, screened till and geosynthetics. Geosynthetic materials shall be disposed of by the Contractor.

4. All demolished materials shall be hauled to locations on the site, designated by the Owner for recycling/disposal.

5. Existing drainage pipe may be salvaged for reuse on the project or stockpiled at a location designated by the Owner and as approved by the Engineer. Existing Concrete culverts shall be demolished and hauled off for disposal on-site at location designated by the Owner.

6. Demolition of pump stations, Wet Well I, and leachate piping involves excavation of soil; protection of existing on- and off-site utilities and other facilities; removal of piping, manholes, and compacted backfill.

7. Placement, compaction and grading of all fill materials shall be conducted in accordance with the Excavation and Filling Specifications, Sections 02222 and 02223, respectively. Clean excavated soil can be used for backfill subject to the provisions of these specifications.

8. Contractor shall protect existing monitoring wells and gas probes throughout the course of the work. Wells proposed to be modified through lowering, extension, decommissioning or replacement shall be completed by a licensed NH well contractor in accordance with Section 02960.

9. The work will be conducted in full accordance with the project erosion and sedimentation control plans, specifications, and the Site Specific Permit conditions.

10. Not all landfill gas wells, vents or collection pipes are shown. See Sheets C-21 through C-23 for landfill gas collection system requirements.

11. Please see sheet C-1 for Plan References

CMA ENGINEERS
CIVIL/ENVIRONMENTAL ENGINEERS

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Phone: 603/431-6196
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E-mail: info@cmaengineers.com

North Country Environmental Services, Inc.
Bethlehem, NH

project:
Stage IV Phase II
Type IB & II Permit Application

title:
Site/Boring Location Plan

(in feet)
1 inch = 60 ft.

no.	comment	date	by

designed by: JSM/RJG	date: February 2009
drawn by: DAA/MAM/APV	project no: 656.05
approved by: RJG/WAS	sheet no: 1

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT Senco Landfill Bethlehem, NH	REPORT OF BORING NUMBER P-1 SHEET 1 OF 2 DATE 12/29/86 FILE D-20002

BORING CO. Maine Test Borings, Inc.
FOREMAN Ervin Giguere
GZA ENGINEER Mitchell Plummer

BORING LOCATION See exploration location plan
GROUND ELEV. 1328 MSL
DATE STARTED 12/29/86 DATE ENDED 12/31/86

CASING	SAMPLER
SIZE: SSA to 10'; NW casing to 20'	TYPE: Standard split-spoon OTHER:
HAMMER: 300 lb.	HAMMER: 400 lb.
FALL: 16"	FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	ELEVATION	TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	RMKS.
		S-1	24/21	2-4	8-23-32-31	Very dense, gray-brown, fine to coarse SAND, some Silt, little Gravel.	SILTY SAND		
							4'		
		S-2	24/21	4-6	29-42-73-71	Very dense, gray, fine SAND, little Silt, trace Gravel.			
5									
		S-3	24/15	6-8	53-79-83-82	Very dense, gray, fine SAND, little Silt, trace Gravel.	SILTY FINE SAND		1
	31	S-4	24/22	8-10	32-53-72-93	Very dense, gray, fine SAND, little Silt, trace Gravel.			
	29								
10									
	54	S-5	24/12	10-12	29-30-34-95	Very dense, gray, fine SAND, some Silt, trace Gravel.			2
	37								
	169	S-6	24/14	12-14	125-79-46-59	Very dense, gray, fine SAND, little Silt, little Gravel.			3
	151								
							14'		
	81	S-7	24/12	14-16	51-41-71-69	Very dense, gray-brown, fine to medium SAND, little Silt, little Gravel.			
15	87						SAND		
	70	S-8	24/17	16-18	43-36-61-98	Very dense, brown, fine to medium SAND, little Silt, trace Gravel.			
	213								
							18'		
	189	S-9	12/11	18-19	76-193	Very dense, gray-brown, fine to coarse SAND, some Silt, trace Gravel.			
	463								
20							SILTY SAND		
		S-10	18/15	20-21.5	41-141-203	Very dense, brown, fine to coarse SAND, some Gravel, little Silt.			
		S-11	11/11	221-23	142-217/5"	Very dense, brown, fine to coarse SAND, some Silt, little Gravel.			
		S-12	17/16	24-25.4	59-27-200/5"	Very dense, gray-brown, fine to coarse SAND, some Silt, little Gravel.			
25									

REMARKS:
1. S-3" 2" brown, fine to coarse SAND, some Silt, at top of sample.
2. S-5: Some thin laminae of Silty SAND.
3. S-6: One broken cobble in spoon.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT Sanco Landfill Bethlehem, NH	REPORT OF BORING NUMBER P-1 SHEET 2 OF 2 DATE 12/19/86 FILE D-20002

BORING CO. Maine Test Borings, Inc.
FOREMAN Ervin Giguere
GZA ENGINEER Mitchell Plummer

BORING LOCATION See exploration location plan
GROUND ELEV. 1328 MSL
DATE STARTED 12/29/86 DATE ENDED 12/31/86

CASING	SAMPLER
SIZE: SSA to 10'; NW to 20'	TYPE: Standard split-spoon OTHER:
HAMMER: 300 lb.	HAMMER: 140 lb.
FALL: 16"	FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING	STABILIZATION TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. and GEN. DESC.	EQUIPMENT INSTALLED	RMKS.
							26'		
		S-13	24/23	26-28	35-42-56-51	Very dense, gray, SILT and fine to coarse Sand, little Gravel.			
		S-14	24/23	28-30	47-56-62-57	Very dense, bluish-gray, SILT and fine to coarse Sand, little Gravel. No Plasticity.	SANDY SILT		
30		S-15	24/24	30-32	18-26-32-38	Very dense, bluish-gray, SILT and fine to coarse SAND, little Gravel. No Plasticity.			
		S-16	24/24	32-34	22-27-33-42	Very dense, bluish-gray, SILT and fine to coarse Sand, little Gravel. No Plasticity.			
		S-17	24/24	34-36	20-32-42-56	Very dense, bluish-gray, SILT and fine to coarse SAND, little Gravel. No Plasticity.			
35							36' SANDY SILT & CLAY		
		S-18	24/24	36-38	27-39-47-56	Hard, bluish-gray, SILT & CLAY, some fine Sand, trace Gravel. Low plasticity.			
		S-19	19/18	38.4-40	37-43-52-51/1"	Very dense, brown, fine to medium SAND & Gravel, little Silt.	38.1' COBBLE 38.4' GRAVELLY SAND		
40						Bottom of Boring @ 40.0'.	40.0'		4,5 6,7

REMARKS:
4. Unable to allow reasonable stabilization time; no groundwater readings.
5. No refusal encountered.
6. Washed ahead of casing from 10' to bottom of boring.
7. Boring sealed with bentonite/cement grout upon completion.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Sanborn Landfill, Bethlehem, NH

REPORT OF BORING NUMBER: P-4
SHEET: 1 OF: 2
DATE: 12/22/86 FILE: D-20002

BORING CO.: Maine Test Boring
FOREMAN: Ervin Giguère
GZA ENGINEER: Mitch Plummer

BORING LOCATION: See exploration location plan
GROUND ELEV.: 1341 MSL
DATE STARTED: 12/22/86 DATE ENDED: 12/29/86

CASING
SIZE: SSA to 9', MW to 35'
HAMMER: 300 lb
FALL: 16"

SAMPLER
TYPE: 1 3/8" I.D. Std. SS
HAMMER: 140 lb.
FALL: 30"
OTHER: "

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
12/24	33.1	35'	Overnight
12/29	35.5	38'	5 days

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. and GEN. DESC.	EQUIPMENT INSTALLED	RMKS.
							TOPSOIL 1'		
		S-1	18/12	1-2.5	6-7-24	Dense, brown, fine to medium SAND, some Silt, some Gravel.	SILTY SAND		
		S-2	18/12	2.5-4	21-27-103	Very dense, gray-brown, fine to medium SAND, some Silt, some Gravel.	4'		
5		S-3	18/13	4-5.5	24-23-48	Very dense, gray, fine to coarse SAND, little Silt, trace Gravel.			
		S-4	24/10	5.5-7.5	27-40-35-42	Very dense, gray, fine to coarse SAND, little Silt, trace Gravel.	SAND		
		S-5	18/12	7.5-9	24-29-36	Very dense, gray, fine to coarse SAND, little Silt, trace Gravel.			
	19	S-6	24/16	9-11	10-14-23-24	Dense, gray-brown, fine SAND, little Silt.	9"		
10	21								
	47	S-7	18/12	11-12.5	21-23-24	Dense, gray-brown, fine SAND, little Silt.	FINE SAND		
	117								
		S-8	24/18	125-145	23-112-93-122	Very dense, gray-brown, fine SAND little Silt.	13'		
	187								
	138						SAND		
15		S-9	16/9	14.5-15.8	83-134-200/4"	Very dense, gray-brown, fine to coarse SAND, little Gravel, little Silt.	15.7'		
	51						BOULDER 16.5'		
	79	S-10	18/12	16.5-18	42-72-142	Very dense, gray-brown, fine to coarse SAND, little Gravel, little Silt.	SAND		
	127								
	372	S-11	24/18	18-20	106-124 221-239	Very dense, gray-brown, fine to coarse SAND and Gravel, some Silt; grading to fine to coarse SAND, little Gravel, little Silt.			
	39								
20	273	S-12	5/5	20-20.4	63/5"	Very dense, dark gray, fine SAND, little Silt.	20.4'		
							BOULDER 21.7'		
	312								
	327	S-13	24/12	22-24	32-61-68-178	Very dense, greenish-brown, fine to coarse SAND, little Silt, trace Gravel.	SAND		
	507								
	117	S-14	5/0	24-24.4	237/5"	No Recovery.	24.4'		
							COBBLE		

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Sanco Landfill, Bethlehem, NH

REPORT OF BORING NUMBER P-4
SHEET 2 OF 2
DATE 12/22/86 FILE D-20002

BORING CO. Maine Test Boring, Inc.
FOREMAN Ervin Giguere
GZA ENGINEER Mitchell Plummer

BORING LOCATION See exploration location plan
GROUND ELEV. 1341 MSL
DATE STARTED 12/22/86 DATE ENDED 12/29/86

CASING
SIZE: SSA to 9'; NW casing to 35'
HAMMER: 300 lb.
FALL: 16"

SAMPLER
TYPE: Standard split-spoon OTHER:
HAMMER: 140 lb.
FALL: 16"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. and GEN. DESC.	EQUIPMENT INSTALLED	RMKS.
	47								
	143	S-15	24/12	26-28	42-62-117-123	Very dense, fine to medium SAND, trace Silt.	SAND		
	469								
	44	S-16	16/12	28-29.3	32-117-192/4"	Very dense, gray-green, fine to coarse SAND, some Gravel, little Silt.	29.3' COBBLE		
	28						29.8'		
30	89								
	47								
	44	S-17	24/16	32-34	37-78-147-161	Very dense, gray-brown, fine to coarse SAND, trace Silt, trace Gravel.			
	50								
	323	S-18	18/12	34-35.5	42-90-231	Very dense, grayish-greenish, fine to coarse SAND, some Gravel, little Silt.	SAND		1, 2
35									
		S-19	24/20	36-38	75-80-125-149	Very dense, gray-brown, fine to coarse SAND, little Silt, trace Gravel.			
		S-20	24/24	38-40	89-192-216-211	Very dense, brown, fine to coarse SAND, little Gravel, little Silt.			3
40						Bottom of Boring @ 40.0'.	40.0'		4, 5

REMARKS:
1. S-18: some subtle layering of fine SILT & SAND lenses.
2. Permeability test conducted from 38' to 40'.
3. Boring sealed with bentonite/cement grout upon completion.
4. No refusal encountered.
5. Washed ahead of casing from 10' to bottom of boring.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

MAINE TEST BORINGS, INC. BREWER, MAINE 04412	CLIENT Sanco, Inc.	SHEET 1 OF 3 HOLE NO. B-202
DRILLER Gerry Rudnicki	PROJECT NAME landfill	LINE & STATION
JOB NUMBER 86-4	LOCATION Bethlehem, NH	OFFSET

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BARREL	
AT ____ FT AFTER ____ HOURS	TYPE	NW	SS		DATE START 1/14/86 DATE FIN. 1/17/86
AT ____ FT. AFTER ____ HOURS	SIZE I.D.	3"	1 3/8"		SURFACE ELEV.
	HAMMER WT.	300	140		GROUND WATER ELEV.
	HAMMER FALL	16"	30"		

	CASING BLOWS PER FOOT	SAMPLE NO	O.D.	PEN.	REC	DEPTH @ BOT	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	VANE READING	DEPTH	STRATUM DESCRIPTION
	pledge											
	"											Brown silty fine sand w/med. to coarse sand, gravel, cobbles.
	"	D	2"	2"	0.0	2.2	100					
	"										4.0	
	"											
	62	1D	2"	12"		6.0	90	106				
	147											Brown silty fine sand w/med. to coarse sand, gravel, cobbles
	296											
	313											
shell	27											
pad	29	2D	2"	8"		10.7	93	100			11.5	
"	110											
"	86											
"	96											
	125											
	18											Brown silty fine to med. sand w/coarse sandy gravel, cobbles.
	31	3D	2"	18"		16.5	63	56	41			Siltier w/depth
"	43											Brown Till
"	62											
	69											
	60											
	96	4D	2"	18"		21.5	51	34	27			
	88											
	88											
	75											
	53											
	50	5D	2"	18"		26.5	45	46	30			
	71										28.0	
	64											
	62											Brown fine to med. sand w/gravel, cobbles, trace of coulders, trace of silt.
"	44	6D	2"	12"		31.0	140	99				
"	80											Brown Sand and gravel
"	78										33.0	
"	165											
"	249											
"	65											
"	59	7D	2"	18"		36.5	73	47	57			Brown fine to med. sandy gravel w/cobbles & silt.
"	96											
"	170											
"	250											

SAMPLES
- D = Split Spoon
- C = 2" Shelby Tube
- U = 3½" Shelby Tube

SOIL CLASSIFIED BY:
- [X] Driller - Visually
- [ ] Soil Technician - Visually
- [ ] Laboratory Tests

REMARKS:

HOLE NO. B-202

TB-14

MAINE TEST BORINGS, INC. BREWER, MAINE 04412	CLIENT Sanco, Inc.	SHEET 2 OF 3 HOLE NO. B-202
DRILLER Gerry Rudnicki	PROJECT NAME landfill	LINE & STATION
T.B. JOB NUMBER 86-4	LOCATION Bethlehem, NH	OFFSET

GROUND WATER OBSERVATIONS

AT ____ FT AFTER ____ HOURS

AT ____ FT. AFTER ____ HOURS

	CASING	SAMPLER	CORE BARREL
TYPE	NW	SS	
SIZE I.D.	3"	1 3/8"	
HAMMER WT.	300	140	
HAMMER FALL	16"	30"	

DATE START 1/14/86 DATE FIN 1/17/86

SURFACE ELEV. ____

GROUND WATER ELEV. ____

	CASING BLOWS PER FOOT	SAMPLE NO.	O.D.	PEN.	REC.	DEPTH @ BOT	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	VANE READING	DEPTH	STRATUM DESCRIPTION
washed	52											
ahead	124	8D	2"	16"		41.3	49	90	100			Brown fine to med. sandy gravel w/cobbles & silt.
"	65											
"	140										44.0	
"	195											Gray silty sand and gravel
"	139											
"	192	9D	2"	18"		46.5	60	46	106			
"	197											
"	242											
"	288											
	86											
	99	10D	2"	18"		51.5	39	25	25			Gray silty fine to coarse sandy gravel w/cobbles. GREY TILL
	120											
	204											
	140											
	71	D	2"	2"	0.0	55.2	150					
	105											
"	212											
"	281											
"	416											
"	129	11D	2"	12"		61.0	84	163				
"	123											
"	134											
"	236											
"	342											
"	63											
"	100	12D	2"	16"		66.3	93	107	150			
"	122											
"	120										69.0	
"	143											
"	109	D	2"	2"	0.0	70.2	150					
"	187											
"	273											
"	457											
"	271											Cobbles with gray fine sand, trace of med. to coarse sand, gravel, silt.
"	124	D	2"	4"	0.0	75.3	150					
"	112	D	2"	2"	0.0	76.2	150					
"	150											
"	500											
"												

SAMPLES
D - Split Spoon
C - 2" Shelby Tube
U - 3½" Shelby Tube

SOIL CLASSIFIED BY:
[X] Driller - Visually
[ ] Soil Technician - Visually
[ ] Laboratory Tests

REMARKS

HOLE NO. B-202

MTB-14

MAINE TEST BORINGS, INC. BREWER, MAINE 04412	CLIENT Sanco, Inc.	SHEET 3 OF 3 HOLE NO. B-202
DRILLER Gerry Rudnicki	PROJECT NAME landfill	LINE & STATION
J.O. JOB NUMBER 6-4	LOCATION Bethlehem, NH	OFFSET

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BARREL	
AT ____ FT. AFTER ____ HOURS	TYPE	NW	SS		DATE START 1/14/86 DATE FIN. 1/17/86
	SIZE I.D.	3"	1 3/8"		SURFACE ELEV.
AT ____ FT. AFTER ____ HOURS	HAMMER WT.	300	140		GROUND WATER ELEV.
	HAMMER FALL	16"	30"		

CASING BLOWS PER FOOT	SAMPLE NO.	O.D.	PEN.	REC.	DEPTH @ BOT	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	VANE READING	DEPTH	STRATUM DESCRIPTION
washed ahead	13D	2"	14"		81.2	64	43	150			Cobbles w/gray fine sand, trace of med. to coarse sand, gravel, silt.
"										83.0	
											Bottom of boring @ 83.0'
											Installed 2 wells

SAMPLES
D = Split Spoon
C = 2" Shelby Tube
U = 3½" Shelby Tube

SOIL CLASSIFIED BY:
[X] Driller - Visually
[ ] Soil Technician - Visually
[ ] Laboratory Tests

REMARKS:

HOLE NO. B-202

MTB-14

MAINE TEST BORINGS, INC. BREWER, MAINE 04412	CLIENT Sanco, Inc.	SHEET 1 OF 1 HOLE NO. B-202A
DRILLER Gerry Rudnicki	PROJECT NAME landfill	LINE & STATION
M.T.B. JOB NUMBER 86-4	LOCATION Bethlehem, NH	OFFSET

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BARREL	
AT ____ FT AFTER ____ HOURS	TYPE	NW			DATE START 1/21/86 DATE FIN. 1/21/86
	SIZE I.D.	3"			
AT ____ FT. AFTER ____ HOURS	HAMMER WT.	300			SURFACE ELEV.
	HAMMER FALL	16"			GROUND WATER ELEV.

CASING BLOWS PER FOOT	SAMPLE NO	O.D.	PEN.	REC.	DEPTH @ BOT	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	VANE READING	DEPTH	STRATUM DESCRIPTION
probe											Brown silty fine sand w/med. to coarse sand, gravel, ~~& cobbles~~.
"											
"											
"										4.0	
"											
"											
"											Brown ~~Gray~~ silty fine sand w/med. to coarse sand, fine gravel ~~& cobbles~~.
"											
"											
"											
"											
"										11.5	
"											
"											
"											
"											
50											Brown silty fine to med. sand w/coarse sand, gravel, & cobbles.
52											
61											
51											
59										20.0	
											Bottom of boring @ 20.0'
											Installed well

SAMPLES
D = Split Spoon
C = 2" Shelby Tube
U = 3½" Shelby Tube

SOIL CLASSIFIED BY:
[X] Driller - Visually
[ ] Soil Technician - Visually
[ ] Laboratory Tests

REMARKS:

HOLE NO. B-202A

MTB-14

MAINE TEST BORINGS, INC. BREWER, MAINE 04412	CLIENT Sanco, Inc.	SHEET 1 OF 1 HOLE NO. B-205
DRILLER Gerry Rudnicki	PROJECT NAME landfill	LINE & STATION
F&B JOB NUMBER 86-4	LOCATION Bethlehem, NH	OFFSET

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BARREL	
AT ____ FT AFTER ____ HOURS	TYPE	NW	SS		DATE START 1/10/86 DATE FIN. 1/13/86
AT ____ FT. AFTER ____ HOURS	SIZE I.D.	3"	1 3/8"		SURFACE ELEV.
	HAMMER WT.	300	140		GROUND WATER ELEV.
	HAMMER FALL	16"	30"		

	CASING BLOWS PER FOOT	SAMPLE NO.	O.D.	PEN.	REC.	DEPTH @ BOT	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	VANE READING	DEPTH	STRATUM DESCRIPTION
	prote											
	"											Brown silty fine sand w/med. to coarse gravel, cobbles, trace of boulders
	"	1D	2"	5"		2.4	100					
	"											
	"										5.2	
	126											
	161	2D	2"	18"		6.5	36	58	69			
	103											
	76											Gray, brown silty fine sand - fine sandy silt w/ trace of coarse sand
	66											
	21											
	26	3D	2"	18"		11.5	13	14	19			
	43											
	51											
	53											
	30										16.2	
	32	4D	2"	18"		16.5	17	15	25			
	46											
	31											
	57											Brown silty fine sand - fine sandy silt w/med. to coarse sand, trace of gravel.
ushed	31	5D	2"	12"		21.0	58	78				
head	26											
"	20											
"	27										24.0	
"	29											
"	21											
"	19	6D	2"	17"		26.4	35	64	100			
"	42											
"	43											Gray fine sandy silt w/trace of silt layers, & fine sand layers.
"	52											
"	40	7D	2"	12"		31.0	50	118				
"	43											
"	42											
	77											
	114											
											36.5	
		8D	2"	18"		36.5	42	77	121			
												Bottom of boring @ 36.5' installed well

SAMPLES
D = Split Spoon
C = 2" Shelby Tube
U = 3½" Shelby Tube

SOIL CLASSIFIED BY:
[X] Driller - Visually
[ ] Soil Technician Visually
[ ] Laboratory Tests

REMARKS

HOLE NO. B-205

MTB-14

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Sanco Landfill, Bethlehem, NH

REPORT OF BORING NUMBER B-307
SHEET 1 OF 2
DATE 1/6/87 FILE D-20002

BORING CO. Haley Test Boring, Inc.
FOREMAN Tom Schaefer
GZA ENGINEER Paul Sirois/Mitch Plummer

BORING LOCATION See exploration location plan
GROUND ELEV. 1351.8 MSL
DATE STARTED 1/6/87 DATE ENDED 1/14/87

CASING
SIZE: HW to 21', NW to 80'
HAMMER: 300 lb.
FALL: 16"

SAMPLER
TYPE: Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
1/9	40.5	45	overnight
1/12	42.5	60	overnight

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. AND GEN. DESC.	EQUIPMENT INSTALLED	RMKS.
								0.5' CONCRETE SEAL	1
								1.0' BENTONITE SEAL	
		S-1	18/18	2-3.5	7-12-12	Medium dense, brown, fine to coarse SAND, trace Gravel, trace Silt.		PROTECTIVE CASING	
5		S-2	18/18	5-6.5	12-13-13	Medium dense, brown, fine to medium SAND, little Silt.		WASHED SAND	
								6.0' BENTONITE SEAL	
								8.0'	
10	66	S-3	18/14	10-11.5	22-28-34	Very dense, brown, fine to coarse SAND, trace Gravel, trace Silt.	SAND	WASHED SAND	
	82								
	97								
	140								
	171								
15	24	S-4	18/12	15-16.5	54-130-205	Very dense, brown, fine to medium SAND, little Silt.		3/4" PVC RISER PIPE	
	27								
	26								
	28								
	31								
20	29	S-5	13/13	20-21.1	73-113-124/1"	Very dense, brown, fine to coarse SAND, little Silt, little Gravel.	21.2' BOULDER 22.5'		
	32								
	47								
	53								
	97								
25	57	S-6	10/10	25-25.8	65-198/4"	Very dense, brown, fine to coarse SAND, little Silt, little Gravel.	SAND		
	51								
	89								
	49						29'	COLLAPSED FORMATION 29.5'	
	47								
30	53	S-7	5/5	30-30.4	179/5"	Very dense, brown, fine to coarse SAND, some Gravel, little Silt.		BENTONITE SEAL	
	57								
	61								
	79								
	85						GRAVELLY SAND		
35	59	S-8	3/1	35-35.3	154/3"	Very dense, brown, fine to coarse SAND, some Gravel, little Silt.			
	73								
	76							37.8'	
	83								
	97								
40	198	S-9	18/12	40-41.5	65-118-198	Very dense, brown, fine to medium SAND, little Silt.	40'	40.0'	
	73							WASHED SAND	
	39								
	46								
	49								
45	23	S-10	18/15	45-46.5	24-32-65	Very dense, fine to medium SAND, little Silt, trace Gravel.	SAND	3/4" SLOTTED PVC WELLSCREEN	2
	27								
	26								
	31								
	39						49'	50.0'	

REMARKS:

1. Boring advanced with solid stem augers to 10'; augers removed and NW casing subsequently driven to 20'. Encountered 1.3' diameter boulder at 21.2' and cored with NX core barrel after advancing roller bit to 22'. Removed NW casing and drove HW to 21', spon H core barrel through boulder and telescoped NW casing through open hole to 25'. Washed ahead of casing from 20' to bottom of boring.
2. Permeability tests conducted at 45' and 80'.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT Sanco Landfill Bethlehem, NH	REPORT OF BORING NUMBER B-307 SHEET 2 OF 2 DATE 1/8/87 FILE D-20002

BORING CO. Maine Test Boring, Inc.
FOREMAN Tom Schaefer
GZA ENGINEER Paul Sirois/ Mitch Plumer

BORING LOCATION See exploration location plan
GROUND ELEV. 1351.8' MSL
DATE STARTED 1/6/87 DATE ENDED 1/14/87

CASING	SAMPLER
SIZE: HW to 21', NW to 80'	TYPE: Split Spoon OTHER:
HAMMER: 300 lb.	HAMMER: 140 lb.
FALL: 16"	FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. and GEN. DESC.	EQUIPMENT INSTALLED	RMKS.
	28	S-11	6/6	50-50.5	196	Very dense, gray, fine to coarse SAND and Gravel, trace Silt.	GRAVELLY SAND	50.5' WASHED SAND; BENTONITE SEAL; 52.5'	
	36								
	99								
	123								
55	167								
	187						56'		
	215								
	237								
	298								
	362								
60	62	S-12	18/15	60-61.5	32-49-137	Very dense, fine to coarse SAND, little Silt, trace Gravel.	SAND	3/4" PVC RISER PIPE	1
	74								
	153								
	187								
	189							COLLAPSED FORMATION	
65	197						66'		
	234								
	234								
	293								
	327								
70	131	S-13	18/16	70-71.5	66-85-142	Very dense, gray, fine to coarse SAND, some Gravel, trace Silt.	GRAVELLY SAND	73.0' BENTONITE SEAL	
	149								
	152								
	153								
	173						75'	75.0'	
75	71							76.0' COLLAPSED FORMATION; 76.5' BENTONITE SEAL	
	78								
	89						SAND	FILTER SAND	
	124							78.5' 3/4" SLOTTED PVC WELLSCREEN	
	132								
80		S-14	18/12	80-81.5	43-62-67	Very dense, brown, fine to coarse SAND, little Silt, trace Gravel.	81.5'	80.5' 81.5' COLLAPSED FORMATION	2
						Bottom of Boring @ 81.5'.			

REMARKS:
3. S-12: No recovery in first attempt; 15" recovery in second attempt.
4. No refusal encountered.
5. Piezometer with 7' x 3" ID protective steel casing equipped with a vented locking cap installed at completion of boring. 2.5' stickup above ground surface.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

Berkeley, NH

SHEET 1 OF 1 DATE [illegible] FILE [illegible]

B-401

BORING CO. Maine Test Borings, Inc.
FOREMAN Irving Gimmer
GEA ENGINEER Doug Lansing

BORING LOCATION See Exploration Location Plan
GROUND ELEV. 1342.84 Site Datum
DATE STARTED 9/23/87 DATE ENDED 9/23/87

CASING	SAMPLER
SIZE: SSA to 5', NW to 45'	TYPE: 2" x 18" split spoon OTHER:
HAMMER: 300 lb	HAMMER: 140 lb
FALL: 20	FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
9/25	13.7	screened	48 hours

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. and GEN. DESC.
5		S-1	18/16	5-6.5	18-22-21	Dense, olive-brown, fine to medium SAND, little Silt, trace Gravel.	
	10						
	26						
	43						
	105						GLACIAL TILL
10	167						
	6	S-2	12/12	10-11	11-17-7	Very dense, olive-brown, fine to medium SAND, trace Silt, trace fine Gravel.	
	3						
	61						
	213						
15	139						
	27	S-3	4/3	15-15.3	126/4"	Very dense, olive-brown, fine to medium SAND, some Silt, little Gravel.	
	29						
	29						
	22						
20	28						
	27	S-4	6/6	20-20.5	100/6"	Very dense, olive-brown, fine to medium SAND, some Silt, little Gravel.	
	44						
	26						
	36						
25	49						
	31	S-5	12/12	25-26	46-75	Very dense, olive-brown, fine to medium SAND, some Silt, little Gravel.	
	36						
	45						28'
	43						
30	57						
	46	S-6	6/6	30-30.5	106/6"	Very dense, olive-brown, fine to medium SAND, trace Silt, trace fine Gravel.	
	37						
	41						STRATIFIED DRIFT
	39						
35	52						
	30	S-7	18/18	35-36.5	31-36-64	Very dense, olive-brown, fine to medium SAND, trace Silt, trace Gravel.	
	35						
	40						
	42						
40	78						
	32	S-8	18/12	40-41.5	31-37-49	Very dense, olive-brown, fine to medium SAND, little fine Gravel, trace Silt.	
	33						
	27						
	41						
45	83						
		S-9	18/12	45-46.5	37-46-59	Very dense, olive-brown, fine SAND, trace Silt.	
50							
		S-10	18/18	50-51.5	34-32-56	Very dense, olive-brown, fine to medium SAND, trace Silt.	51.5'
52						Bottom of boring at 51.5	

EQUIPMENT INSTALLED

REMARKS:
1. A thickness of approximately 18 inches of topsoil had been removed from the boring location to facilitate access.
2. Washed ahead of casing from 5 feet to bottom of the boring.
3. Monitoring well with 7' x 2" I.D. steel casing equiped with a vented locking cap installed at completion of the boring.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL, 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE

RECEIVED
OCT 03 1994

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Sanco Landfill, Bethlehem, NH

REPORT OF BORING NUMBER B-503
SHEET 1 OF 1
DATE 9/15/87 FILE D-20002.2

BORING CO. Maine Test Boring
FOREMAN John Budnicki
GZA ENGINEER Doug Lansing

BORING LOCATION See Monitoring Well Location Plan
GROUND ELEV. 1351.6'
DATE STARTED 9/15/87 DATE ENDED 9/16/87

CASING
SIZE: 3" NW from 10'
HAMMER: 300 lb.
FALL: 20"

SAMPLER
TYPE: 3" x 18" split spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
9/16	Dry	37	18 hours
9/17	42.8	screened	18 hours
9/21	42.9	screened	5 days

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	RMKS.
						Dark brown, fine to medium SAND, some Silt, with organic material, and with 1-3' diameter boulders observed at surface.	TOPSOIL 1.0'	PROTECTIVE CASING; CEMENT/BENTONITE SEAL 4'	
5		S-1	6/4	5-5.5	138/6"	Very dense, olive-gray, fine to medium SAND, little Silt, trace Gravel.			1
10	19, 12, 1, 1, 85	S-2	8/6	10-10.7	94- 50/2"	Very dense, olive-gray, fine to medium SAND, little Silt, trace fine Gravel.		14" PVC RISER PIPE	
15	36, 35, 38, 36, 108	S-3	6/6	15-15.5	200/6"	Very dense, olive-gray, fine to medium SAND, little Silt, little Gravel.	GLACIAL TILL		
20	41, 25, 22, 24, 170	S-4	6/6	20-20.5	90/6"	Very dense, olive-gray, fine to coarse SAND, some Gravel, little Silt.		FILTER SAND AND FORMATION MATERIAL	
25	52, 75, 107, 180, 58	S-5	2/1	25-25.5	100/2"	Similar to above.			
30	80, 130, 94, 153, 170	S-6	6/5	30-30.5	135/6"	Very dense, olive-gray, fine to coarse SAND, some Gravel, little Silt.		32.0' BENTONITE SEAL	
35	110, 183, 51, 30, 210	S-7	0/0	35	150/0"	No recovery.	39'	35.7'	
40	67, 48, 214, 225, 132	S-8	3/1	41-41.3	100/3"	Very dense, olive-gray, GRAVEL and fine to coarse Sand, little Silt.		40' 14" PVC (.01" slotted) WELL SCREEN	
		C-1	12/9	43-44		Cobble with Gravel.			
		C-2	12/6	44-45		Cobble with Gravel.	STRATIFIED DRIFT	FILTER SAND	
45	65, 208, 240, 280								
50		S-9	12/10	50-51	78-96	Very dense, brown to gray, fine to coarse SAND, little Gravel, trace Silt.		50'	

Bottom of boring at 51.0'.

REMARKS: 1. Washed ahead of casing from 10 feet to bottom of boring.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER

Sanborn, Head & Associates, Inc.

Log of Well B-901U

PROJECT NO.: *1647*

PROJECT: *North Country Environmental Services, Inc.*

DATE STARTED: *3/31/99* DATE FINISHED: *3/31/99*

LOCATION: *Bethlehem, New Hampshire*

SURFACE ELEVATION: *1363.80' (NAVD '88)*

DRILLING METHOD: *CME 550x Rig w/4 1/4" ID HSA*

DRILLING COMPANY: *Capital Environmental Drilling, Inc.*

FOREMAN: *Mark Voisine*

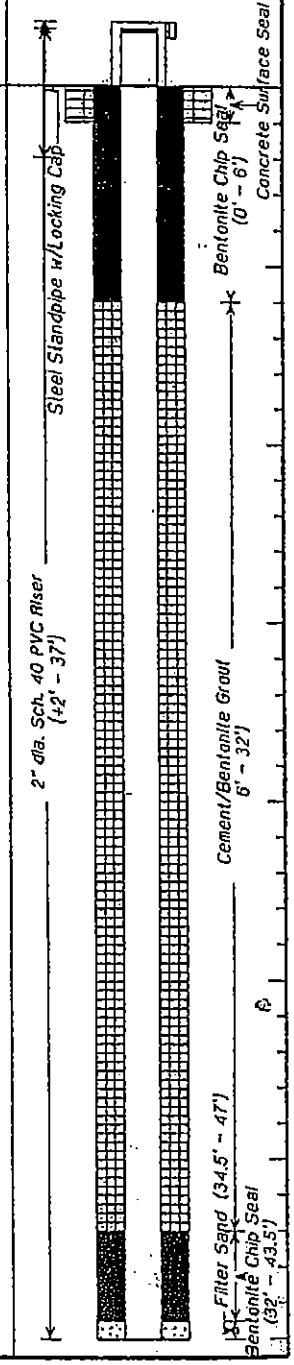
LOGGED BY: *DRP* CHECKED BY: *RSS*

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
3/31/99	16:00	47.2'PVC	Well Inst	15 mins
4/1/99	08:45	47.2'PVC	Well Inst	16.5 hrs.
4/2/99	07:45	47.3'PVC	Well Inst.	40 hrs.

DEPTH feet	SAMPLE NO. Depth (ft.)	BLOWS/6"	PEN/REC (in.)	PID (ppm) VALUES	PID (ppm) PROFILE 0 200	GRAPHIC LOG	STRATUM DESCRIPTION	GEOLOGIC DESCRIPTION
	S-1 0-2'	12-7 7-3	24/18				TILL FILL	S-1: Medium dense, fine to coarse SAND, some Silt, trace Gravel, FILL;
							TOPSOIL	Change at 1.5' to brown, SILT, little Organic Material, trace fine to medium Sand. TOPSOIL. Dry.
5	S-2 5-7'	15-20 17-24	24/20					S-2: Dense, olive, fine to coarse SAND and Silt, trace Gravel. Dry.
10	S-3 10-12'	9-13 25-36	24/15					S-3: Dense, olive, fine to medium SAND and SILT, trace Gravel. Dry.
15	S-4 15-16' S-4A 16-17'	14-28 30-40	24/16					S-4: Very dense, olive, fine SAND and Silt, trace Gravel; stratified. S-4A: Change at 16' to gray-brown, fine to coarse SAND and Gravel, little Silt. Dry.
							STRATIFIED DRIFT	
20	S-5 20-22'	26-49 87-83	24/22					S-5: Very dense, olive, fine to coarse SAND, some Silt, little Gravel, stratification from 20-21'. Dry.
25	S-6 25-27'	29-69 90-100/3.5"	22/22					S-6: Very dense, olive, fine to coarse SAND, some Silt, trace Gravel, slight stratification. Dry.
30	S-7 30-32'	17-19 32-50	24/20					S-7: Very dense, olive, Clayey SILT, trace fine Sand, stratified with 3" thick fine Sand seam at 30.3'. Dry. S-8: Very dense, olive, Clayey SILT, trace fine Sand, slight stratification. Moist.
35								

WELL DIAGRAM



Sanborn, Head & Associates, Inc.

Log of Well B-901U

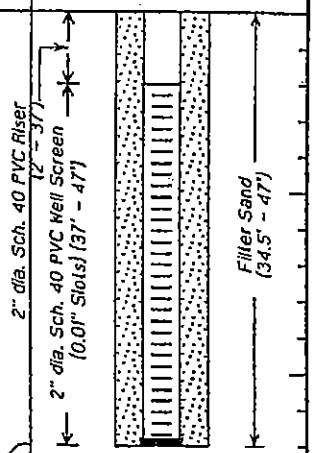
PROJECT NO.: 1647

PROJECT: North Country Environmental Services, Inc.

DATE STARTED: 3/31/99 | DATE FINISHED: 3/31/99

DEPTH feet	SAMPLE NO. Depth (ft.)	BLOWS/6"	PEN/REC (in.)	PID (ppm) VALUES	PID (ppm) PROFILE 0 200	GRAPHIC LOG	STRATUM DESCRIPTION	GEOLOGIC DESCRIPTION
	S-8 35-37'	17-28 34-52	24/18					
	S-9 37-39'	17-27 31-35	24/21					S-9: Very dense, olive, Clayey SILT, trace fine Sand, slight stratification. Wet.
	S-10 38-40.2	13-22 36-48	24/18					S-10: Very dense, olive, SILT & CLAY, trace fine Sand, stratified. Wet;
40	S-10A 40.2'-41'	19-37 41-45	24/20				STRATIFIED DRIFT	S-10A: Change at 40.2' to olive, fine to medium SAND, trace Silt. Dry.
	S-11 41-43'							S-11: Very dense, olive-brown, fine to coarse SAND, little Gravel, trace Silt;
	S-12 43-45'	11-27 25-34	24/15					Change at 42.5' to olive, SILT, trace fine Sand. Stratification. Wet.
45	S-13 45-47'	7-11 18-30	24/19					S-12: Very dense, olive, fine to coarse SAND, little Silt, trace Gravel. Wet.
								S-13: Very dense, olive, fine to coarse SAND, trace Gravel, trace Silt. Slight stratification. Wet.
								Bottom of Boring at 47'.
50								**Notes:**
								1) Approximately 1-1.5' of frost observed in first soil sample.
								2) Groundwater was observed in soil samples from 35-47'.
55								3) The presence of landfill gas was noted during drilling and after the well was installed. Measurements of gas venting from the top of the completed well with an Indstrial Scientific LTX-310 O2/LEL/H2S meter indicated 20.97% oxygen, 0% H2S and 100% LEL.
60								
65								
70								
75								

WELL DIAGRAM



Sanborn, Head & Associates, Inc.

Log of Well B-901L

PROJECT NO.: 1647

PROJECT: North Country Environmental Services, Inc.

DATE STARTED: 4/01/99 | DATE FINISHED: 4/07/99

LOCATION: Bethlehem, New Hampshire

SURFACE ELEVATION: 1361.4' (NAVD '88)

DRILLING METHOD: CME 550x Rig PW/HW Cased Boring

DRILLING COMPANY: Capital Environmental Drilling, Inc.

FOREMAN: Mark Voisine

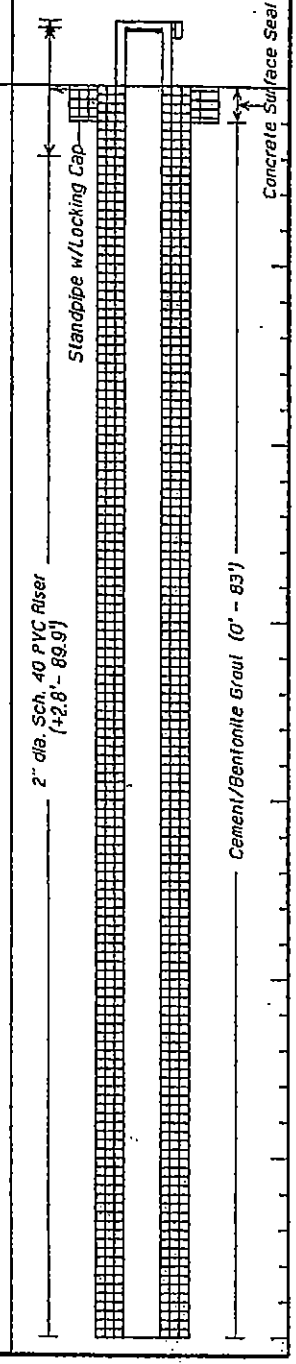
LOGGED BY: DRP | CHECKED BY: RSS

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
4/2/99	07:30	34.1'PVC	Well Inst	15 mins
4/5/99	08:30	45.1'PVC	Well Inst	64.5 hrs.
4/7/99	08:30	47.75'PVC	Well Inst.	100.5 hrs.

DEPTH feet	SAMPLE NO. Depth (ft.)	BLOWS/6"	PEN/REC (in.)	PID (ppm) VALUES	PID (ppm) PROFILE 0 200	GRAPHIC LOG	STRATUM DESCRIPTION	GEOLOGIC DESCRIPTION
5								
10								No Samples obtained from 0-47'. See log of well B-901U for soil descriptions.
15							STRATIFIED DRIFT	
20								
25								
30								
35								

WELL DIAGRAM



Sanborn, Head & Associates, Inc.

Log of Well B-901L

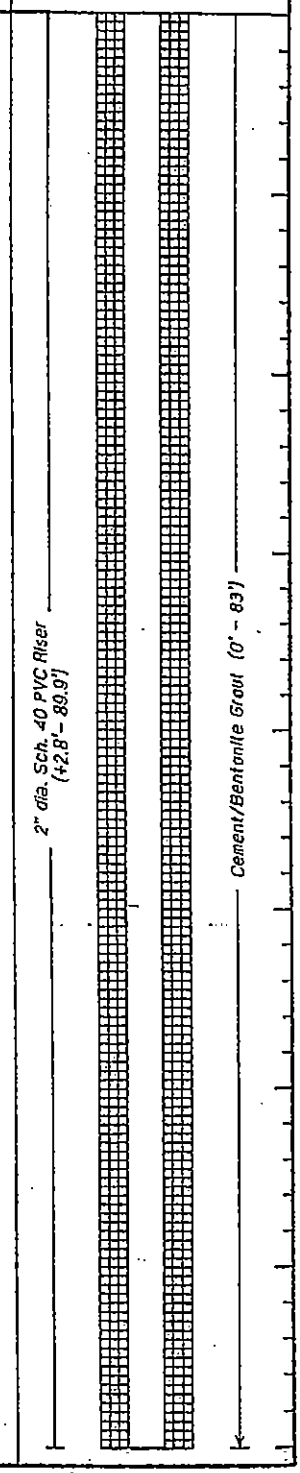
PROJECT NO.: 1647

PROJECT: North Country Environmental Services, Inc.

DATE STARTED: 4/01/99 | DATE FINISHED: 4/07/99

DEPTH feet	SAMPLE NO. Depth (ft.)	BLOWS/6"	PEN/REC (in.)	PID (ppm) VALUES	PID (ppm) PROFILE 0 200	GRAPHIC LOG	STRATUM DESCRIPTION	GEOLOGIC DESCRIPTION
40								
45	S-1 47-49'	38-49 44-55	24/12					S-1: Very dense, olive, fine to coarse SAND, little Silt. Slight stratification. Wet.
	S-2 49-51'	53-51 57-58	24/16					S-2: Very dense, olive, fine to coarse SAND, little Silt, trace Gravel. Slight stratification. Wet.
50	S-3 51-53'	18-39 39-43	24/11					S-3: Very dense, olive, fine to coarse SAND, little Silt, trace Gravel. Wet.
	S-4 53-55'	34-40 42-61	24/14					S-4: Very dense, olive, fine to coarse SAND and Gravel, trace Silt;
55	S-5 55-57'	42-31 19-34	24/9				STRATIFIED DRIFT	Change at 54' to olive, fine to medium SAND, little Silt, trace Gravel. Wet. S-5: Dense, olive, fine to coarse SAND and Gravel, little Silt. Wet.
	S-6 57-58' S-6A 58-49'	42-49 69-82	24/13					S-6: Very dense, olive-gray, fine to medium SAND, little Silt, trace Gravel, slight stratified discolorations throughout;
60	S-7 58-61'	33-48 80-75	24/14					Change at 58' to olive-gray, fine to coarse SAND and Gravel, little Silt. Wet. S-7: Very dense, olive-gray, fine to coarse SAND and GRAVEL, little Silt. Wet.
	S-8 61-63'	69-98 100/4'	16/4					S-8: Very dense, fine to coarse SAND and Gravel, trace Silt. Wet.
	S-9 63-65'	71-50 54-50	24/13					S-9: Very dense, olive-gray, fine to coarse SAND and Gravel, trace Silt. Wet.
65	S-10 65-67'	161/6"	6/4					S-10: Very dense, olive and brown, fine to coarse SAND and Gravel, trace Silt. Wet.
	S-11 67-67.5'	115/6"	6/0					S-11: No recovery.
70	S-12 69-69.9	85-100/4	10/5					S-12: Very dense, gray-brown, fine to coarse SAND and Gravel, little Silt. Wet.
	S-13 71-73'	50-100/6'	12/6					S-13: Very dense, gray, GRAVEL, little fine to coarse Sand, trace Silt. Wet.
	S-14 73-75'	75-64 77-86	24/17					S-14: Very dense, gray, fine to coarse SAND and GRAVEL, trace Silt,
75								Change at 73.3' to gray, fine to medium SAND, trace Gravel, trace Silt. Stratified. Wet

WELL DIAGRAM



Sanborn, Head & Associates, Inc.

Log of Well B-901L

PROJECT NO.: 1647

PROJECT: North Country Environmental Services, Inc.

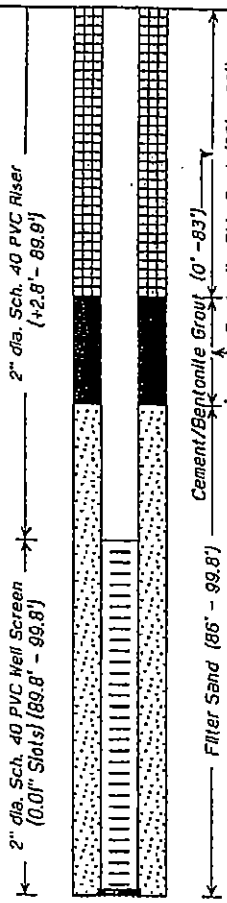
DATE STARTED: 4/01/99 | DATE FINISHED: 4/07/99

DEPTH feet	SAMPLE NO. Depth (ft.)	BLOWS/6"	PEN/REC (in.)	PID (ppm) VALUES	PID (ppm) PROFILE 0 – 200	GRAPHIC LOG	STRATUM DESCRIPTION	GEOLOGIC DESCRIPTION
	S-15 75-77'	67-87 99-62	24/12				STRATIFIED DRIFT	S-15: Very dense, gray, fine to coarse SAND, little Gravel, little Silt. Stratified. Wet.
	S-16 77-77.7	103-100/3'	9/4				GLACIAL TILL	S-16: Very dense, gray GRAVEL and fine to coarse Sand, some Silt. Wet.
80	S-17 79-81'	92-113 100/3'	15/10					S-17: Very dense, gray, fine to coarse SAND, some Gravel, some Silt. Wet.
	S-18 81-83'	87-154	12/9					S-18: Very dense, gray, fine to coarse SAND and Gravel, little Silt; Changed at 81.3' to gray, fine to coarse SAND and Silt, trace Gravel. Wet.
	S-19 83-85'	234	6/6					S-19: Very dense, gray, fine to coarse SAND and Silt, little Gravel. Wet.
85	S-20 85-87'	217	6/3					S-20: Very dense, gray, fine to coarse SAND and SILT, little Gravel. Wet.
	S-21 87-89'	169	6/3					S-21: Similar to S-20
90	S-22 89-91'	170	6/3					S-22: Similar to S-21
	S-23 91-93'	237	6/3					S-23: Similar to S-21
	S-24 93-95'	502	6/3					S-24: Very dense, gray, fine to coarse SAND, some Silt, little Gravel. Wet.
95	S-25 95-97'	232	6/3					S-25: Very dense, gray, fine to coarse SAND, and Silt, trace Gravel. Wet.
	S-26 98-99.8	183	6/3					S-26: Similar to S-25.
100								Bottom of Boring at 99.8'.
105								
110								
115								

Notes:

1) Falling head (wick) tests performed with wicks at 49 to 51 feet, and 93 to 95 feet.

WELL DIAGRAM



Section IV

REVISED OPERATING PLAN

FACILITY OPERATING PLAN

Stage IV Phase II Construction
North Country Environmental Services, Inc.
Bethlehem, New Hampshire

Prepared for:
North Country Environmental Services, Inc.

Prepared by:
Sanborn, Head & Associates, Inc.
Revisions by North Country Environmental Services, Inc.

Updated by:
CMA Engineers, Inc.
~~March 2008~~ February 2009

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APPENDICES

Appendix A: Rules and Regulations for Facility Use, Certificates of Acceptable Waste Forms and Random Waste Inspection Worksheet Special Waste Profile Form

Appendix B: Letters of Agreement for Leachate Disposal

Appendix C: Facility Inspection Checklist

Appendix D: Operations and Maintenance Manual, Gas Management System

Appendix E: Confined Space Entry Plan

Appendix F: Odor Complaint Form

Appendix G: Current Facility Groundwater Permit

Appendix H: Leachate Breakout Repair Logs and Field Sketch

Appendix I: Operating Procedures for Segregating and On-Site Stockpiling and Processing of Construction and Demolition Debris (C & D)

Appendix J: Bird Control Plan

Appendix K: Liner Settlement Monitoring Plan

FACILITY OPERATING PLAN

This Facility Operating Plan (Plan) is for the North Country Environmental Services, Inc. (NCES) landfill facility located off of Trudeau Road in Bethlehem, New Hampshire. This Plan is an update of prior operating plans for the facility and was prepared in consideration of Stage IV development and includes revisions by NCES on facility inspection program made November 16, 2007. This Plan references drawings prepared by CMA Engineers, Inc. (CMA) dated February~~,~~ 2009 for "Stage IV Phase II Construction". Also referenced are previous design drawings prepared by Sanborn, Head & Associates, Inc. (SHA) dated March 2002 and entitled "Stage IV Design, North Country Environmental Services, Inc. Bethlehem, New Hampshire," drawings dated April 2004 entitled "Grading Modifications, North Country Environmental Services, Inc., Bethlehem, New Hampshire," and drawings dated July 2005 entitled "Stage IV Phase I Construction." The purpose of this Plan is to describe the operating requirements for the facility in accordance with the New Hampshire Solid Waste Rules. A copy of this Plan is to be maintained at the facility and updated as required.

1.0 FACILITY IDENTIFICATION

The facility is owned and operated by NCES. The current mailing address and telephone number for the facility are:

North Country Environmental Services, Inc.
581 Trudeau Road, PO Box 9
Bethlehem, NH 03574
Telephone (603) 869-3366
Facsimile (603) 869-2152

The facility is a lined landfill comprised of four Stages. Stages I, II and III were permitted by the New Hampshire Department of Environmental Services (NHDES) in 1987, 1989 and 2000 (Permit Nos. DES-SW-87-022, DES-SW-89-009 and DES-SW-SP-00-003), respectively. As part of the development of Stage II, an unlined landfill located in the general vicinity of the Stage II footprint was excavated and relocated to the Stage I landfill area. Phase I of Stage IV was constructed in 2006.

The NHDES permitted Stage IV provides about 2,050,000 cubic yards of capacity for waste and daily cover. The constructed Phase I and the proposed Phase II will provide approximately 1,770,000 of that permitted capacity.

Stage IV Phase I provided about 470,000 cubic yards of capacity for waste and daily cover. Previous grading modifications utilized 153,000 cubic yards. Stage IV Phase II provides the

remaining 1,280,000 cubic yards of the available capacity. The facility is a commercial disposal facility and thus, has no defined service area. The facility receives waste from commercial and residential sources generally located in New Hampshire and border towns in Maine, Massachusetts and Vermont.

The Permitee, Property Owner and Operator is NCES.

2.0 AUTHORIZED AND PROHIBITED WASTES

2.1 Authorized Wastes

Wastes which may be accepted at the facility include:

- Municipal solid waste (MSW), that is, solid waste generated by residential, commercial, or industrial establishments and institutions including paper, cardboard, glass, metal, plastics, rubber, fabrics, appliances, putrescible wastes, and other non-hazardous solid wastes.
- Construction and demolition (C&D) debris which includes non-putrescible building material waste and rubble which is solid waste resulting from construction, remodeling, repair or demolition of structures or roads. Examples of such waste include, but are not limited to, bricks, concrete, and other masonry materials, wood, wall coverings, plaster, dry wall, plumbing, fixtures, non-asbestos insulation or roofing shingles, asphaltic pavement, glass, plastics, electrical wiring and components containing no hazardous liquids and/or metals that are incidental to any of the above.
- Special solid wastes which are not hazardous and which have received prior approval of the NHDES before being accepted. Requests for approval are to be accompanied by sufficient waste profile and generation information to facilitate NHDES' review and decision making process. Special wastes include but are not limited to the following:
  - Waste from industrial processes;
  - Waste from pollution control processes including water and wastewater treatment plant sludge;
  - Residue from a spill of a non-hazardous chemical substance or commercial product or a waste listed above;
  - Commercial products which are off-specification, outdated, or unused;
  - Waste produced during the demolition or dismantling of industrial process equipment; or;

- Ash which has been determined to be nonhazardous under the provisions of Env-Wm 502 which is managed in accordance with the requirements of Sw 902.

2.2 Prohibited Wastes

Wastes which are prohibited from disposal at the facility include the following:

- Those wastes prohibited by state and federal law;
- Hazardous wastes (as defined by the federal and New Hampshire Hazardous Waste Rules);
- Untreated infectious waste;
- Asbestos waste including solid waste containing more than 1 percent asbestos by weight;
- Liquid wastes (that is waste containing free liquids as defined by Method 9095 (Paint Filter Liquids Test as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" [USEPA Pub. No. SW-846]);
- Contained gaseous wastes;
- White goods;
- Leaf and yard waste;
- Whole tires; and
- Non-approved special wastes;
- Mercury added products;
- Video Display Devices;
- Wet cell/M-Cad/Rechargeable Batteries; and
- Radioactive materials as defined by He-P 4000.

The definition of hazardous waste used at the NCES facility is as defined in the State of New Hampshire Hazardous Waste Rules. Customers are required to execute a Certificate of Acceptable Waste. A Certificate of Acceptable Waste form is included in Appendix A.

Incoming waste is to be monitored in accordance with the procedures outlined in Section 3.3. Those materials which are specified as unacceptable for disposal are to be rejected as described in Section 6.5. Transporters of unacceptable waste are solely responsible for the appropriate disposal of such waste materials. In the event the unacceptable waste cannot be returned to the transporter, a specialized waste handling company will be contacted to respond within 24 hours if necessary to remove and properly dispose of the unacceptable waste. NCES would utilize one

of the following companies (or similar qualified firms) for removal and disposal of unauthorized waste;

CYN Environmental
100 Tusco Drive
Stoughton Ma.02072
1-800-417-7455

Clean Harbors Environmental Services, Inc.
20 Dunklee Road
Bow, NH
1-603-644-3633

3.0 ROUTINE OPERATIONS PLAN

3.1 Hours of Operation

Regular facility operating hours are from 7:00 a.m. to 3:00 p.m. Monday through Friday, and may be open from 7:00 a.m. to 12:00 p.m. on Saturday. The facility will be closed on Sundays and the following holidays: New Years Day, Thanksgiving Day and Christmas Day. Additionally, the facility may be closed on Memorial Day, Independence Day and Labor Day. Operating hours are expanded as necessary to meet actual disposal requirements of facility users but are restricted to the hours of 6:00 a.m. and 6:00 p.m. All routine landfill operations and inspections, maintenance, repairs, and monitoring under non-emergency circumstances are to be conducted between the hours of 6:00 a.m. and 6:00 p.m. unless otherwise approved by NHDES.

Leachate is generally removed from the facility during routine operating hours; however, from time to time (i.e., such as during the spring snow melt season) it may be necessary to remove leachate from the facility during the hours from 6:00 p.m. to 6:00 a.m.

3.2 Access Control and On-Site Traffic Patterns

Access to the facility is restricted by an electronically operated locking gate located on the access road to the scale house from Trudeau Road. The electronic gate can only be accessed via a restricted access code. Upon exiting the site the gate closes automatically within one minute, site personnel do not leave the access area until the gate has securely closed. Another potential access point to the facility is via the original access road from Muchmore Road located north of the landfill area. This abandoned access location has been blocked by a locked gate and boulders

prohibiting vehicular access. NCES also has ~~may establish~~ additional security measures such as ~~necessary, including;~~ motion activated video surveillance and alarm systems.

Signs are to be posted and maintained at the entrance road, gate and scale house indicating:

1. The facility name and permit number;
2. The name, address, and telephone number of the Permitee;
3. The hours of operation;
4. The types of wastes accepted; and
5. A statement that unlawful dumping shall be subject to fine and prosecution.

The scale house is occupied by NCES personnel during daily operating hours. The scale house operator is also responsible for monitoring traffic flow at the facility gate. The gate is to be locked at night and when~~ever~~ the landfill is closed.

Access to the facility is gained through the Site entrance from Trudeau Road. The scale house is located near the entrance. Incoming vehicles stop on the scale and are weighed, then proceed to the landfill tipping area. After discharging their loads, drivers return to the scale and are weighed to determine the amount of waste disposed. A weight ticket is then printed by the Scale House operator and signed by the vehicle driver and the scale operator.

An access road is located around the facility. The location of access roadways to the active disposal area will vary depending upon the location of the active face at any given time. The landfill compactor operator has a CB radio and can contact trucks drivers to provide further instruction as to where waste is to be discharged.

3.3 Waste Review, Unloading and Inspection Procedures

3.3.1 Waste Review

NCES implements measures to restrict acceptance of prohibited wastes at this facility. Loads identified as having prohibited wastes (as listed in Section 2.2) are to be rejected as described in Section 6.5.

All waste delivery vehicles (excluding residential vehicles and pick-up trucks that solely use the drop-off station) stop at the scale prior to proceeding into the landfill. The scale operator identifies the customer and queries the customer's account in the facility's computer system or manually enters a customer's information. The driver of the vehicle identifies the type and origin of waste which is entered into the facility's computer system by the scale house operator prior to allowing the vehicle

to proceed to the active working area. Only waste authorized for disposal at the facility and identified as such by the waste hauler is allowed to proceed beyond the scale location. The driver must sign a scale ticket for every load delivered which includes a certification statement:

> *"I certify under penalty of perjury that I am familiar with wastes authorized at this facility and that to the best of my knowledge all waste contained in this load is authorized for disposal at this facility".*

In addition, trucks delivering Non-Hazardous Special Waste are not allowed beyond the scale area unless written approval has been received from the NHDES. Refer to section 3.3.2 for Special Waste Program.

The likelihood of unacceptable wastes being delivered to this facility will be minimized by:

1. Customer education;
2. Training landfill operations staff;
3. Signs posted at the facility; and
4. Inspections of incoming waste loads.

3.3.2 Special Waste Program

The facility has a comprehensive program for management and handling of Special Waste. For the purpose of this NCES Facility Operating Plan, Special Waste is defined as:

> *A non-hazardous waste, which because of the process generating the waste or its physical, chemical and/or biological characteristics, potentially requires special testing and/or handling.*

3.3.2.1 Special Waste Acceptance

Prior to servicing new special waste customers, NCES Management or Sales Staff will inform customers of the waste disposal services at the site; including the types of waste accepted. As described in Section 3.3.3 Customer Education, NCES takes steps to educate our customers with respect to acceptable wastes. The initial evaluation of waste generated by special waste customers is conducted by NCES sales representative(s).

- After the initial waste evaluation, the Special Waste Generator must complete a Special Waste Profile Form (included in Appendix A), which characterizes the waste to be disposed and includes a certification statement declaring the waste is not hazardous.
- The completed and signed Special Waste Profile Form is initially reviewed by a technical company representative. If necessary, additional information and testing is requested of the

generator or customer, to sufficiently ensure the wastes are non-hazardous and can be accepted at the Facility.

- Upon review and approval of the waste stream data by a company technical representative, the waste stream data is submitted to the NHDES for review and written approval. A special waste is not to be accepted until written approval has been received by the NHDES.
- Upon NHDES approval, the waste profile and approval documentation is maintained on file at the landfill. If the approval is conditional on tonnage or testing, the approval limitations are entered into the scale system at the scale house and tracked with each incoming load.
- Each customer of special waste generated by a one time disposal event will be required to have a waste tracking document used to track the waste from the point of generation through transportation, to disposal. The waste tracking document contains the customer / generator information, a description of the waste, the transporter information, and the approved disposal facility (destination). Customers of continuous special waste generation (as a part of a business concern) will not be required to utilize a waste tracking document.
- A copy of the waste tracking document is attached to the scale ticket and maintained on file at the Facility.

3.3.2.2 Special Waste Handling

- Upon arrival at the Facility, the Driver will present the required waste tracking document (If one-time event generated waste) to the Scale Attendant. The Scale Attendant will review the documentation and verify the waste approval number and all limitations (e.g. tonnage, testing, etc.) have been satisfied. Once all the paperwork has been checked and verified, the Scale Operator will notify the Operations Manager or his designee that the special waste load is proceeding to the working face.
- The NCES staff will visually inspect the special waste for consistency with the description provided on the Generator Special Waste Profile as the material is unloaded. This confirmation will include comparing the actual color, odor and physical state of the waste with those characteristics as described in the Special Waste Profile Form and the waste tracking document. (If one-time event generated waste)

  NOTE: If a discrepancy is found during the visual inspection, the Landfill Manager or his designee will notify a technical company representative of the issue. The Landfill

Manager or his designee must contact the Generator or Customer for an explanation. If the explanation justifies rejecting the load, the Facility will retain one copy of the waste tracking document. The Facility will follow the procedures for rejecting a load as outlined in Section 6.5.

- After the visual inspection is performed and the load is verified, if applicable, the NCES staff must sign the waste tracking document for the approved acceptable (If one-time event generated waste) load and return a copy of the signed document to the Transporter.
- The completed documentation will be filed at the facility office.

3.3.3 Customer Education

NCES staff will inform customers of the services provided at the Bethlehem landfill facility and to educate them as to what wastes are acceptable and unacceptable for disposal. All customers approved to bring acceptable solid waste to the NCES facility must follow standard Rules and Regulations for Facility Use. They are required to accept and sign a copy of the Rules and Regulations and to execute a Certificate of Acceptable Waste form. Copies of these forms are provided in Appendix A.

Customers are also provided with informational packets. The information packet includes;

- NHDES Construction & Demolition Waste Management Outreach Effort information
- NHDES Asbestos Abatement Inspection and Notification Requirements
- NHDES Asbestos Demolition/Renovation Notification Form & Instructions
- NHDES Certified Asbestos Consultant List
- USEPA Asbestos Containing Materials Sample List and Table

NCES will provide updated information to new and existing customers on acceptable and prohibited wastes with any changes in the prohibited list in the regulations via mail or distributed at the scale house. NCES staff encourages customers to contact the facility with any questions they may have on acceptable wastes.

3.3.4 Facility Signs

Signs are posted at the entrance gate and at the scale location. The signs clearly identify acceptable and unacceptable wastes as described in Section 2.0.

3.3.5 Waste Unloading & Routine Inspection

Once vehicles are in the disposal area, compactor operators visually inspect the waste as the vehicles discharge their load onto the working face. As refuse is spread at the working face, operators are to look for unacceptable materials which may have been placed in the load. The facility's equipment operators are trained in identifying acceptable and unacceptable wastes and if necessary will contact their supervisor to view questionable materials.

3.3.6 Random Load Inspection

In addition to the routine visual inspection of the waste as it is discharged at the working face, 5% of loads are chosen to be inspected more thoroughly on random basis. Consideration for random inspection is given based on the type of waste, accounts serviced, and whether the hauler has a record of disposing unauthorized wastes at the facility.

Random load inspections are performed by NCES personnel with NHDES Solid Waste Operator Certification trained in identification of unacceptable materials.

Random Load Inspection:

A. An NCES representative will randomly select a hauler at the scale or the working face;

B. The NCES Representative will notify the hauler of the random load inspection program and that he/she has been selected for an inspection;

C. If the hauler will not allow the inspection, they will not be permitted to unload at the site;

D. If the hauler will allow the inspection the scale house will notify operators at the working face and the truck will be directed to the designated random load inspection area and met by NCES representative(s);

E. The load will be discharged in an area where it can be spread and visually inspected for unauthorized waste. The NCES representative shall thoroughly observe the waste and not handle the waste. A Load Inspection Form will be completed;

F. Any unauthorized waste as identified in Section 2.2 of this document will be handled in accordance with Section 6.6 Receipt of Prohibited Waste and will be noted on the Load Inspection Form. The hauler will be given a copy of the inspection form if they request it. A copy of the Waste Inspection Form is included in Appendix A;

G. Photographs may be taken of the unauthorized waste, truck or its contents;

H. Unauthorized waste will be segregated and handled according to Section 3.3 of the Facility Operating Plan;

I. Any load identified as having a confirmable or suspected unauthorized waste will be documented on the Load Inspection Form. The hauler shall be sent a letter including photographs and an invoice for expenses associated with the management and proper disposal of any confirmed unauthorized waste. The hauler may be banned from future use of the facility;

J. Site personnel will file the report at the site where it will be available for NHDES review and will consist of:

1) The completed Load Inspection Form
2) Any photos
3) A copy of the scale ticket

K. Records are kept in accordance with procedures outlined in Section 8.0.

Please refer to the contingency section for management of an unauthorized waste, Section 6.

3.3.6.1 Personal Protective Equipment for Random Load Inspections

Personal Protective Equipment (PPE) appropriate for the specific job, will be consistent with the current Health and Safety Program requirements for the Facility and periodically updated consistent with OSHA regulations.

3.4 Method for Tracking Waste Quantities

As indicated in Section 3.2, haulers bringing waste to the facility are required to stop at the facility scale for weighing prior to proceeding to the landfill. After off-loading, trucks return to the scale for reweighing to determine the weight of the waste left at the working face. After this second weighing, a scale ticket is generated and signed by the scale house operator and the driver

of the vehicle. One part of the weight ticket is given to the truck driver while the other part is used for billing and record keeping purposes by the facility.

At the end of each day, a report is generated by the scale operator. The computer database is backed up daily.

Waste quantity tracking records are to be maintained at the facility until such time as approval to move or destroy the records is granted by NHDES.

3.5 Method of Tracking Outgoing Waste or Certified Waste-Derived Products

The facility is a disposal facility and should not generate solid waste requiring off-Site disposal. Leachate is collected at the facility and transported off-Site for disposal in accordance with the procedures outlined in Section 4.0. Any vehicle hauling leachate off-Site is weighed prior to and after loading to determine the volume removed. Trucks hauling C&D debris which is segregated for off-Site transport will be weighed before and after loading to track the quantity leaving the Site. Recyclables at the residential drop off are weighed before going off-Site. The facility will not produce waste-derived products which will be removed from the Site.

3.6 Waste Storage Time and Capacity Limits

Authorized waste materials delivered to the facility will be disposed within the lined landfill. C&D debris suitable for processing to produce ADC occurs in accordance with the procedures identified in Appendix I. The volume of C&D stockpiled on-Site for processing is not to exceed 3,000 cubic yards. Processed C&D material will also be stockpiled within the active landfill and used by the facility as ADC. As indicated in Section 3.3, prohibited waste delivered to the facility may be stored temporarily on-Site until such time as the hauler or qualified disposal company removes the waste.

3.7 Waste Management Following Receipt (Fill Sequence Plan)

An objective of the design and development of Stage IV is to limit leachate generation by limiting, to the degree practical, the amount of precipitation and stormwater which contacts the waste. To meet this objective, Stage IV will be developed in phases. Stormwater run-off from areas of overlay liner will also be shed prior to placement of waste materials.

In general, access roads to the base of each operating phase will be constructed to slope at not more than 8 to 10 percent. A minimum of 4 feet of cover is to be provided over the anchor

trench and the landfill liner system in other areas where temporary access roads are to be constructed. Swales may be constructed on slopes above the active fill area to divert stormwater runoff from filled areas and minimize leachate production.

The scale house operator will direct refuse hauling vehicles to the active fill area where they will discharge their load. Compactor operators will spread and compact the load in lifts. The filling procedures described below will typically be followed during the disposal of solid waste.

3.7.1 Initial Lift in Base Areas and Above Overlay Liner

An initial 5-foot lift of select refuse (typically household trash) is to be placed in the base area of the landfill and above the overlay liner system. Care is to be taken during initial refuse placement in these areas to remove items from the waste that could damage the liner system. During placement of the initial lift in the base areas, a full-time spotter is to observe the placement of refuse onto the base area of the landfill and remove items such as poles, pipes, and steel rods. Compaction of the initial lift in the base area will be performed with a bulldozer or similar equipment to limit the potential for damage to the liner system.

3.7.2 Subsequent Lifts

Once the initial lift is placed, additional waste is to be spread by the compactor in shallow layers generally about 2 feet thick. Additional compaction will be applied by routing trucks over the waste. Following placement of the initial lift, fill placement is to proceed in daily cells built in successive compacted layers to a height typically between 6 and 12 feet depending upon the incoming refuse volume. Generally, reducing the area susceptible to surface water infiltration limits the amount of leachate generated. Increased daily cell thicknesses will also result in a faster rate of vertical development. This concentrated vertical development provides a greater amount of refuse moisture-holding capacity and shorter time for an operating stage to reach intermediate or final grades and receive intermediate or final cover.

Once filling proceeds above perimeter anchor trench grades, lifts will be graded to drain to the perimeter slopes to promote run-off to the perimeter swale. Grading of the top of each daily cell is to slope away from the active face to direct run-off away from the operating area. Sideslopes should be graded to establish 3H:IV slopes at the time of final closure. Slopes steeper than 3H:IV may be graded during operation to account for pre-closure settlement.

To provide control at the toe of the slope, markers may be installed along the limit of waste containment to serve as a reference points for waste placement. Grades are to be established periodically on perimeter slopes to further assure that waste is not placed beyond the toe.

Intermediate cover is to be placed over the waste on the perimeter sideslopes to limit potential leachate breakouts. The intermediate cover will be seeded and mulched during times of the year when vegetation is generally established.

It is noted that actual day-to-day operations are left to the discretion of the Landfill Manager, and the fill sequencing and lift development outlined above may be adjusted based on actual operating conditions including waste volumes and weather conditions. Fill sequencing and lift development must remain consistent with applicable State regulations and the objectives detailed above.

3.7.3 Landfill Cover

Daily cover consisting of six inches of soil or an approved ADC material is to be applied to the working face at the conclusion of each working day. Twelve inches of intermediate cover soil is to be applied in areas where active filling will not occur for a period of one month or more or prior to the placement of final cover material. The purpose of the intermediate cover is to limit odors from the Site, limit the potential to attract vectors, promote drainage of surface water, limit windblown litter, reduce the potential for fire, provide stability, and to serve as subgrade for the capping system. Soil cover material is to be applied and graded to direct runoff away from the filled area and limit leachate production. Silt fences and/or hay bales, or stone check dams are to be used as necessary to filter suspended soil particles from within the runoff from areas which have received soil cover. Soil for daily and intermediate cover is available from on-Site sources.

ADC materials consisting of processed C&D materials, geotextiles, tarps, or spray-on foams have been used successfully at landfill sites throughout the country. ADC is often superior to soil covers and helps to extend operating site life. ADC must serve all the cover material functions identified above and may be used only after gaining approval from the NHDES through a Type III Permit Modification.

~~*3.7.4 Fill Adjacent to Reinforced Earth Berm*~~

~~The potential for long-term differential settlement of the cap exists where the waste interfaces with the perimeter reinforced earth berm (REB) because MSW is compressible and degradable, whereas the REB has a near vertical interior wall and is essentially incompressible. To eliminate or mitigate differential settlement, the area immediately in front of the REB will be filled to an internal slope of 3H:1V with incompressible and non-putrescible wastes such as demolition debris, waste-to-energy ash residue, contaminated soil or similar materials, subject to the waste disposal market while the filling occurs. To the extent that MSW is placed adjacent to the REB wall, the following operational measures will be employed to mitigate and manage any~~

~~differential settlement:~~

1. ~~A substantial and sustained compactive effort is to be employed on any MSW placed in the zone of soil adjacent to the wall to limit future mechanical settlement.~~

2. ~~Areas of MSW filling adjacent to the REB wall may be surcharged with waste or other materials to accelerate mechanical settlement.~~

3. ~~Old degraded MSW excavated from Stage I as part the Stage IV Phase II development, or from other areas as available, will be placed adjacent to the REB wall, if feasible.~~

4. ~~Periodic filling/surcharging of perimeter MSW may occur throughout the operational life of the landfill to promote compression or degradation prior to closure.~~

5. ~~A relatively porous intermediate cover is to be applied to these MSW areas to maintain a high waste water content and promote degradation of the waste into a more inert material prior to closure.~~

4.0 RESIDUAL WASTE MANAGEMENT

4.1 Leachate Management Plan

The leachate collection system for the NCES facility consists of a double liner system with primary and secondary liquid collection. The collection, pumping and handling system was designed so that liquids are removed from the landfill as efficiently as possible. In addition, operational and design measures directed toward limiting the production of leachate include:

1. Phased or sequential development to limit the open area and thus the quantity of stormwater contacting waste.
2. Diverting stormwater run-off away from the active landfill area.
3. Filling operating cells as fast as practical to keep the moisture content of the refuse from reaching field capacity.
4. Compacting the refuse and placing daily/intermediate cover material to limit infiltration.
5. Placing final cover and vegetation to limit infiltration into the disposed refuse.

4.1.1 Anticipated Leachate Quantities

The quantity of leachate generated varies and is a function of weather conditions, (temperature and precipitation), the amount of waste in place, how long the cell has been open, whether the fill has progressed above grade so that runoff may occur, and the landfill cover condition.

Based on operating experience at the facility, the long-term average leachate generation during operation ranges from about 300 to 500 gallons per acre per day (gpa/d). Following construction of final cover, leachate generation rates gradually diminish with time. During initial operations~~,~~ when waste is present in an operating area at elevations below the perimeter berm crest, most, if not all, rainfall becomes leachate. This scenario will exist during filling in newly active areas in Stage IV and is addressed in Section 4.1.4.

4.1.2 Phasing and Cell Development

To limit leachate quantities, the NCES facility has been developed in phases. Stages I and II were developed in four and two phases, respectively. Stage III was developed in one phase subdivided into three cells. Each landfill phase has its own leachate collection piping.

~~Stage IV Phase I development is depicted on SHA's July 2005 Construction drawings. To limit leachate quantities during early operations in Phase I, a temporary sideslope drainage swale is to be constructed on the existing Stage I and II landfill sideslopes. The swale will divert clean stormwater around the fill area.~~

Stage IV Phase II development is depicted on CMA Engineers ~~November 2007~~ February 2009 Construction drawings. To limit leachate quantities during early operations, diversion swales on the intermediate cover and overlay liner systems will be maintained as long as possible. The swales will divert clean stormwater around the active fill area, and around ~~or through the~~ constructed ~~REB's~~ berms.

4.1.3 Pumping/Removal Schedule

The collection system in Stage I is being reconstructed with the construction of Stage IV, Phase II. New sumps for both primary and secondary systems will be constructed. With this modification, collection sumps for the primary and secondary collection systems are provided for all Stages and Phases of the facility. (This is currently absent for Phase I of Stage I.) The overlay liner to be constructed over the existing and regraded waste materials over Stage I, Phases I, II and III will discharge primary leachate into the Stage IV, Phase II primary leachate collection system and will have its own secondary leachate collection system and collection sump.

Leachate will be automatically pumped from collection sumps through force mains to ~~the wet well and~~ two underground storage tanks using dedicated submersible pumps. Leachate consolidated from each pump station in the underground storage tanks is pumped to a 150,000 gallon above ground storage tank. From the aboveground storage tank, leachate will be pumped to a new leachate unloading facility. A new pump station will be constructed in the vicinity of Stage I (Pump Station I). Pump Station I will manage the primary and secondary leachate collected from Stage I, Stage IV Phase II, and the overlay liner. Pump Station II ~~will be relocated to the Northeast,~~ and Pump Station III will remain. ~~New facilities will be constructed as follows: a wet well consolidation tank and pump station, a new ±150,000 gallon above ground storage tank (AST), and a new leachate unloading facility.~~ New dual wall force mains will be constructed between pump stations I, II, and III directly to the underground storage tanks ~~wet well~~. ~~A new dual walled forcemain will be constructed from Pump Station I and will tie into the existing force main from the leachate consolidation building. The existing force main will then be connected to the wet well. The wet well will pump directly into the AST, simplifying leachate management.~~

Liquid levels in the sumps are measured using submersible water level transducers, and are monitored via the pump control system. The controls for all pump stations will have digital readouts to permit direct readout of leachate head levels. The pump controls are designed to activate the pumps when the leachate level is equivalent to the liner grade adjacent to the sump. Therefore, under routine operating conditions, there should not be excess head on the liner.

The pump controls are to be monitored on a daily basis to determine that the system is operating and to monitor the leachate head in the sump.

Liquids collected from the secondary systems of all stages, will be pumped automatically, measured and consolidated with the primary leachate in the primary leachate sumps, and will be pumped with the primary leachate to the consolidation underground storage tanks ~~wet well~~. Quantities pumped are to be tracked using flow meters prior to consolidation with the primary leachate in the side slope riser buildings provided for the individual sumps.

A new leachate loadout facility is proposed ~~as a component of Stage IV Phase II~~. The facility would be enclosed, and founded on a containment slab. ~~From Pump Station II, l~~Leachate can be pumped from the AST to the leachate loadout facility.

On a monthly basis, the Operations manager is to calculate the average leakage rate from an average of the daily pumping rates determined above and the contributory area to the flow. If it is determined that the calculated monthly rate exceeds 25 gallons per contributory acre per day, it is to be reported to NHDES within one week of the rate identification. If the rate exceeds 50 gallons per contributory acre per day, NCES is to file an investigative report. The objective of the report will be to identify the potential course(s) and appropriate response actions presented to NHDES in the form of a response action plan which may include any of the following actions deemed necessary on the basis of the likely cause and remedy of the problem:

1. Increased monitoring and reporting;
2. Instituting operational changes to limit hydraulic head on the primary liner;
3. Locating and repairing leak(s);
4. Retrofitting the primary liner; and/or
5. Closing part or all of the facility if necessary to protect human health and environment.

Leachate which is pumped into tankers for off-Site disposal will be disposed of at one or more of the facilities listed below.

FACILITY
Montpelier, Vermont WWTF
Concord, New Hampshire WWTF
Plattsburgh, New York WWTF

Letters of Agreement for the Concord, Montpelier and Plattsburgh facilities indicating these facilities will accept leachate from the NCES facility are provided in Appendix B. NCES may enter into agreements with other facilities but must maintain agreements with at least two facilities to manage the quantity of leachate generated by the facility.

The primary pump controls for all pump stations serving all Stages are to activate the pumps when leachate has reached a level approximately corresponding to the primary high density polyethylene (HDPE) base liner elevation adjacent to the sump. Liquid is to be pumped from the secondary collection sumps when the level is at an elevation not higher than the secondary liner grade adjacent to the sump. Liquid is pumped directly from the sumps through dual-walled HDPE force mains to the consolidation underground storage tanks ~~wet well~~. The controls were designed to turn the pumps off when the liquid level is about 3 to 6 inches above the pump in the various sumps. The quantities of liquid pumped from the primary and secondary sumps are measured using flow meters. The flows are to be recorded by facility staff each operating day.

Initial Operations in Stage IV

A programmable logic controller shall control the process of transferring liquids from the sumps to the leachate consolidation ~~wet well tank~~ underground storage tanks. The programmable logic controller is configured such that pumps will not be activated if the leachate ~~wet well tank is~~ underground storage tanks are full. Furthermore, an alarm will be indicated if the ~~wet well tank is~~ underground storage tanks are full.

While the system is designed to operate automatically, it may also be operated manually.

Pumping leachate to a tanker truck at the new leachate loadout facility for off-Site disposal is to be initiated manually by NCES personnel. Leachate pumping activities will be monitored.

The quantity of leachate stored in the tanks at the facility is to be monitored daily. As required by the accumulation of leachate, a call is to be placed by the Facility Manger to schedule tanker trucks for removal of stored leachate to a wastewater treatment facility. The leachate system operator is to complete a daily pumping report indicating the pre-pumping levels in each of the tanks monitored and managed during the day.

4.1.4 Leachate Contingency Considerations

The sideslope riser buildings are equipped with pump control panels, which contain indicator lights and alarms to notify landfill personnel of pump failures. The pumps specified are readily available submersible pumps. At least one spare pump is to be available at the facility to be installed to replace a failed pump. The failed pump may also be repaired. In the event of an extended power outage, NCES is to institute alternative power supply contingencies as outlined below:

- Stage I- Pump station I: The new Pump station I will serve Stage I and Stage IV Phase II. During operations in Phase II of Stage IV, a generator with a capacity of at least 100 kilowatts is available for use as an alternative power supply. The generator is to be connected at the transfer switch adjacent to the Stage I power supply panel thus safely disconnecting the PSNH power line. This generator will supply power to the Stage I leachate pumps and heat to the building.
- Stages III and IV Phase I- Pump stations II, and III: The sideslope riser buildings for Stages III and IV will be energized with alternative power provided by a portable generator located

at the landfill. An electrical transfer switch is to be installed and operable at each leachate vault. The transfer switch will allow facility personnel to disconnect the PSNH power from the vault and connect the temporary power supply. The generator will be used to power pumps in the primary and secondary sumps. The pumped liquid will be pumped up the sideslope riser pipes directly into a tanker truck positioned adjacent to the vault.

The pumps and tanks have been designed based on the quantity of liquid estimated to be produced by the 100-year 24-hour storm event. The condition during which the most liquid would be produced is during initial filling in a cell when all precipitation falling in the cell is presumed to become leachate. Calculations prepared for Phase II of Stage IV indicate approximately 560,000 gallons of leachate may be generated as a result of the contingency event. To remove the excess leachate in seven days, approximately 90,000 gallons must be hauled off-Site each day requiring a pumping rate of approximately 70 gallons per minute (gpm). A primary pump with a minimum capacity of 75 gpm is to be provided.

Should the contingency or other large storm occur during initial operations, so that the quantity of leachate exceeds the capacity available in the facility's leachate storage tanks, additional storage will be provided through temporary storage on the liner. As discussed in Section 6.1, operations staff are to take steps to remove leachate to increase storage capacity when severe weather is predicted. NCES is to implement measures to remove the additional leachate from the Site in an expeditious manner using additional tank trucks to haul the excess leachate to the treatment plants indicated in Section 4.1.3. Under no circumstances is temporary storage on the liner to last for more than seven days.

4.1.5 Record Keeping and Monitoring

The amount of leachate pumped from the various sumps to the consolidation underground storage tanks ~~wet well~~ and leachate above ground storage tanks is to be recorded. The facility is to maintain records for each load of leachate shipped, identifying the quantity of leachate shipped, the date shipped, and the name of the wastewater treatment facility receiving the leachate.

NCES is to sample the leachate consistent with the requirements of the Solid Waste Rules, the facility permit, and the requirements of the various disposal facilities. The Solid Waste Rules require sampling the primary leachate in the months of April, July and November for the following parameters:

PH	Iron	Lead
Temperature	Manganese	Chromium
COD	Sulfates	Cadmium
Specific Conductance	Chloride	Volatile Organic Compounds (VOCs)

4.2 Condensate Management

Condensate generated in the piping between the landfill and the gas management system blower is collected in an HDPE condensate knockout structure (1,000 gallon tank) located near the flare and a knockout pot located to the west of Detention Pond No. 4. A dedicated pneumatic pump or Blackhawk Pump is located in each of the knockouts. ~~and used to pump the condensate to an underground 1,000 gallon storage tank located near the flare or the condensation wet well. The long term method for the condensate disposal is through evaporation at the leachate evaporation system. In the event the evaporation system is not operating, c~~Condensate is to be pumped from ~~the 1,000 gallon tank~~ condensate tank and Knockout ~~into a tanker and hauled off Site for disposal condensate pumped~~ to the consolidation underground storage tank ~~wet well~~ ~~will~~ to be mixed and managed with the leachate. Samples of condensate are to be collected at least once per year and characterized ~~to determine hazard classification~~. ~~If the condensate is determined to be nonhazardous, it may be mixed with and disposed with leachate from the facility.~~

5.0 FACILITY MAINTENANCE, INSPECTION, AND MONITORING PLAN

The areas in and around the vicinity of the landfill are to be maintained in a neat and orderly manner. The access roads are to be graded when necessary and maintained in a serviceable condition at all times. The scale, office, and the maintenance building are to be maintained on a regular basis. The maintenance, inspection, and monitoring will include routine (not less than monthly) inspections to confirm that facility appurtenances and operations are functioning as designed.

In addition to the routine inspection of the active phases, closed portions of the facility will also be inspected. The purpose of inspecting the closed portions of the Site will be to evaluate the integrity of the final capping system, the stormwater management system, erosion control measures, and leachate collection systems.

When routine inspections of the facility operating and support areas are performed, personnel are to complete a Routine Inspection Checklist Form (included as Appendix C). For items which are identified as requiring attention, inspectors will complete the section available on the inspection

form for comments and/or proposed action. All outstanding items are to be resolved as soon as practicable. Specific elements to be considered during facility inspections are discussed below.

5.1 Spontaneous Combustion and Other Fire Hazards

Fire protection controls on-Site consist of cover soils, fire extinguishers housed in the facility's heavy equipment, and the Site water truck. Routine inspections are to note that fire extinguishers are available and fully charged. Gas Management System records are to be periodically reviewed to observe that system monitoring is being performed and that the concentrations of the various gases within the landfill gas collection system are within expected ranges. (Operation and maintenance [O&M] provisions for the Gas Management System are included in Appendix D.)

5.2 Vector Production

Vectors are not normally a problem at this site. Compaction and the use of cover material limits vector access to the waste. If necessary, appropriate measures such as use of a professional exterminator would be employed.

5.3 Gas Monitoring and Control

An active landfill gas system has been constructed at the NCES facility and will be expanded as necessary. The system consists of drilled gas extraction wells and lateral extraction trenches which are connected via gas collection piping. Blowers are used to extract the landfill gas and control devices are utilized to destruct the gas.

Monitoring for gas is to be conducted when persons are performing maintenance or inspecting leachate collection system appurtenances such as inspecting or repairing leachate pumps, cleaning out leachate collection lines, etc. When performing such work in confined areas, workers are to use a device which continually monitors atmospheric conditions within the work area. A device is to be used to monitor for methane, oxygen, and hydrogen sulfide gases. This meter provides a visual and audible alarm if gas concentrations exceed or drop below set levels. In the event that monitoring detects the presence of gas at unacceptable concentrations, workers are to exit the area until such time as monitoring indicates that gas concentrations are within allowable levels. A written plan for confined space entry prepared in accordance with Occupational Safety and Health Administration (OSHA) requirements is provided in Appendix E. This plan is to be followed by all personnel when entering confined spaces.

Monitoring for landfill gas outside the limits of the landfill will involve sampling gas monitoring probes as described in the Gas Monitoring Plan in Appendix D. These probes are to be monitored for explosive gas, using a dual-range natural gas indicator such as a Gas Tech Model NP-204 or equivalent. The results of the monitoring are to be recorded in the landfill operation records and maintained at the facility.

The following steps are to be implemented in the event that monitoring results indicate combustible gas concentrations in the soil exceed 50 percent of the lower explosive limit (LEL) at the property line or 25 percent of the LEL in on-Site structures excluding leachate collection and gas recovery components (note that the LEL defined above corresponds to 5 percent methane by volume in air):

- Take all necessary steps to ensure protection of human health and notify NHDES [This notification shall be deemed to have taken place when the Department's Project Manager in the Solid Waste Compliance Section 603-271-2925 is notified.];
- Within seven (7) days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and
- Within sixty (60) days of detection, implement a remediation plan for the methane gas release, place a copy of the plan in the operating record, and notify the Director that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.

Locations where gas concentrations exceed 50 percent of the LEL at the property line are to be identified in a separate report which is to be forwarded to NHDES.

Should the combustible gas concentrations be determined to exceed 50 percent of the LEL at any permanent probe location, an evaluation is to be made to determine whether the frequency of monitoring should be increased, and whether the monitoring network and type of monitoring should be modified to enhance detection. If continued monitoring indicates elevated levels of landfill gas at the property line, an appropriate plan to control gas concentrations, such as further expansion of the active gas system, is to be developed and submitted to NHDES for review.

If monitoring indicates that additional control measures are necessary, they are to be installed so that:

1. Gas concentrations at the property boundaries will be less than 50 percent of the LEL; and

2. Gas concentrations at any structure will be less than 25 percent of the LEL.

5.4 Odors

The application of daily cover in conjunction with the active gas management system should provide effective odor control. The final cover system has been designed with a synthetic membrane. This membrane will minimize odors that may be associated with the generation of landfill gas by constraining gas to the active system.

Other measures to control odors which may be considered include deployment of odor control products. An odor-neutralizing chemical may also be applied as a mist in areas where odors are noted. The potential for additional odors may exist during waste excavations. Before initiating waste excavations, the facility is to assure that an odor neutralizing system is set up and operated as needed to control odors during construction.

Odor control will be considered during waste inspections conducted at the facility. If waste streams are identified which routinely exhibit unacceptable odor, the generator will be informed and required to take the measures to reduce the odor. If this cannot be accomplished, the waste stream will not be accepted at the facility until the condition is resolved by the waste generator.

Items to check during routine inspections include:

- The active gas collection system records to observe that gas is being extracted effectively from the various collection locations;
- That there is adequate daily or intermediate cover on the waste; and
- That, if necessary, the solid odor neutralizing product or misting agent is deployed effectively around the Site.

When the facility receives an odor complaint, the facility is to implement an odor inspection to identify the source of the odor. In addition, someone from the facility, generally the operations manager or supervisor, is to visit the area from which the complaint was made. For those persons who may be calling during hours when the facility is not open, the call is automatically forwarded to an answering service which is to contact an NCES representative. The NCES representative will follow the procedures outline above.

The facility is to maintain a log of odor complaints using the form included in Appendix F. The completed form provides a log of the time and place odors are noted and is to identify the response implemented by the facility. The completed odor complaint log is forwarded to the NHDES in Concord, NH.

5.5 Dust Control

Dust control procedures include proper maintenance of vegetated areas and gravel service roads. Dust is to be controlled on the facility access roads by the application of gravel as needed and by watering. Water is available from the on-Site well, stormwater detention ponds or with the Town's permission, the hydrant located near the northern end of the Site.

5.6 Windblown Litter

Blowing litter is to be minimized by limiting the active working face and applying daily cover to the active fill areas. Other methods, such as the utilization of litter pickers and portable fencing, are employed. Any loose paper or windblown litter collected is to be disposed at the active face and covered with daily cover material. Increased efforts during the spring of each year might be necessary.

Litter will be collected along the entrance area and roadways. Refuse hauling trucks are required to have their loads tarped or use closed containers/truck bodies which reduces the likelihood of windblown litter. The operations manager is responsible to assure litter control efforts are sufficient.

5.7 Leachate

Leachate levels are monitored at the collection sumps through the pump control systems. The leachate collection systems are to be monitored daily to ensure continued operation. The quantity of liquid pumped from the primary and secondary collection systems is recorded and provided to the NHDES. Leachate from the various collection sumps is pumped through dual-walled piping or is provided secondary containment. Leachate manholes are equipped with leak detection systems for monitoring of subsurface leachate piping for leaks.

The leachate collection piping are cleaned annually, using industrial pipe cleaning procedures. Clean-outs are to be checked to ensure they have not been damaged. Any damage noted during inspections is promptly repaired.

5.8 Spills

Routine inspections will look for evidence of leachate spills in the vicinity of the leachate loadout area. In the event a spill is noted, the affected soil is to be excavated and placed in the active landfill. The cause of the spill is to be investigated and steps are to be implemented to limit the potential for future spills.

NCES has a spill prevention and countermeasure control plan (SPCC Plan). Spills will be managed in accordance with this plan.

5.9 Stormwater Management System

Stormwater will drain through swales and ditches constructed on the intermediate cover or over lay liner system to direct water away from the active area. The surface water management systems are inspected in accordance with the Site's Stormwater Pollution Prevention Plan (SWPPP). Catch basins and swales on the reinforced earth berm are to be maintained to be free of snow, ice, sediment and debris.

In addition to the ditches and detention ponds, sideslopes and surfaces of the exterior landfill berms are to be inspected for erosion. All sideslopes should have well-established vegetation.

In any areas of the landfill where waste will not be placed for several months, the intermediate cover will be seeded during the Spring and Fall growing seasons. The intent of seeding is to limit erosion and enhance evapotranspiration. These steps should limit infiltration of moisture into the waste and improve the appearance of the facility.

5.10 Groundwater Monitoring

Permanent groundwater monitoring wells are installed to monitor groundwater quality at the Site. The monitoring wells are constructed using polyvinyl chloride (PVC) well screen and riser piping. The well screen for the monitoring wells is surrounded by a sand filter. A bentonite seal and cement/bentonite grout surrounds the riser pipe from the sand filter to the ground surface. Monitoring wells are provided with protective casings and locking caps.

Sampling and analyses of groundwater will be performed in accordance with the current facility groundwater permit. A copy of the most recent groundwater permit is included as Appendix G.

With regard to inspections, the integrity of the monitoring wells and protective casing will be reviewed. The inspectors will note that the monitoring wells are secure (i.e., locked) and that the exposed portion of the well, the riser pipe and protective casing, have not been disturbed and/or damaged.

5.11 Leachate Breakouts

Inspections are to include observations of landfill sideslopes for evidence of leachate breakouts. Breakouts are to be repaired promptly. Methods to repair breakouts may include excavation of the breakout and backfill with free draining material to promote drainage into the landfill. A log is to be maintained at the facility which identifies the locations of breakouts and the methods used to repair them. The locations are also to be recorded on a field sketch and submitted with the monthly facility report. Copies of the repair log form and field sketch are provided in Appendix H.

5.12 Bird Control

The facility is to take steps to limit the number of birds visiting and foraging at the landfill. Steps to discourage birds from visiting the site are identified in the Bird Control Plan provided in Appendix J.

5.13 Liner Settlement Monitoring

In accordance with Condition 5(b) of the Stage IV permit development of ~~Phase I of~~ Stage IV will involve construction of liner and leak detection system above the waste in Phase I through III of Stage I. In accordance with the permit, settlement of the liner system constructed ~~over Stage I~~ is to be monitored and liner strain is to be evaluated. Settlement monitoring is to be performed in accordance with the Liner Settlement Monitoring Plan provided in Appendix K. A portion of the liner system over Phase I of Stage I was constructed in 2008. The remainder of the liner system over the remainder of Stage I will be constructed as part of Stage IV Phase II development.

~~5.14 Reinforced Earth Berm~~

~~Monitor the interior (to the extent exposed) and exterior face of the reinforced earth berm for evidence of erosion, decay or damage. Any damaged noted is to be repaired and the cause determined and addressed. Remove any woody growth in excess of 2" in diameter from the exterior face of the reinforced earth berm. Catch basins on the reinforced earth berm are to be maintained to be free of snow, ice, sediment and debris.~~

6.0 CONTINGENCY PLAN

Specific actions to be taken in the event of severe storm, fire, operator injury, spills and receipt of prohibited wastes are described in the following section. A list of emergency phone numbers is provided below. For police, fire and medical emergencies, 911 may be dialed.

List of Emergency Organizations		
Type of Service	**Name of Organization**	**Telephone**
Fire	Bethlehem Fire Department	869-2232
Poison Center	Hanover Poison Center	(800) 562-8236
Hospital	Littleton Regional Hospital	444-7731
Spill Notification	NHDES	271-3503

6.1 Severe Storm

If severe weather is predicted including the potential for a large amount of precipitation, operating staff are to evaluate the available leachate storage capacity and initiate additional leachate removal if warranted to maximize on-Site storage capacity for storm-related leachate.

In the event of a severe storm, operations staff will evaluate the need for facility closure. A preemptive closure may allow operating staff more time to cover the refuse, secure equipment, and secure the facility.

6.2 Fire and Explosions

The Bethlehem Fire Department (869-2232) will be contacted in the event of a fire at the facility.

Loads of refuse which are suspected to be burning will not be disposed in the active disposal area. Instead, such loads will be dumped in the hot load area located to the east of Stage II. If an incoming load of refuse is suspected of being on fire, the haul vehicle will be directed immediately to the hot load area. The hot load will be monitored, allowed to cool and possibly quenched with water (if necessary) prior to disposal in the active area.

The use of water to extinguish fires within the disposal area will be used as a backup to alternative methods, including smothering with soil and excavation of burning refuse. The soil used for cover material will be the source used for smothering fires at the working face. Water will be available from the on-site water truck, normally used for dust control, to help extinguish fires.

Appropriate fire extinguishers are carried on the facility's heavy equipment at all times and can be used to control a small equipment or landfill fire that may occur. Fire fighting will not be done at the risk of personal injury. The fire fighting efforts will be directed toward preventing a fire from spreading and will be carried out by facility staff until the emergency is over or any outside assistance has arrived.

6.3 Injury

In the event of personal injury, first aid should be administered and an assessment should be made as to whether emergency (ambulance) care is required.

6.4 Petroleum Spills

Please refer to SPCC and SWPPP Plans.

6.5 Leachate Spills

When a leachate spill occurs a determination is to be made as to:

- Location of the release, or spill;
- Source of the leachate;
- An estimate of any quantity released;
- The direction in which any spill or release is heading; and/or
- The possibility of fire and/or explosion.

There are three major steps that can be taken in the event of a release or spill. These include:

- Control
- Transfer
- Disposal

The following are general procedures that are to be followed in the event of a spill at the facility:

Control – The first task should be to stop the release of leachate, if possible, by such actions as shutting off pumps, placing soil against a leak, or diverting flow to a collection point. If the release of leachate cannot be controlled, begin the second step (transfer) immediately.

Response personnel shall wear appropriate protective clothing and equipment.

If a spill occurs on the ground surface, use absorbents if the spill is relatively small. Otherwise, use dirt, sand, or other relatively impervious material to dam the spill and prevent flow. Plug any drains in the area of the spill as soon as possible after a spill has occurred.

If the spill has reached a body of water the entire body of water must be considered leachate until such time analytical testing can suggest that impact has been remediated.

Transfer – Once a spill is contained, the spilled material must be transferred to appropriate storage containers before disposal. If a spill is small and absorbents are used, they may be manually placed in waste containers and transported to the landfill workface for disposal at the facility. Collected liquids are to be transported off-Site for disposal at an appropriate wastewater treatment facility.

Leachate should be pumped into an appropriate bulk tank truck, or to a container or tank suitable for storage of the material. Care is to be taken not to mix the spilled material with incompatible materials. **Handling of spilled material is not to be done at the risk of personal injury.**

Disposal – The disposal methods would be the landfill or a permitted wastewater treatment facility.

6.6 Receipt of Prohibited Waste

When a prohibited waste stream is discovered, the procedure outlined below is to be followed:

- An unapproved special waste or other prohibited waste which is deposited on the working face and which does not appear to be an immediate threat to health or safety (e.g., whole tires, white goods, etc.) is to be isolated by the compactor operator. The customer is to be identified, and requested to remove the waste. If the source of the waste or hauler cannot be

identified, NCES will evaluate the situation and implement appropriate procedures for the management of the waste. NCES staff will notify the Landfill Manager and PCE personnel immediately. The unauthorized waste will be separated and if appropriate, placed in a secure container. The unauthorized waste will be evaluated by trained personnel and characterized for proper disposal. If the waste is identified to be potentially hazardous, NCES staff will contact an authorized hazardous waste company as identified in Section 2.2.

- In the event a waste disposed on the working face is believed to present an immediate threat to health and safety (e.g., reactive chemicals, ruptured drums containing liquids), the waste is to be left in place undisturbed and NCES staff will immediately notify the Landfill Manager, PCE personnel and the NHDES. A company specializing in the handling of various waste materials such as Clean Harbors, Inc. of Bow, New Hampshire (1-603-224-6626) is to be contacted to evaluate the waste and to remove the waste for proper disposal. The waste is to be evaluated and characterized with respect to proper handling and disposal requirements and managed accordingly. Such waste is to be promptly transferred using licensed waste transporters and transported to a licensed disposal facility.

7.0 EMPLOYEE TRAINING PROGRAM

NCES facility management and operating staff receive a variety of training. In addition to employee training, a trained Region Safety Manager and a Region Permits, Compliance and Engineering (PCE) Manager is available to all operational staff for assistance, advice and problem solving. The Region PCE Manager is trained in Hazardous Waste Operations and Emergency Response (HAZWOPPER) and the Landfill Manager is a certified Solid Waste Association of North America (SWANA) Manager of Landfill Operations (MOLO).

The operations management at the facility is to be provided by persons who are certified by NHDES for the level of responsibilities. At least one person on-site shall be a certified Level IV Operator. For every five operators (person directly involved in solid waste management activities), there is to be at least one Level III or Level IV Operator.

NCES provides regular and on-going training to all staff on job responsibilities, human resource matters, operations/equipment, health and safety, and environmental. Training is primarily done by qualified internal staff, however third-party consultants/experts, or certificate programs and seminars may be incorporated. Necessary job-related training is provided to new-hire employees. Training related to landfill operations staff includes:

1. Health and Safety

Training on a variety of Health and Safety related topics is provided primarily by on-site management. Generally training occurs once per month and ranges from ½ hour to 1 hour sessions depending on the topic.

2. **Specific Technical Training on Operating Equipment and Procedures**

The Landfill Manager will ensure employees are technically trained in proper equipment use prior to operation. On-site and off-site training is provided for staff and management on specific equipment from suppliers.

3. **Facility Operating Plan**

The Facility Operating Plan is reviewed annually by the Landfill Manager and Region PCE Manager. Facility Operations Staff are trained regularly and as necessary on various components of the Operating Plan.

a. **Identification of Acceptable and Unacceptable Waste**

Annual training is provided to equipment/compactor operators in identification of acceptable and unacceptable waste (Hazardous waste, CFC's, asbestos, etc.). Training topics may include: definitions, what is unacceptable, identification practices, load inspection, handling procedures, and procedures for unapproved or unacceptable deliveries, contact information.

b. **Special Waste Training**

Annual training is provided to the Landfill Manager, sales representative, and equipment/compactor operators, involved in the management of special wastes, as applicable to their related duties. Additional training may be required when there are new handling requirements, new rules or policies, or new waste streams. Training topics may include: definitions, examples of special wastes, identification of special waste, special waste approval process, load inspection, handling procedures, and procedures for unapproved or unacceptable deliveries, contact information.

c. **Emergency and Contingency Plan Procedures**

The Emergency and Contingency Plan Procedures are reviewed annually by the Landfill Manager and Region PCE Manager. Facility Operations Staff are trained regularly and as necessary on various components of the Plan.

4. **Spill Prevention Control and Countermeasures (SPCC)**

   Provided the Facility is required to have a SPCC Plan by 40 CFR 112, annually, discharge prevention briefings will be held for oil-handling employees on the SPCC Plan and emergency response procedures. In addition, the training includes a review of the NHDES criteria for reporting petroleum discharges and emergency contact information.

5. **Storm Water Pollution Prevention Plan (SWPPP)**

   Provided the Facility is required to have a SWPPP by the US EPA National Pollution Discharge Elimination System (NPDES) Program, annually, storm water pollution prevention briefings will be held for operational employees on good housekeeping, material maintenance and spill response procedures.

8.0 RECORD KEEPING AND REPORTING

The following records are to be maintained at the facility as well as the Permitting and Compliance office:

- Copies of facility permits and approvals;
- Quantity, type, and origin of all waste received by the facility;
- Quantity and destination of leachate generated by the facility;
- Quantity, type and destination of all certified waste-derived products used produced by the facility, if any;
- Record of inspections, maintenance, and repairs;
- Record of accidents, violations, remedial and emergency event response actions;
- Record of complaints received and related response actions;
- Data from all environmental monitoring performed at or for the facility, whether required by the Solid Waste Rules or the permit or undertaken voluntarily;
- Documentation of contact with the waste management district(s) served by the facility as required by Env- Sw 1105.06 (11);
- The facility design reports;
- Hydrogeologic reports;
- Other record keeping information and documentation required by the Rules; and

- Other information and documentation as required by the terms and conditions of the facility permits and approvals.

The operating records identified above are to be maintained at the facility at all times during the active life of the facility, unless approval is granted pursuant to a Type V Permit Modification or a Waiver is granted to relocate or destroy the records. Operating records are to be made available for NHDES inspection and copies provided to the department pursuant to Env-Sw 2000. Following closure of the facility, the operating records are to be maintained at a location approved by NHDES in the Closure Plan, unless destruction of the records is approved pursuant to a Type V Permit Modification.

The Permitee is to notify the Department in writing within thirty (30) calendar days of any change in the facility address, telephone number, key certified operators and contact person(s).

An annual facility report is to be filed by March 31 each year for the prior calendar year and include the information required by Env-Sw 1105.13.

A daily record will be maintained at the scale house detailing the types of wastes received, weight, hauler, and origin. Waste received from a consolidation facility such as a solid waste transfer station will be identified by the specific transfer station. The daily records will include the leachate quantities pumped from the sumps transported from the Site. Quarterly reports will be prepared and submitted to NHDES in compliance with State rules. All water quality data and any laboratory analysis will be kept on file for the life of the landfill. Copies of any reports submitted to the NHDES are to be available at the facility.

APPENDIX K

LINER SETTLEMENT MONITORING PLAN

APPENDIX K
Liner Settlement Monitoring Plan

INTRODUCTION

This liner Settlement Monitoring Plan (Plan) describes the means to monitor settlement and evaluate strain in that portion of the Stage IV liner constructed above the waste in Stage I.

SETTLEMENT MONITORING PROGRAM

A settlement monitoring system provided by Geokon, Inc. of Lebanon, New Hampshire will be used to monitor settlement at three locations along the slopes of the overlay liner system. A total of five slope lengths of the overlay liner will be monitored, three on the north slope and two slope lengths on the south slope. The system (Geokon's Model 4600 Settlement System) consists of a settlement plate and reservoir installed above the liner system within the select sand. The settlement reservoirs are connected to a vibrating wire pressure transducer via a liquid filled line. The pressure transducers are set in a manhole located outside the landfill anchor trench, and will have a known and fixed reference elevation. Three sensors will be installed in each manhole. The pressure transducers signal cable is routed to a remote terminal box mounted central to the manhole locations. A single terminal box will be installed on the north and south sides of the landfill. The sensor detects hydraulic head from the settlement plate and reservoir above and relays this signal to the terminal box. The hydraulic head at the terminal box can be measured for each settlement location, converted to elevation and compared to an initial reading to calculate settlement.

Prior to obtaining readings, the elevation at the location of the settlement plate and transducers will be surveyed to provide a current reference elevations. Readings will be taken and recorded following construction, and then quarterly. Data will be presented in tabular form comparing initial readings with subsequent measurements to evaluate settlement at the established locations along each slope.

STRAIN EVALUATION

It is anticipated that settlement will result in relaxation of the geomembrane over the majority of the slope and not cause damaging tensile strain. Tensile strain may occur in areas where there is differential settlement leading to elongation of the geomembrane and could be induced as locations on the slope settle more relative to locations further up the slope. The strain between adjacent monitoring locations will be calculated and the maximum tensile strain will be identified following each monitoring event. The calculated maximum tensile strain will be compared against a yield strain for HDPE geomembrane of 10 percent. Note that this yield strain is appreciably lower than the strain at break, which for textured HDPE geomembrane is typically 100 percent or more. With time, it is anticipated that secondary settlement will tend to lessen overall differential settlement and associated strain.

DATA REPORTS

Data from the monitoring events will be provided in the applicable quarterly report to NHDES. The data reports will include the tabulated data, and discussion of the calculated tensile strain relative to the strain at yield and break for geomembrane.

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Appendix A

Rules and Regulations for Facility Use, Certificates of Acceptable Waste Forms And Random Waste Inspection Worksheet

NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.

RULES AND REGULATIONS FOR FACILITY USE

A. These Rules and Regulations For Facility Use ("Rules") shall be issued to each HAULER using this Facility. The Rules, which shall be endorsed by the HAULER/OWNER, will be kept on file with the OPERATOR and shall contain the following information:
   1. Company Name
   2. Address
   3. Business and after-hours telephone contact number and name
   4. Make, body type, and owners' name for all vehicles of such Hauler which will be used to deliver Acceptable Waste to the Facility

B. A Certificate of Insurance for all vehicles (used to deliver Acceptable Waste to the Facility) of such HAULER shall accompany the signed Rules. It is the responsibility of each HAULER/SUPPLIER to make sure that all insurance certificates are kept current and forwarded to the Landfill. The minimum required liability coverage will be one million dollars.

C. All drivers shall register with the OPERATOR before being allowed to enter the Facility. This registration shall take place at the Facility and will include:
   1. Inspection to ensure the vehicle is wholly contained and covered.
   2. Verification that adequate comprehensive general liability insurance is in force with regard to said vehicle. The adequacy of said liability insurance is at the sole discretion of the OPERATOR.
   3. Issuance of a Permit Number which is to be permanently affixed to the vehicle in such a manner as to be seen clearly from the scale office.
   4. Disclosure of origins and constituents of the waste contained in each truck.

D. All vehicles arriving and departing from the landfill, except those servicing the local area, are to use the Route 3 access onto Trudeau Road.

E. The Facility shall be operated from the hours of 7:00 a.m. to 3:00 p.m. on non-holiday weekdays. No vehicle will be admitted on a non-holiday weekday after 3:00 p.m. unless prior notification, such as a truck running late, has been given. No vehicle shall arrive at the Facility prior to 6:30 a.m. Under no circumstances will any vehicle park upon ~~a public highway, including~~ Trudeau Road, while awaiting admission to the Facility. The Facility shall be closed on the following holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving, and Christmas. North Country Environmental Services, Inc. shall determine the date of these holidays when the State, Federal, and/or traditional holidays conflict.

F. The quantity of waste delivered to the Facility will be measured by the OPERATOR on its Facility scales and the weights evidenced thereby shall be conclusive evidence of the quantity of Acceptable Waste delivered. At the SUPPLIER's

request, the OPERATOR shall make available appropriate scale certification documents and records.

G. After weighing, the driver shall proceed to a point in the Facility as directed and discharge the load.

H. Upon discharging the load, the driver will return to the scales for reweighing and the determination of the net weight. The driver will sign and receive a copy of the weight slip for each load.

I. Upon receipt of the weight slip, the driver shall immediately remove his vehicle from the Facility in order to make room for other vehicles.

J. Only Acceptable Waste, as defined by these Rules (Section Q), shall be disposed at the Facility. A Certificate of Acceptable Waste must be executed by the SUPPLIER, or its designated HAULER, and forwarded to the Facility prior to disposal. It is the affirmative obligation of each and every authorized HAULER and SUPPLIER to disclose the presence or suspected presence of any non-acceptable waste. The presence of any non-acceptable waste may result in a denial of access to the Facility at the sole discretion of the OPERATOR.

K. The OPERATOR retains the right to inspect any load presented at the gate prior to its admission to the Facility.

L. All damage to the Facility caused by a driver or vehicle shall be reported immediately to the Facility Supervisor. All drivers have the ultimate responsibility to maintain and operate their vehicles in a safe and proper fashion.

M. The vehicle registration form (Section A, 4) required by these Rules must be renewed annually (at a minimum) or at any time a vehicle is added or deleted. Any vehicle not registered will NOT be admitted to the Facility.

N. Refusal of any driver of any vehicle to register upon arrival at the gate of the Facility will result in denial of access, with such denial being considered rejected waste.

O. All vehicles entering the Facility for disposal purposes must be able to discharge or tip their loads by mechanical or hydraulic means without assistance from the OPERATOR's equipment. Should the vehicle experience problems in discharging its load due to mechanical breakdown, frozen conditions, or jammed loads, then OPERATOR may render assistance, pending the availability of equipment, and assess charges for any equipment and labor time rendered. This assistance and the charges will be made at the OPERATOR's sole discretion and will be based on rates charged for comparable services and equipment in the construction industry.

P. All vehicles entering the Facility will be equipped with suitable tow hooks for the purpose of assisting the vehicle to the working face during inclement weather conditions. Any towing of vehicles will be done at the sole risk of the vehicle owner or driver. The OPERATOR will be held harmless for any damage done to vehicles while providing towing assistance, but will use due caution when providing this

service. CB radios are required to provide communication between the drivers and the Landfill Facility personnel.

Q. **ACCEPTABLE WASTE** shall be defined as non-hazardous waste that can be legally disposed of at the NORTH COUNTRY ENVIRONMENTAL SERVICES, INC. (NCES) Landfill Facility in accordance with all applicable regulations, permits, and requirements. Acceptable waste are categorized by type in the following manner:

1. **MUNICIPAL SOLID WASTE**
   All waste, garbage, trash, rubbish, refuse, and offal that is now normally disposed of by or collected from residential, commercial, institutional, and industrial establishments **excluding:**
   a) bulky items including, but not limited to, mattresses, box springs, carpeting, and upholstered furniture, carpeting, televisions, etc.
   b) white goods such as refrigerators, stoves, washers, dryers, air conditioners, and other large metal appliances
   c) tires
   d) explosives
   e) asbestos and/or asbestos-contaminated construction material and demolition debris
   f) stumps, leaves, brush and other yard waste
   g) barrels, drums, and other liquid receptacles
   h) waste which, pursuant to applicable Federal and State laws, may not be disposed by landfilling without special handling and/or other extraordinary treatment
   i) HAZARDOUS WASTE, which shall have the meaning assigned to it by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, includes all of those substances regulated under the Toxic Substances Control Act and, in addition, shall include all petroleum or petroleum derivatives, all radioactive material, all sludge from air pollution control devices, any material which is hazardous within the meaning of RSA 147-A, and the regulations promulgated thereunder, and infectious waste within the meaning of He-P 1901.03(x) as it may be amended or replaced from time to time
   j) any material which in NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.'s sole judgement is deemed harmful to NCES' equipment or personnel
   k) Acceptable Waste which, by any Federal, State, or other applicable law, may not be disposed of at the Facility
   l) Non-hazardous industrial wastes requiring special permission for disposal from the New Hampshire Department of Environmental Services (NH DES)

2. **CONSTRUCTION AND DEMOLITION DEBRIS**
   All waste generated from the construction and/or demolition of buildings, structures, roadways, etc. These wastes typically include lumber, sheetrock, plastic, brick, mortar, concrete, glass, insulation, and the like. Construction materials must be free of all friable and non-friable asbestos material. NCES may refuse to accept C&D loads that, in its sole discretion, are deemed harmful

NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.

CERTIFICATE OF ACCEPTABLE WASTE

The undersigned hereby certifies that, to the best of their knowledge and belief, the materials which are delivered for disposal at the North Country Environmental Services, Inc. solid waste facility are Acceptable Wastes as defined by these Rules & Regulations and incorporated herein by reference.

_____ _____

Date Customer/Supplier

DISCLOSURE OF INTEREST STATEMENT

In accordance with our standard practice, we issue statements monthly as of the last business day of the month. Our statements are payable upon receipt. Any balance on a statement which is not paid before the date of the first monthly statement following the statement on which such amount was first billed is deemed to be a past due balance. All payments received and all credits allowed since the date of the most recently previous statement are deducted in determining the past due balance. We add a finance charge (interest) to any past due balance shown on statement. We figure the finance charge by applying the Periodic Rate (1.5% per month) to the past due balance. The above-stated periodic rate is an annual effective rate of 18.00%.

In order to avoid any finance charges, you must pay the new amount first billed on each monthly statement prior to the date of the first succeeding monthly statement. If you receive a statement which includes a finance charge on a past due balance, in order to avoid additional finance charges, you must pay the entire previous balance shown on that statement prior to the date of the next monthly statement.

to Facility personnel or equipment due to the unique nature or consistency of the material (i.e., large wooden beams, steel beams, etc.).

3. **BULKY WASTE**
   Bulky waste is solid waste which is difficult to manage; this includes, but is not limited to, materials such as upholstered furniture, mattresses, box springs, carpeting, appliances, household generated televisions, computers, and the like.

4. **SPECIAL WASTE**
   Special waste are materials that may be accepted provided that they meet all Landfill criteria and are tested and found to be NON-HAZARDOUS and are free from properties which might create unusual problems in the operation of the Landfill. Examples of this type of material are virgin oil-contaminated soils, wood ash, MSW incinerator ash, residue or by-products of processing facilities such as sludges, grit, and grindings. All special wastes must be individually approved in writing by the NH DES prior to acceptance.

5. **DES INFORMATION**
   NCES strongly recommends that commercial haulers and business, industry, and institutional solid waste generators contact New Hampshire Department of Environmental Services at 603-271-2900 or **www.des.state.nh.us/pcas** with any questions regarding recycling and solid waste disposal, particularly Universal Waste Requirements for items such as: anti-freeze, lamps, mercury containing devices, cathode ray tubes, batteries, thermostats and certain pesticides.

Date:_____ Signature:_____

NORTH COUNTRY ENVIRONMENTAL SERVICES

RANDOM LOAD INSPECTION

DATE:

CUSTOMER: TIME:

LOAD ORIGIN: TRANSFER STATION / LOCAL ROUTE — PERMANENT CAN / SPOT PLACEMENT

REMARKS: TRAILER-DUMP / TRAILER / ROLL-OFF / PACKER / PICK-UP — MUNICIPAL SOLID WASTE / CONSTRUCTION DEBRIS / MIXED M.S.W. & C.D. / SPECIAL WASTE

CUSTOMER: TIME:

LOAD ORIGIN: TRANSFER STATION / LOCAL ROUTE — PERMANENT CAN / SPOT PLACEMENT

REMARKS: TRAILER-DUMP / TRAILER / ROLL-OFF / PACKER / PICK-UP — MUNICIPAL SOLID WASTE / CONSTRUCTION DEBRIS / MIXED M.S.W. & C.D. / SPECIAL WASTE

CUSTOMER: TIME:

LOAD ORIGIN: TRANSFER STATION / LOCAL ROUTE — PERMANENT CAN / SPOT PLACEMENT

REMARKS: TRAILER-DUMP / TRAILER / ROLL-OFF / PACKER / PICK-UP — MUNICIPAL SOLID WASTE / CONSTRUCTION DEBRIS / MIXED M.S.W. & C.D. / SPECIAL WASTE

CUSTOMER: TIME:

LOAD ORIGIN: TRANSFER STATION / LOCAL ROUTE — PERMANENT CAN / SPOT PLACEMENT

REMARKS: TRAILER-DUMP / TRAILER / ROLL-OFF / PACKER / PICK-UP — MUNICIPAL SOLID WASTE / CONSTRUCTION DEBRIS / MIXED M.S.W. & C.D. / SPECIAL WASTE

[illegible]

Appendix B

Letters of Agreement for Leachate Disposal

CITY OF CONCORD, N.H.

DEPARTMENT OF GENERAL SERVICES
WASTEWATER DIVISION

PERMIT TO DISCHARGE
INDUSTRIAL WASTEWATER TO THE MUNICIPAL SEWER SYSTEM

[X Concord WWTF [ ] Penacook WWTF Permit No. H34

1. Name of Industry: North Country Environmental Services, Inc
2. Address of Industry: 581 Trudeau Road, Bethlehem, N.H.
3. Name of Owner: NCES Phone # 603-869-3366
4. Owner's Address: Same
5. Person in Responsible Charge/Phone No.: Kim Crosby 802-223-7221
6. Existing Environmental Permit(s):

STATE	EPA
See Attached	See Attached

7. Standard Industrial Classification of Various Operations:

   4953 Refuse System

8. Brief description of the nature and average rates of production and operations:
   Residual liquids (leachate from a lined lanfill that accepts non- hazardous waste for permanent disposal. Average daily rate of leachate generated is approximately 5000, to 10,000 gallons per day.

9. Brief description of each regulated process and applicable Federal categorical pretreatment standard: Not Applicable

10. If under categorical pretreatment standards, please attach a process flow diagram of your facility. Not Applicable

11. Wastewater flow (gallons per day):

Industrial Process + Domestic = Total Flow

Average Daily: Not Applicable Limits are based on BOD(lbs./day
Maximum Daily: **See Section 16**
Maximum Hourly:

12. Please attach certified analyses showing the nature and concentrations of pollutants in discharge as indicated (Y or N).....[ ]
(Current data on file)

13. Brief description of all wastewater pretreatment equipment and/or systems currently in use:

Leachate from NCES is not pretreated

14. Schedule of actions regarding further pretreatment of wastestream(s) if noncompliant with Federal and/or City discharge limitations.

Not Applicable

15. All industrial users shall immediately notify the City of any spills, bypasses or slug discharges of waste or wastewater discharged by such a user and shall provide protection from accidental discharges of prohibited materials or other substances regulated by the City's Sewer Use Ordinance. The City may request the industrial user to develop a slug discharge control plan.

All industrial users shall immediately notify the City of any new or changed discharge not covered under the existing industrial discharge permit.

16. Wastewater Discharge Limitations and Monitoring Requirements:

The industrial user shall comply with the effluent limitations specified below and all general discharge standards in **Section 5-2-13 & 13.1** of the City of Concord's Sewer Use Ordinance.

Parameter	Daily Average	Daily Maximum	(##) Sampling Frequency/Type
Flow (gpd)	NA	----------	
Arsenic(T)	NA	0.25	(See Schedule A)
Cadmium(T)	NA	0.07	
Copper (T)	NA	0.30	
Zinc(T)	NA	10.00	
Lead(T)	NA	0.10	

Other pH----------(5.0 to 10.0 s.u.)----------
(BOD 5-Day)----1500 pounds per day (Max. daily limit)

(##) Sampling Requirements for Reporting Purposes: (Further description of Section 16 above).

Scheduled testing of representative leachate samples for pH, listed metals, BOD, COD, chloride, volatile organic compounds, base/neutral extractable Organic compounds per Schedule A

Sampling for quarterly reports will be performed during the first two weeks of February, April, July, and November. Quarterly reports will be due on the 15th of the month after each respective sampling month.

A signed certification statement must accompany all reports.

Sampling for annual reports will be performed during the first two weeks of November with reporting due by December 31st.

Manifests documenting information on volumes of leachate transported and discharged to the Hall St. WWTF will be supplied for each truckload delivered. Invoicing by the City for leachate will be based on the volume declared on the manifest.

16(a). All sampling and analyses conducted by any industrial user or by the industrial user's contract laboratory must be in accordance with **40 CFR Part 136**.

All industrial users must maintain records of all information resulting from any monitoring activities as specified in **40 CFR 403.12(o)**.

All industrial users shall be required to retain for a maximum of five (5) years any records of monitoring activities and results and shall make such records available for inspection and copying by the City. This period of retention shall be extended during the course of any unresolved litigation regarding the industrial user or City, or when requested by the City.

16(b). Monitoring reports must include reporting requirements in **40 CFR 403.6(a)(2)(ii)** for signature and certification.

17. Inspection Requirement/Frequency: 1 per year.

18. Reporting Information:

The industrial user is required to submit reports to the City on the results of its sampling for the parameters specified in Section 16 of this permit.

Frequency of Reporting: **See Schedule A Section 16 of the Permit**

Report #1 due on or before: _____

Sampling period for Report #1: _____

_____

_____

Report #2 due on or before: _____

Sampling period for Report #2: _____

Wastewater Sampling Location(s): _____

_____

_____

(Please include a diagram indicating the location of the sampling point(s)).

Note: All reports must be submitted to the following address:

City of Concord
Dept. of General Services
Wastewater Division
125 Hall Street
Concord, N.H. 03301
Attn: Tom Neforas

19 (a). When self-monitoring by an industrial user indicates a violation, the industrial user must notify the City within 24 hours of becoming aware of the violation and must resample and resubmit the result(s) within thirty (30) days.

INDUSTRIAL SLUG CONTROL PLAN

Not Applicable

INDUSTRIAL FACTS SHEET

North Country Environmental Services, Inc.

Address: 581 Trudeau Road, Bethlehem, NH

Use Type: Transported Waste

Contact: Kim Crosby (802) 223-7221

Reporting Requirements: **See Schedule A Section 16 of the Permit**

Parameters:

Flow (gpd)	NA	---------	
Arsenic(T)	NA	0.25	(See Schedule A)
Cadmium(T)	NA	0.07	
Copper (T)	NA	0.30	
Zinc(T)	NA	10.00	
Lead(T)	NA	0.10	

Other: pH----------(5.0 to 10.0 s.u.)----------
(BOD 5-Day)----1500 pounds per day (Max. daily limit)

Issued by:

Laboratory Supervisor

10/20/08
Date

2010 (10-20)
Expiration Date

Approved by:

General Services Director

10/20/08
Date

This permit is non-transferable without prior notification to the City and without providing a copy of the permit to the new operator or owner. A copy of this permit shall be provided to the NHDES if so requested.

********** SCHEDULE A **********

Municipal Landfill Leachate Treatment Project

North Country Environmental Services, Inc. Landfill

Bethlehem, N.H.

Permit No. H34

The permittee shall monitor and record the quality of leachate discharges to the Hall St. WWTF according to the following schedule:

Parameter	Frequency of Analysis	Sample Type
pH (1)	Daily	Grab
Biochemical Oxygen (1) Demand	Weekly	Grab
Chemical Oxygen Demand (1)	Weekly	Grab
Metals (Total) (2) (3)	Quarterly	Grab
Chloride (2)	Quarterly	Grab
Volatile Organic Compounds (2)	Quarterly	Grab
Acid and Base Neutral Extractables (2)	Annually	Grab

All samplings/measurements described above shall be representative of the volume and nature of the monitored, permitted discharge to the Hall St. WWTF.

Note:

(1) Weekly and daily analytical testing results shall be compiled in a monthly reporting format and sent to our offices by the 15th of each following month.

(2) For annual and quarterly reporting, please refer to the schedule in section 11 of the permit.

(3) Samples shall be analyzed for arsenic, cadmium, copper, chromium, lead, mercury, molybdenum, nickel, selenium and zinc.

file\NCLP02SA

Date: 12-20-08

VERMONT

Application file Copy
Final Permit

State of Vermont
Department of Environmental Conservation

AGENCY OF NATURAL RESOURCES
Wastewater Management Division
103 South Main St. - Sewing Bldg.
Waterbury VT 05671-0405
Telephone: (802) 241-3822
FAX: (802) 241-2596

November 3, 2006

RECEIVED
NOV - 9 2006
CASELLA WASTE SYSTEMS, INC.
PERMITS, COMPLIANCE & ENGINEERING

John Gay
New England Waste Services, Inc.
3 Pitkin Street
Montpelier, VT 05602

Re: Pretreatment Discharge Permit No. 3-1406

Dear Mr. Gay,

Enclosed is your copy of Discharge Permit No. 3-1406 that has been signed on behalf of the Commissioner of the Department of Environmental Conservation. This permit authorizes the of landfill leachate from your Coventry, VT, Bethlehem, NH, and Central Vermont facilities to the Montpelier and Burlington "North" wastewater treatment facilities.

Please read the permit carefully and make note of the conditions regarding the effluent limitations, sampling and reporting, and the other special conditions. As proposed in the draft of this permit there are changes in this permit from the permit that currently authorizes your discharge. Specifically:

1. This permit no longer authorizes a discharge to the Troy/Jay wastewater treatment facility since the Town(s) have revoked NEWS authorization to discharge to their facility.

2. Per your application the maximum flow to both the Montpelier and Burlington "North" wastewater treatment facilities has been increased to 23,000 gpd.

With respect to the comments, we have corrected the typographical errors on Page 2 and 3. However, your comments were received after the comment period closed and the majority of the comments did not contain any statements explaining why the change in the permit condition was necessary. Therefore they could not be not considered.

In regards to amending the permit to add more wastewater treatment facilities, please note that a written agreement between NEWS and each municipality stating the volume of leachate and the amount of BOD allocated to NEWS must be included with application. As part of the application process we will review capability of each wastewater treatment facility to properly treat leachate and may impose specific restrictions at each facility to ensure its proper operation.

Please note that this permit does not become effective until January 1, 2007.

If you have any questions regarding this permit or the permitting process please contact Randy Bean at our office.

Sincerely,

Brian D. Kooiker, Chief
Direct Discharge and O&M Section

Enclosure

cc. w/attachments
Ron Mercier, City of Montpelier
Laurie Adams, City of Burlington
Dennis Bryer, VT DEC WWMD
Liz Dickson, VT DEC WWMD

AGENCY OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WASTEWATER MANAGEMENT DIVISION
103 SOUTH MAIN STREET
WATERBURY, VERMONT 05671-0405

Permit No.: 3-1406
File No.: 12-11
PIN: SJ91-0001

PRETREATMENT DISCHARGE PERMIT

In compliance with the provisions of the Vermont Water Pollution Control Act, as amended, (10 V.S.A. Chapter 47 §1251 et. seq),

New England Waste Services, Inc
3 Pitkin Court
Montpelier, VT 05602

(hereinafter referred to as the "permittee") is authorized, by the Secretary, Agency of Natural Resources, to discharge to the:

City of MontpelierWastewater Treatment Facility

and the

City of Burlington "North" Wastewater Treatment Facility

in accordance with effluent limitations, monitoring requirements, and other conditions set forth in Parts I, II, III hereof.

This permit shall become effective on January 1, 2007

This permit and the authorization to discharge shall expire on December 31, 2011.

Signed this 6th day of November, 2006.

Jeffrey Wennberg, Commissioner
Department of Environmental Conservation

By Christine Thompson
Christine Thompson, Director
Wastewater Management Division

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. From January 1, 2007 through December 31, 2011the permittee is authorized to discharge solid waste landfill leachate from its Coventry, VT, Bethlehem, NH, and Central Vermont facilities to **the Montpelier Wastewater Treatment Facility.** Such discharges shall be limited by the permittee as specified below:

Discharge Limitations Requirements			Monitoring	
Effluent Characteristic	**Daily Maximum**	**Weekly Maximum**	**Measurement Frequency**	**Sample Type**
Flow	23,000 gpd (1)		Daily	Total Volume
Biochemical Oxygen Demand (BOD)	1,200 lbs (1)	7,200 lbs	Weekly (2)	Grab
Chemical Oxygen Demand (COD)	monitor only		Weekly	Grab
pH	Range: 5.0 - 9.5 SU		Daily	Grab

(1) The Daily Maximum leachate flow may exceed 23,000 gpd only if the Biochemical Oxygen Demand (BOD) of the leachate discharged on that day does not exceed **1,200 pounds**.

On days when the flow exceeds **23,000 gallons**, the permittee shall sample and analyze a representative sample(s) of the entire volume of leachate discharged to the facility and report the **total** pounds of BOD discharged to the WWTF for that day to verify that less than **1,200 pounds** of BOD was discharged.

(2) BOD shall be sampled at a **minimum** of weekly, even if the daily flows for the week have not exceeded **23,000 gpd.**

2. From January 1, 2007 through December 31, 2011, the permittee is authorized to discharge: solid waste landfill leachate from its Coventry, Vermont and Bethlehem, New Hampshire facilities to the **Burlington "North" Wastewater Treatment Facility**. Such discharges shall be limited by the permittee as specified below:

	Discharge Limitations		Monitoring Requirements	
Effluent Characteristic	**Weekly Average**	**Daily Maximum**	**Measurement Frequency**	**Sample Type**
Flow		23,000 gpd (1)	Daily	Total Volume
BOD		900 lbs (1,2)	Weekly	Grab
COD	Monitor only		Weekly	Grab
pH	Range: 5.0 - 9.5 SU		Daily	Grab

(1) The Daily Maximum leachate discharged to the "Day Leachate Storage Tank" shall not exceed 23,000 gpd **or 900 pounds per day of Biochemical Oxygen Demand.** The permittee may deliver additional leachate to the wastewater treatment facility for storage in the unused aeration tanks at the discretion of the City of Burlington.

(2) BOD shall be sampled at a minimum of weekly, even if the daily flows for the week have not exceeded 23,000 gpd.

B. SPECIAL CONDITIONS:

1. Leachate shall be discharged to holding tanks at the wastewater treatment facilities or in a manner as specified by the chief operator or other authorized City or sewer department representative. Any leachate discharge into the Montpelier Wastewater Treatment Facility's collection system shall not occur during storm events, snow melt, or when a storm event is imminent.

2. Leachate samples collected in accordance with the monitoring requirements of this permit shall be taken **from the holding tank(s) at the landfills**, and the samples shall be well mixed and representative of the leachate discharged to the wastewater treatment facilities.

3. This permit constitutes authorization by the Vermont Agency of Natural Resources to discharge leachate to the wastewater treatment facilities specified in Part I.A.1, and 2, above. This permit does not constitute authorization by the City of Montpelier or the City of Burlington to discharge leachate to their wastewater treatment facilities. The municipalities have the right to restrict the discharge of leachate to a lesser volume than is specified in Part I.A.1, and 2, of this permit or to refuse acceptance of the discharge.

4. Leachate shall not be introduced into the treatment process at the Montpelier Wastewater treatment facility on any day in which the maximum rate of influent flow to the facility exceeds the facility's peak design flow of 8.0 MGD.

5. If the monitoring results indicate the presence of substances in such concentrations as may interfere with or are otherwise incompatible with the Montpelier Wastewater Treatment Facility or the Burlington North Wastewater Treatment Facility or may pass through without treatment and cause a violation of Vermont Water Quality Standards in the receiving stream, the Department may reopen this permit and modify effluent limitations, monitoring requirements, or other permit conditions as required. The Department may also require the cessation of this discharge until such time as the discharge will not interfere with or cause an adverse effect on the Facility or receiving stream.

C. REAPPLICATION

If the permittee desires to continue to discharge after the expiration of this permit, the permittee shall reapply on the application forms then in use at least 180 days before this permit expires.

Reapply for a Discharge Permit by: **June 30, 2011.**

D. OPERATING FEES

This discharge is subject to operating fees. The permittee shall submit the operating fees in accordance with the procedures provided by the Secretary.

E. MONITORING AND REPORTING

1. Metal, Organic and Inorganic Sampling

In addition to the monitoring required in Condition I.A. above, the permittee shall monitor and record the quality and quantity of discharge(s) to the Montpelier and Burlington "North" wastewater treatment facilities, according to the following schedule and other provisions.

Until December 31, 2011:

Parameter	Minimum Frequency of Analysis	Sample Type
Metals (Total) (1,2)	Quarterly	Grab
Chloride (1)	Quarterly	Grab
Total Kjeldahl Nitrogen (1)	Quarterly	Grab
Volatile Organic Compounds (1,3)	Annually	Grab
Acid and Base/Neutral Extractable (1,4)	Annually	Grab

(1) Leachate from each landfill cell which was transported and disposed at any of the permitted wastewater treatment facilities during the prior quarter or year shall be analyzed.

(2) Samples shall be analyzed for the following: arsenic, cadmium, chromium, copper, lead, molybdenum, mercury, nickel, selenium, and zinc.

(3) Volatile Organic Compounds shall be analyzed by EPA Method 8260.

(4) Acid and Base/Neutral Extractable shall be analyzed by EPA Method 8270.

2. Sampling and Analysis

The sampling, preservation, handling, and analytical methods used shall conform to regulations published pursuant to Section 304(g) of the Clean Water Act, under which such procedures may be required. Guidelines establishing these test procedures have been published in the Code of Federal Regulations, Title 40, Part 136 (Federal Register, Vol. 56, No. 195, July 1, 1999 or as amended).

If applicable, Escherichia coli shall be tested using test method 9213 D, found in Standard Methods for the Examination of Water and Wastewater, 18th or subsequent edition(s).

Samples shall be representative of the volume and quality of effluent discharged over the sampling and reporting period. All samples are to be taken during normal operating hours. The permittee shall identify the sampling location used for each discharge.

3. **Reporting**

The Permittee is required to submit monitoring results as specified on a Discharge Monitoring Report (Form WR-43). Reports are due on the 15th day of each month, beginning with the month following the effective date of this permit.

If, in any reporting period, there has been no discharge, the permittee must submit that information by the report due date.

Signed copies of these, and all other reports required herein, shall be submitted to the Secretary at the following address:

Agency of Natural Resources
Department of Environmental Conservation
Wastewater Management Division
103 South Main Street, Sewing Building
Waterbury, Vermont 05671-0405

and the
Montpelier Wastewater Treatment Facility
Attn: Ron Mercier

and the
Burlington Department of Public Works
Attn: Laurie Adams

All reports shall be signed:

a. In the case of corporations, by a principal executive officer of at least the level of vice president, or his/her duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge described in the permit form originates;

b. In the case of a partnership, by a general partner;

c. In the case of a sole proprietorship, by the proprietor;

d. In the case of a municipal, State, or other public facility, by either a principal executive officer, ranking elected official, or other duly authorized employee.

4. **Recording of Results**

The permittee shall maintain records of all information resulting from any monitoring activities required including:

a. The exact place, date, and time of sampling;
b. The dates and times the analyses were performed;
c. The person(s) who performed the analyses;
d. The analytical techniques and methods used including sample collection handling and preservation techniques;
e. The results of all required analyses.
f. The records of monitoring activities and results, including all instrumentation and calibration and maintenance records;
g. The original calculation and data bench sheets of the operator who performed analysis of the influent or effluent pursuant to requirements of Section I.(A) of this permit.

The results of monitoring requirements shall be reported (in the units specified) on the Vermont reporting form WR-43 or other forms approved by the Secretary.

5. **Additional Monitoring**

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form WR-43. Such increased frequency shall also be indicated.

PART II

A. MANAGEMENT REQUIREMENTS

1. **Facility Modification / Change in Discharge**

All discharges authorized herein shall be consistent with the terms and conditions of this permit. Such a violation may result in the imposition of civil and/or criminal penalties as provided for in Section 1274 and 1275 of the Vermont Water Pollution Control Act. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new permit application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Noncompliance Notification

In the event the permittee is unable to comply with any of the conditions of this permit due, among other reasons, to:

a. breakdown or maintenance of waste treatment equipment (biological and physical-chemical systems including, but not limited to, all pipes, transfer pumps, compressors, collection ponds or tanks for the segregation of treated or untreated wastes, ion exchange columns, or carbon absorption units),

b. accidents caused by human error or negligence, or

c. other causes such as acts of nature,

the permittee shall notify the Secretary within 24 hours of becoming aware of such condition or by the next business day and shall provide the Secretary with the following information, in writing, within five (5) days:

i. cause of non-compliance

ii. a description of the non-complying discharge including its impact upon the receiving water;

iii. anticipated time the condition of non-compliance is expected to continue or, if such condition has been corrected, the duration of the period of non-compliance;

iv. steps taken by the permittee to reduce and eliminate the non-complying discharge; and

v. steps to be taken by the permittee to prevent recurrence of the condition of non-compliance.

3. Operation and Maintenance

All waste collection, control, treatment, and disposal facilities shall be operated in a manner consistent with the following:

a. The permittee shall, at all times, maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

b. The permittee shall provide an adequate operating staff which is duly qualified to carry out the operation, maintenance, and testing functions required to insure compliance with the conditions of this permit; and

4. **Quality Control**

The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at regular intervals to ensure accuracy of measurements, or shall ensure that both activities will be conducted.

The permittee shall keep records of these activities and shall provide such records upon request of the Secretary.

The permittee shall analyze any additional samples as may be required by the Agency of Natural Resources to ensure analytical quality control.

5. **Records Retention**

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed, calibration and maintenance of instrumentation, and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, and shall be submitted to Department representatives upon request. This period shall be extended during the course of unresolved litigation regarding the discharge of pollutants or when requested by the Secretary.

6. **Duty to Mitigate**

The permittee shall take all reasonable steps to minimize or prevent any adverse impact to the receiving wastewater treatment facility resulting from non-compliance with any condition specified in this permit, including accelerated or additional monitoring as necessary to determine the nature and impact of the non-complying discharge.

7. **Bypass**

The diversion or bypass of facilities, necessary to maintain compliance with the terms and conditions of this permit, is prohibited, except where authorized under terms and conditions of an emergency pollution permit issued pursuant to 10 V.S.A. Section 1268.

8. **Solids Management**

Collected screenings, sludges, and other solids removed in the course of treatment and control of wastewaters shall be stored, treated and disposed of in accord with 10 V.S.A., Chapter 159 and with the terms and conditions of any certification, interim or final, transitional operation authorization or order issued pursuant to 10 V.S.A., Chapter 159 that is in effect on the effective date of this permit or is issued during the term of this permit.

9. **Emergency Pollution Permits**

Maintenance activities, or emergencies resulting from equipment failure or malfunction, including power outages, which result in an effluent which exceeds the effluent limitations specified herein, shall be considered a violation of the conditions of this permit, unless the permittee immediately applies for, and obtains, an emergency pollution permit under the provisions of 10 V.S.A., Chapter 47, Section 1268. The permittee shall notify the Department of the emergency situation by the next working day.

10 V.S.A., Chapter 47, Section 1268 reads as follows:

"When a discharge permit holder finds that pollution abatement facilities require repairs, replacement or other corrective action in order for them to continue to meet standards specified in the permit, he may apply in the manner specified by the secretary for an emergency pollution permit for a term sufficient to effect repairs, replacements or other corrective action. The permit may be issued without prior public notice if the nature of the emergency will not provide sufficient time to give notice; provided that the secretary shall give public notice as soon as possible but in any event no later than five days after the effective date of the emergency pollution permit. No emergency pollution permit shall be issued unless the applicant certifies and the secretary finds that:

(a) there is no present, reasonable alternative means of disposing of the waste other than by discharging it into the waters of the state during the limited period of time of the emergency;

(b) the denial of an emergency pollution permit would work an extreme hardship upon the applicant;

(c) the granting of an emergency pollution permit will result in some public benefit;

(d) the discharge will not be unreasonably harmful to the quality of the receiving waters;

(e) the cause or reason for the emergency is not due to wilful or intended acts or omissions of the applicant."

Application shall be made to the Secretary of the Agency of Natural Resources, Department of Environmental Conservation, 103 South Main Street, Waterbury, Vermont 05671-0405.

10. Power Failure

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. Provide an alternative power source sufficient to operate the wastewater control facilities, or if such alternative power source is not in existence,

b. Halt, reduce, or otherwise control production and/or all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater control facilities.

B. RESPONSIBILITIES

1. Right of Entry

The permittee shall allow the Secretary or authorized representative, upon the presentation of proper credentials:

a. to enter upon the permittee's premises in which an effluent source or any records required to be kept under terms and conditions of the permit are located;

b. to have access to and copy any records required to be kept under the terms and conditions of the permit;

c. to inspect any monitoring equipment or method required in the permit; or

d. to sample any discharge of pollutants.

2. Transfer of Ownership or Control

This permit is not transferable without prior written approval of the Secretary. All application and operating fees must be paid in full prior to transfer of this permit. In the event of any change in control or ownership of facilities from which the authorized discharges emanate, the permittee shall provide a copy of this permit to the succeeding owner or controller and shall send written notification of the change in ownership or control to the Secretary. The permittee shall also inform the prospective owner or operator of their responsibility to make an application for transfer of this permit. This application must include as a minimum; a written statement from the prospective owner or operator certifying:

a. The conditions of the operation that contribute to, or affect, the discharge will not be materially different under the new ownership.

b. The prospective owner or operator has read and is familiar with the terms of the permit and agrees to comply with all terms and conditions of the permit.

c. The prospective owner or operator has adequate funding to operate and maintain the treatment system and remain in compliance with the terms and conditions of the permit.

d. The date of the sale or transfer.

The Department may require additional information dependent upon the current status of the facility operation, maintenance, and permit compliance.

3. **Confidentiality**

Pursuant to 10 V.S.A. 1259(b):

"Any records, reports or information obtained under this permit program shall be available to the public for inspection and copying. However, upon a showing satisfactory to the secretary that any records, reports or information or part thereof, other than effluent data, would, if made public, divulge methods or processes entitled to protection as trade secrets, the secretary shall treat and protect those records, reports or information as confidential. Any records, reports or information accorded confidential treatment will be disclosed to authorized representatives of the state and the United States when relevant to any proceedings under this chapter."

4. **Permit Modification**

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. violation of any terms or conditions of this permit;

b. obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge.

5. **Toxic Effluent Standards**

That if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under section 307(a) of the Federal Act for a toxic pollutant which is present in the permittee's discharge and such standard or prohibition is more stringent than any limitation upon such pollutant in the permit, the secretary shall revise or modify the permit in accordance with the toxic effluent standard or prohibition and so notify the permittee.

6. **Civil and Criminal Liability**

Except as provided in, "Bypass" (Part II.A., paragraph A.7.), "Power Failure" (Part II.A., paragraph 10.), and "Emergency Pollution Permits" (Part II, paragraph A.9.), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Civil penalties, as authorized under 10 V.S.A. §1274 and 10 V.S.A. §8010, shall not exceed $10,000 a day for each day of violation. Criminal penalties, as authorized under 10 V.S.A. §1275, shall not exceed $25,000 for each day of violation, imprisonment for up to six months, or both.

7. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under 10 V.S.A. §1281.

8. State Laws

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Clean Water Act.

9. Property Rights

Issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

10. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

11. Authority

This permit is issued under authority of 10 V.S.A. §1259 which states that: "No person shall discharge any waste, substance, or material into waters of the State, nor shall any person discharge any waste, substance, or material into an injection well or discharge into a publicly owned treatment works any waste which interferes with, passes through without treatment, or is otherwise incompatible with those works or would have a substantial adverse effect on those works or on water quality, without first obtaining a permit for that discharge from the Secretary", and under the authority of Section 402 of the Clean Water Act, as amended.

PART III

A. OTHER REQUIREMENTS

This permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under Sections 301(b) (2) (C), and (D), 304(b) (2), and 307 (a) (2) of the Clean Water Act, if the effluent standard or limitation so issued or approved:

1. Contains different conditions or is otherwise more stringent than any effluent limitation in the permit; or

2. Controls any pollutant not limited in the permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Vermont Water Pollution Control Act then applicable.

B. DEFINITIONS

For purposes of this permit, the following definitions shall apply.

The Act - The Vermont Water Pollution Control Act, 10 V.S.A. Chapter 47

Annual Average - The highest allowable average of daily discharges calculated as the sum of all daily discharges (mg/l, lbs or gallons) measured during a calendar year divided by the number of daily discharges measured during that year.

Average - The arithmetic means of values taken at the frequency required for each parameter over the specified period.

The Clean Water Act - The federal Clean Water Act, as amended.

Composite Sample - A sample consisting of a minimum of one grab sample per hour collected during a 24-hour period (or lesser period as specified in the section on Monitoring and Reporting) and combined proportionally to flow over that same time period.

Daily Discharge - The discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling.

For pollutants with limitation expressed in pounds the daily discharge is calculated as the total pounds of pollutants discharged over the day.

For pollutants with limitations expressed in mg/l the daily discharge is calculated as the average measurement of the pollutant over the day.

Grab Sample - An individual sample collected in a period of less than 15 minutes.

Incompatible Substance (Pollutant) - Any waste being discharged into the treatment works which interferes with, passes through without treatment, or is otherwise incompatible with said works or would have a substantial adverse effect on these works or on water quality. This includes all pollutants required to be regulated under the Federal Clean Water Act.

Instantaneous Maximum - A value not to be exceeded in any grab sample.

Major Contributing Industry - One that: (1) has a flow of 50,000 gallons or more per average work day; (2) has a flow greater than five percent of the flow carried by the municipal system receiving the waste; (3) has in its wastes a toxic pollutant in toxic amounts as defined in standards issued under Section 307(a) of the Act; or (4) has a significant impact, either singly or in combination with other contributing industries, on a publicly owned treatment works or on the quality of effluent from that treatment works.

Maximum Day (maximum daily discharge limitation) - The highest allowable "daily discharge" (mg/l, lbs or gallons).

Mean - The mean value is the arithmetic mean.

Monthly Average - (Average monthly discharge limitation) - The highest allowable average of daily discharges (mg/l, lbs or gallons) over a calendar month, calculated as the sum of all daily discharges (mg/l, lbs or gallons) measured during a calendar month divided by the number of daily discharges measured during that month.

NPDES - The National Pollutant Discharge Elimination System.

Secretary - The Secretary of the Agency of Natural Resources

State Certifying Agency Agency of Natural Resources
Department of Environmental Conservation
Wastewater Management Division
103 South Main Street
Waterbury, Vermont 05671-0405

Weekly Average - (Average weekly discharge limitation) - The highest allowable average of daily discharges (mg/l, lbs or gallons) over a calendar week, calculated as the sum of all daily discharges (mg/l, lbs or gallons) measured during a calendar week divided by the number of daily discharges measured during that week.

NCES LF file Copy

AGREEMENT

THIS AGREEMENT made this 9th day of May, 2007, by and between New England Waste Services, Inc., a Vermont Company ("NEWS") and the VILLAGE OF ESSEX JUNCTION, a Vermont municipality located in Chittenden County, Vermont ("Village").

WITNESSETH:

WHEREAS, Village owns and operates a wastewater treatment facility ("Facility") which presently has treatment capacity which is in excess of the present needs of the Village; and

WHEREAS, NEWS owns Landfills ("Landfills") which generate leachate from facilities listed in permit 3-1406 which must be treated before disposal; and

WHEREAS, Village is willing to receive and treat leachate from the Landfills at the Facility as long as the Facility has treatment capacity available for such leachate and such treatment does not cause the Facility to violate applicable permits, regulations, laws and standards; and

WHEREAS, NEWS is willing to dispose of the Landfills leachate at the Facility upon the terms and conditions set forth herein.

NOW, THEREFORE, in consideration of these mutual promises and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties hereto covenant and agree as follows:

1. NEWS will pay fees for disposal of Landfills leachate at the Facility in amounts equal to the Village's customary fee structure for industrial and commercial users served by the Facility, modified as follows:

> The wholesale rate for domestic waste treatment at the Facility (current as of the date of billing) shall be increased by a factor of 2.5 or such other factor as the Village may establish in the future for all users of this Facility for the disposal of commercial or industrial waste. This increased rate shall be multiplied times the average BOD concentration (measured in mg/l) for the billing period. This product will then be divided by 220. The minimum BOD to be billed shall be 220 mg/l.

The Village shall grant NEWS reasonable access to its records to enable NEWS to verify the Village's fee structure for industrial and commercial users.

During the term of this Agreement, payment will be due net thirty (30) days from date of invoice. Interest charges of 1% per month will be added to all overdue invoices. The Village shall have the right to discontinue the acceptance of leachate, without penalty, if NEWS account becomes ninety (90) days past due.

2. During the term of this Agreement, Village will allocate to NEWS a capacity equivalent to 30,000 gallons per day at the Facility with a varying concentration of high strength BOD with a 1,200 lb. BOD allocation.

3. The Village is obligated to accept for treatment at the Facility leachate which:

   a. will not interfere with the proper operation of the Facility;

   b. will not cause the Village to violate the requirements of its discharge permit, state sludge certification, or any applicable federal, state or local regulation or statute;

   c. will not result in the production of sludge that fails to meet applicable standards for disposal at the Village permitted sludge management sites or other disposal site used by the Village; and

   d. will not cause undue or persistent odors at the facility; and

   e. has been tested to ensure compliance with subsections b and c above, the cost of such testing to be paid by NEWS.

The Village may refuse to accept for treatment at the Facility any leachate which does not meet the standards of this section. NEWS shall be responsible for disposal of such leachate.

The Village shall have the right to schedule delivery of leachate upon reasonable notice to NEWS.

4. The Village shall:

   a. indemnify and hold NEWS harmless for any and all costs and damages incurred due to negligence of the Village not related to unacceptable leachate quality; and

b. maintain general liability insurance or equivalent with policy limits equivalent to those maintained by NEWS, and name NEWS as an additional insured

5. NEWS shall:

a. use reasonable efforts to prohibit delivery to the Facility of any Landfill leachate with characteristics that require regulation of such leachate under the Vermont Hazardous Waste Management Rules, as amended;

b. provide the Village an analysis of leachate quantities and qualities on a frequency as required by all applicable Village and NEWS permits;

c. indemnify and hold the Village harmless for any and all costs and damages incurred by the Village, including fines imposed by any governmental entity, as a result of delivery by NEWS to the Facility of leachate that does not meet the standards set forth in paragraph 3 above,

d. maintain general liability insurance with policy limits equivalent to those maintained by the Village (provide a certificate of said insurance), and name the Village as an additional insured, and designate the Village as a party to be given notice of termination of said insurance.

6. NEWS will obtain all permits and approvals required to implement the terms of this Agreement at its sole expense. Village will cooperate with and assist NEWS in obtaining and/or renewal of such permits and approvals. NEWS will provide copies of any documents received or submitted in connection with any permit or approval at the request of the Village.

7. NEWS will develop a contingency plan for disposal of leachate in the event Facility is unavailable for treatment and disposal. The Village agrees to cooperate with and assist NEWS in developing such plan by providing information or documents in its possession or control and providing access to information or documents in the possession of third parties.

8. This Agreement commences on the date of signature and shall be in effect until December 31, 2011. The Village is under no obligation to renew this Agreement and may decide not to renew the Agreement for any reason. However, this Agreement is renewable at any time prior to the expiration upon written consent of the parties.

9. Billing volume of liquid waste delivered to the facility shall be calculated based on truck scale readings converted at 8.34 lbs. per gallon. Rounding will occur to the nearest gallon using standard rounding methods.

10. This Agreement does not obligate NEWS to deliver all leachate from the Landfills to the Facility.

11. Either party may terminate, without cause, this Agreement by providing written notice of termination to the other party four (4) weeks prior to the date of termination.

12. This Agreement contains the entire agreement between the parties relating to the subject matter set forth herein and may be amended in part or in whole at any time with the written agreement of both parties.

Dated at Essex Junction, Vermont, this 9th day of May, 2007.

WITNESSES:

Teresa A. Hass

Susan McNamara-Hill

VILLAGE OF ESSEX JUNCTION

By: Patricia A. Benoit
Its Duly Authorized Agent

Dated at MONTPELIER, VERMONT, this 16TH day of MAY, 2007.

WITNESSES:

[illegible]

Janet E. Shatney

NEW ENGLAND WASTE SERVICES, INC.

By: [illegible]
Its Duly Authorized Agent

Appendix C
Facility Inspection Checklist

NCES LANDFILL
ROUTINE INSPECTION CHECKLIST FORM

INSPECTORS:_____ DATE:_____

WEATHER: Today: _____

Yesterday: _____

Reason for Inspection (CIRCLE):

Routine Emergency Other

	YES	NO	N/A	COMMENTS/ACTION ITEMS
1. Is the working face limited to as small an area as practical?				
2. Is the waste being spread in 2-foot layers and adequately compacted?				
3. Have 6 inches of compacted daily cover material (or approved ADC) been placed over the entire working face?				
4. Have 12 inches of compacted intermediate cover been placed over areas filled to final grade or which will not receive additional fill for 1 month or more? Should this lift be seeded?				
5. Is there evidence of erosion or damaging settlement to areas which have received final cover?				
6. Is the lift graded properly to promote runoff?				
7. Is the lift at the proper height? (8 to 10 ft. normally)				
8. Are all surface water diversion ditches in place and free of sediment or debris?				
9. Are culverts clear of debris and sediments?				
10. Are there any blown papers or debris which should be picked up?				
11. Is the landfill access road well graded and/or plowed?				
12. Is the access road to the working face in good condition?				
13. Have daily records of leachate, waste quantities and quality, cover material, and other applicable measurements been noted?				
14. Is there evidence of leachate breakouts?				
15. Do the detention ponds need to be cleaned?				
16. Are there eroded areas that need attention?				
17. Is the litter fence properly located & functioning?				

	YES	NO	N/A	COMMENTS/ACTION ITEMS
18. Are the blower and flare functioning consistently and as expected?				
19. Are there odors evident?				
20. Are dust control measures needed?				
21. Are berms intact with no evidence of erosion?				
22. Are the leachate vaults weather-tight and are all pump systems valves and controls operating as intended?				
23. Is there evidence of leakage in the leachate vaults, leak detection manholes or valve box?				
24. Have monitoring well riser pipes been disturbed? Are they secure?				
25. Are gas probe riser pipes secure?				
26. Is the Gas Management System functioning with gas composition within required parameters?				
27. Are gas wells intact and without undue stress in the piping at each wellhead?				
28. Is the landfill equipment functioning properly?				
29. Check the interstitial monitoring of all tanks. Are any problems noted?				

ADDITIONAL COMMENTS:

SIGNATURE

DATE

Copy to Company Compliance and Permitting Office

S:\DATA\1600s\1650\Operating Plan\Appendix C.doc

Appendix D

O & M Manual Gas Management System

OPERATION AND MAINTENANCE MANUAL
GAS MANAGEMENT SYSTEM

North Country Environmental Services, Inc.
Bethlehem, New Hampshire

Prepared for
North Country Environmental Services, Inc.

Prepared by
Sanborn, Head & Associates, Inc.

File 1650
March 2002

OPERATION AND MAINTENANCE MANUAL
GAS MANAGEMENT SYSTEM

North Country Environmental Services, Inc.
Bethlehem, New Hampshire

File 1650
March 2002

Further revisions by
CMA Engineers, Inc.
February 2007

OPERATION AND MAINTENANCE MANUAL
GAS MANAGEMENT SYSTEM

North Country Environmental Services, Inc.
Bethlehem, New Hampshire

Copied by SHA-NH

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1.0 INTRODUCTION

This manual describes procedures for operation and maintenance of the gas management system at the North Country Environmental Services, Inc. (NCES) landfill in Bethlehem, New Hampshire. The objective of the gas management system is to assure that the concentrations of methane and other explosive gases do not exceed:

- 25 percent of the lower explosive limit (LEL) for gases in structures on- or off-site excluding leachate collection and gas recovery and control structures; and
- 50 percent of the LEL for gases at and beyond the property boundary within soil.

A further objective is to provide for control of odors emanating from the landfill.

Before operating a landfill gas (LFG) collection and control system and related process equipment, individuals should be properly trained in the potential hazards and proper operating procedures for such operation. This manual is a general guide and not intended to be a substitute for proper hands on training in process operations, regulatory requirements, or special safety activities, which may be required by various local, state, or federal regulations. Landfill operations staff should become familiar with the properties of landfill gas and related hazards discussed below.

2.0 CHARACTERISTICS OF LANDFILL GAS AND POTENTIAL HAZARDS TO PERSONNEL

2.1 Characteristics

LFG is produced by anaerobic bacteria which consume organic matter in the refuse and is chiefly composed of methane and carbon dioxide. Other major gases that may be present include oxygen, nitrogen, and water vapor. LFG usually contains traces of hydrogen, ethane, and many other trace gases including volatile organic compounds (VOCs). Oxygen and nitrogen are usually present because of air entrained in the landfill (air is approximately 21 percent oxygen and 79 percent nitrogen), either during placement of refuse, from atmospheric weather effects, because of LFG system operations, or by diffusion of air into the landfill. Typical ranges in the concentrations of constituents in landfill gas are presented in Table 1.

Important characteristics of LFG are as follows:

- Consists primarily of methane (about 55 percent) and carbon dioxide (about 45 percent).
- LFG has a relatively high moisture content; cooling almost always results in the formation of condensate.
- LFG is flammable (i.e., potentially explosive).
- LFG may migrate through surrounding soils, within open conduits, and trench backfill.
- LFG may accumulate in confined spaces.
- The weight (specific density) of LFG is usually close to the weight of air.
- Typical temperature range is 16 degrees (°) to 58 ° Celsius (C) (60 ° to 120 ° Fahrenheit [F]) within the landfill.

- Component gases (methane, carbon dioxide, water vapor and others) tend to stay together but may separate through soil and liquid contact.
- Secondary constituents (trace gases) may cause nuisance odors, environmental pollution and may create a health risk.

The flammable range of methane is approximately 5 to 15 percent (by volume) in air. The lower limit of 5 percent is referred to as the LEL; the upper limit of 15 percent is referred to as the Upper Explosive Limit (UEL). Walking across a carpet in leather shoes creates a static charge sufficient to ignite methane. The auto-ignition temperature of methane is 540° C (1004° F). The specific density of methane and carbon dioxide are 0.55 and 1.52, respectively; however, the specific density of LFG is close to that of air. It should not be assumed that methane gas will rise. The landfill gas mixture may be lighter or heavier than air and its behavior will be dictated by its overall composition.

LFG has its own characteristic odor due to trace compounds in the gas. Some of the most significant examples of the classes of odor causing trace constituents include esters, phenols, organic acids, solvents, and sulfur compounds (including mercaptans). However, LFG may not always exhibit an identifiable odor since the odor carrying trace components may be stripped off as a result of movement through cover or adjacent soil.

LFG levels can be monitored using various meters. At a minimum, the percent LEL, percent oxygen, and percent hydrogen sulfide should be measured at any location where there is potential for landfill gas to be present and personnel will be working.

Personnel should either not enter, or leave immediately if already present if monitor results indicate:

- The percent LEL is 50 percent or higher;
- The concentration of oxygen is lower than 19.5 percent; or
- The concentration of hydrogen sulfide is more than 10 parts per million (ppm).

2.2 Potential Hazards to Personnel

Landfill operations staff should be made familiar with the following types of hazards related to the presence of landfill gas and gas condensate and the appropriate and safe procedures to identify and avoid them:

- Fire hazards;
- Explosive hazards;
- Confined space, toxic exposure, and asphyxiation hazards; and
- Condensate.

Methane is colorless, odorless, flammable and potentially explosive gas that as landfill gas together with other volatile trace gases may be emitted into the atmosphere; LFG that contains other gases may migrate through the soil into surrounding areas or contact groundwater. These other gases may adversely impact the environment. LFG may travel long distances under

ground. It may accumulate underneath and in structures and confined or enclosed spaces creating a potential explosion hazard. Carbon dioxide is colorless, odorless, and non-combustible.

2.2.1 Asphyxiation

Methane and carbon dioxide are asphyxiates. A serious hazard is oxygen deficiency which may cause death by asphyxiation. As LFG builds up it displaces air, hence oxygen in the gas inhaled by a person. An oxygen deficient atmosphere exists when the oxygen comprises 19.5 percent or less. It is imperative that confined space regulations and procedures be followed before personnel enter any confined spaces or any location where oxygen deficiency could occur. Under certain circumstances special "permitted entry" requirements apply.

Potentially lethal concentrations of H_2S may be present at landfills. Personnel must always be alert for the hazards presented by H_2S. H_2S is a colorless, toxic flammable gas, which in low concentration has an offensive odor similar to that of rotten eggs. Sense of smell can be lost within 2 to 15 minutes of exposure. If H_2S is detected or suspected, consult the site Health and Safety Officer, an industrial hygienist or other qualified person.

2.2.2 Explosive Atmosphere

LFG tends to migrate and accumulate in confined spaces. The occurrence and accumulation of methane is sometimes transient. The presence of slight amounts of methane, less than the LEL, is an indication that more may accumulate under other conditions if corrective action is not taken. If methane is detected in concentrations greater than 15 percent (100 percent of the UEL) by volume, there is always the potential for an explosive methane-air "front" that could be formed nearby by dilution.

- Avoid any possible source of ignition when working on the gas management system. **Smoking when working on the LFG system components is prohibited.**
- Synthetic clothing such as polyester is extremely flammable. Wearing synthetic clothing can be fatal in a methane gas flash fire.

2.2.3 Potential for Landfill Fire

If large quantities of air are introduced into the landfill in a localized area, either through natural occurrence or overly aggressive operation of the LFG system, poorly supported combustion of the buried municipal solid waste (MSW) may occur and carbon monoxide may be detected. Subsurface fires produce temperatures of several hundred degrees Fahrenheit within the landfill and typically result from short-circuiting air intrusion into:

- The landfill/cover soil interface;
- Cracks, breaks or buried imperfections in the cover/cap;
- Breaks in buried collection piping and extraction wells; or
- Backfill surrounding collection system components (e.g., from the filter or gravel pack of an

extraction well or the gravel backfill around a sump).

Therefore, preventing the introduction of air into the landfill by good operation of the collection system and maintenance of the landfill cover is the best course of action.

2.2.4 LFG Condensate

LFG condensate may contain trace chemicals and be biologically active. Appropriate protective gloves and splash protection equipment should be used when working with LFG condensate. Operating personnel should avoid direct skin contact.

Condensate is odorous, and may release VOCs. Condensate also usually contains a high concentration of iron which causes the condensate to stain concrete orange. Careful control of condensate handling, treatment and disposal is necessary to limit release of odors.

The vapors emanating from condensate tankage may be flammable.

3.0 SYSTEM COMPONENTS AND MONITORING PROGRAM

The gas management system includes perimeter gas monitoring probes, horizontal collection trenches, gas extraction wells and associated wellheads, transmission piping, blowers, and flares. In addition, passive flares have been installed on certain leachate collection system components. A description of the individual gas management system components is provided below.

The primary objective of the gas management system is to control migration of LFG from the facility and provide for control of odors from the facility. Further, the LFG collection system should be operated in a manner which maintains anaerobic conditions within the landfill limiting the intrusion of air into the waste. To assure the objectives are met, the system components should be monitored on a routine basis. A discussion of the monitoring requirements for the various components is provided below and summarized in Table 2.

3.1 Gas Probes

3.1.1 Perimeter Gas Probes

There are nine gas probes installed at this facility, designated GP-2, GP-4,GP-7, GP-8A and GP-11 through GP-15 ~~installed for Stages I through III and additional probes GP-16, GP-17, and GP-18 installed in conjunction with Stage IV development~~. These are monitored on a weekly basis. In addition GP-1, GP-5, and GP-6 are monitored quarterly. The perimeter gas probes are wells installed beyond the perimeter of the landfill that are used to monitor for the presence of LFG migrating through the soil away from the landfill.

Monitoring of the perimeter gas probes is required on a quarterly basis, at a minimum, in accordance with the Gas Monitoring Plan (GMP) provided as Appendix A.

The atmosphere within each perimeter gas probe will be monitored for combustible gas

concentrations using a combustible gas meter or equivalent device capable of detecting methane at or below 25 percent of the LEL. In the event that combustible gas concentrations exceed 50 percent of the LEL, an evaluation will be made in accordance with the requirements outlined in the GMP.

3.1.2 Sub-liner Gas Wells

There are six sub-liner gas wells located east of the Stage I/II and Stage III delineation line. These wells are designated SGW-1 through SGW-6. The wells are installed with the base slightly into groundwater. Monitoring of the sub-liner gas wells will be performed at the same frequency and for the same parameters as the perimeter gas probes.

3.2 Passive Vents/Flares

Passive gas vents are located on the north, west, and south side slopes of the Stage I landfill area. ~~The passive gas vents are designated GV-1 through GV-17. With the exception of GV-3, each~~ Most of the passive vents have been capped to limit intrusion of air into the landfill from the influence of the active gas extraction system. ~~GV-3 is~~ Several are equipped with ~~a~~ passive flares which facility personnel activate on an as-needed basis depending on gas concentrations and pressure readings at that location. Vents GV-5 and GV-16 are connected to the active gas extraction system. The vents are constructed of 8-inch diameter schedule 80 polyvinyl chloride (PVC) pipe installed in an excavation that was backfilled with crushed stone. The bottoms of the vents are typically about 10 feet below the geomembrane cap grade (about 12 feet below the final grades of the capped landfill). The pipe is perforated below the cap system. Flares originally installed on the passive gas vents were removed to cap the vents. Flares are installed on selected leachate system components to burn the gas collected.

3.3 Lateral Collection

The lateral collection trenches typically consist of 20-foot long sections of 4-inch diameter perforated high density polyethylene (HDPE) pipe butted together inside 6-foot long sections of 6-inch diameter HDPE pipe. The pipes are installed in trenches excavated in the refuse and are bedded in crushed stone. The lateral collection trenches are connected to gas transmission piping. The extraction of gas from the lateral collection trenches is controlled at a wellhead as described in Section 3.5.

3.4 Gas Extraction Wells

Gas extraction wells, constructed of 8-inch diameter schedule 80 PVC pipe, were installed in boreholes drilled with a 30-inch diameter bucket auger to various depths within the refuse. ~~GW-1 through GW-8 were drilled to about 60 feet below the intermediate cover grades. GW-9 through GW-22 were typically drilled to depths ranging from 15 to 20 feet above the liner system.~~ The wells are slotted from depths of 8 to 15 feet below intermediate cover grades to the base of the well. Wells are typically drilled to depths ranging from 15 to 20 feet above the liner system. The slotted sections of the wells are backfilled with crushed stone. Additional wells are proposed as the landfill approaches final grades of Stage IV Phase II.

3.5 Wellhead Assemblies

The wellhead assemblies are located between each gas extraction point (e.g., lateral collection trench, well, passive vent, or leachate collection cleanout pipe) and the gas transmission system piping. Using various hose, fittings, and taps, the wellhead assemblies allow for:

- Differential settlement between the tie-in header and the well;
- Sampling of the gas in the well head;
- Measurement of the gas flow rate;
- Measurement of the gas temperature;
- Control of the gas flow rate; and
- Access to the well from the top for equipment or measurements.

The wellheads shall be monitored on a regular basis to observe their general condition, with particular attention to the condition of the flexible hose between the wellhead and the transmission piping. Additional data to be gathered includes:

- Valve position (percent open);
- Gas flow rate;
- Static pressure;
- Percent methane;
- Percent carbon dioxide;
- Percent oxygen; and
- Gas temperature.

3.6 Transmission Piping

Gas from the wellhead assemblies at the extraction points passes through the transmission piping to the blower and flare. Condensate formed in the transmission piping is directed to condensate traps for removal. The piping consists of 4-, 6-, 8-, 10-, 12- and 14-inch diameter buried HDPE pipe.

The transmission piping shall be monitored on a semiannual basis. The visible portions of the gas transmission piping shall be monitored for general condition, evidence of ground movement from frost or settlement, signs of deterioration, and integrity of the pipe supports.

3.7 Valves

Gate valves are located between each wellhead assembly and the transmission piping, and butterfly valves have also been provided at several locations along the transmission piping. The valves at wellhead assemblies are used to control the gas flow rate from the extraction points. The valves located along the transmission piping are used to isolate sections of the gas collection system for maintenance.

The valves installed in the headers shall be monitored on at least a quarterly basis. The valves shall be exercised to confirm they are operable, and the valve position (percent open) shall be noted.

3.8 Blower

The facility is equipped with ~~two~~ three blowers (two primary and one backup) with variable frequency drives. Any two can be operated concurrently. The blowers are configured in a parallel arrangement and are designed to operate one unit at a time.

The piping on the vacuum side of the blower includes a manually controlled butterfly valve to throttle the flow of gas through the system, and a pneumatically actuated butterfly valve to automatically shut off the flow of gas through the system in the event of a system failure. The valve actuator is powered by a high-pressure cylinder of nitrogen secured to the skid with a regulator to step the nitrogen pressure down to about 80 pounds per square inch (psi). The nitrogen is supplied to the actuator through an electrically actuated solenoid valve which is controlled by the logic wired in the equipment in the system electrical control panel.

The piping on the discharge side of the blower includes an in-line Thermal Instruments Model 62-9 thermal anemometer to measure the gas flow rate, and goes directly to the flame arrester at the base of the flare.

The blower shall be monitored on a weekly basis, and the following data shall be monitored:

- Throttling valve position (percent open);
- Actuator solenoid valve gas pressure; high pressure in the bottle and low pressure supply line;
- Evidence of leakage anywhere on the assembly;
- Gas flow rate through the blower;
- Percent carbon dioxide;
- Percent oxygen;
- Gas temperature; and
- Abnormal noises in the motor or blower.

3.9 Enclosed Flare

NCES utilizes a combination of enclosed and open flare technologies to destruct LFG. The enclosed flare is equipped with temperature sensors and air dampers to control the ratio of combustion air and LFG and to maintain stable combustion conditions. Pilot burners assure that the main flare ignites upon electronic ignition start-up. The flame arrestor prevents the flame from traveling back through the system in the event of a pressure loss. LFG is transmitted to the enclosed flare via stainless steel piping to the base of the flare and is introduced to the stack in a manifold which distributes LFG evenly within the stack where combustion takes place.

The enclosed flare assembly shall be monitored on a biweekly basis, at a minimum, for the

following parameters:

- General conditions;
- Nitrogen supply for control valves;
- Propane supply for ignition system; and
- Back pressure at flame arrestor.

3.10 Open Flare

The open "candlestick" flare assembly consists of the flame arrester near the base of the flare, vertical piping to the flame cup, spark sources mounted to the vertical piping, spark leads, spark plugs, a thermocouple, and guy wires. The system is started with a manually operated propane pilot. The flame arrester prevents the flame from traveling back through the system in the event of a pressure loss. The vertical piping transmits the gas to the flame cup. ~~The spark sources are solar recharged battery-powered power packs which provide a high voltage surge at about 1.5-second intervals. The voltage travels to the flame cup through the spark leads to the spark plugs which are installed through the flame cup and provide the source of ignition for the landfill gas. The thermocouple is installed through the flame cup and is used as a flame sensor to provide input for the logic controls for the system.~~

The open flare assembly shall be monitored on a monthly basis for the following parameters:

- General condition; and,
- Condition of ignitor system.

3.11 Condensate Handling Components

The LFG condensate handling system is designed to remove condensate that forms within the piping of the gas extraction system by allowing it to drain back into the leachate collection system through traps, or collecting it in the condensate storage tank. Condensate traps are incorporated in the piping system to collect and remove LFG condensate. A gas condensate collection tank is located near the blower flare assembly.

Condensate traps are located at low points in the landfill gas transmission piping system. The traps typically consist of a U-shaped tube filled with condensate to provide a seal for the vacuum in the system. To maintain a seal, the liquid column maintained in the trap must be at least as high as the maximum vacuum obtainable in that portion of the system.

Condensate collected in traps located in the landfill flows out the liquid discharge side into the leachate collection system. Condensate collected in the condensate knockout structure located outside the landfill is pumped to the condensate collection tank. The condensate tank is a 1,000-gallon dual-walled sti-P_3 steel tank installed adjacent to the condensate knockout structure. A submersible pressure transmitter is installed through the top of the tank to monitor the liquid level. The transmitter, in conjunction with the system controls, provides low and high level

alarms.

The condensate tank shall be routinely monitored to note:

- Depth of condensate in the tank; and
- Whether liquids are present in the interstitial space between the walls of the condensate tank.

3.12 Controls

The controls for the LFG system rely on flame temperature sensor inputs from either the enclosed or open flare and the condensate tank. Thermocouples are installed at several locations within the enclosed flare and through the side of the flame cup on the open flare to monitor the flare temperature. The temperature switch points in the controller modules are set by the operator. There is also a delay timer which can be adjusted by the operator to provide a delay between the temperature reading and the switching to allow the thermocouple to get up to temperature in the event of a cold start.

If the temperature falls below the low set point for longer than the time set in the delay timer, the controller module activates the solenoid valve on the butterfly valve actuator, which closes the valve and turns off the gas supply to the blower. The control module also causes the blower motor to be turned off. Once the system is off, the automatic telephone dialer, which is also located in the electric control panel, dials a calling service that, in turn, contacts key NCES personnel.

The alarm conditions activate individual labeled alarm indicator lamps on the electric control panel.

The control logic and sensors shall be tested periodically to be sure they function as intended. Conditions shall be fabricated to test:

- The thermocouple and temperature controller module;
- The solenoid valve on the valve actuator;
- The actuated valve; and
- The automatic telephone dialer.

3.13 Ancillary Observations

In the course of monitoring system components, observations of the condition of the cap should also be made including indications of settlement, stressed vegetation, and condition of cover soils. Further, the presence of odors should also be noted.

4.0 OPERATING AND ADJUSTING THE LFG COLLECTION SYSTEM

4.1 Well System Tuning

The adjustment or "tuning" of the LFG extraction system involves monitoring various parameters and making adjustments to optimize the extraction of LFG from each extraction point in the system. The objective of the tuning is to provide for a negative pressure at each extraction point without causing the intrusion of air into the landfill. Tuning is an iterative process, as adjustments to any portion of the system have the potential to affect the entire system. A discussion of the monitoring and tuning procedures is provided below. A summary of the steps to be taken and data to be gathered is presented in Table 3.

Equipment required for monitoring the LFG system includes a device or devices to measure gas flow rates and gas composition, and a volt-ohm meter and amp meter probe to evaluate components of the electrical and control systems. The instrumentation used to monitor LFG flow rates, pressures, and composition is a GEM-500 or 2000 Gas Extraction Monitor provided by Landfill Control Technologies of Commerce, California. The operation manual for this instrument is included as Appendix B.

Like most analytical instrumentation, it is important to field calibrate the GEM-500 or 2000 prior to using it to collect LFG data. The instrument requires calibration with methane, carbon dioxide, and oxygen span gases. The GEM-500 or 2000 shall be field checked with calibration gas, and if necessary, calibrated in accordance with the manufacturer's recommendations at least once each day that it is used. A log of the calibration should be kept with the instrument. Vibration, shock, and large temperature changes can affect the calibration of the instrument. Use care when transporting and handling.

This instrument is not considered to be intrinsically safe or explosion proof. **Do not use this instrument in an explosive atmosphere.**

4.1.1 Indicator Parameters

Typical ranges in concentrations of the various constituents found in landfill gas are presented in Table 1. Normal values for the NCES facility will be established using data collected during operation. The tuning of the system should be performed based on the methane, carbon dioxide, and oxygen concentrations and temperature. Typically, as the methane and carbon dioxide concentrations decrease, the concentrations of oxygen and nitrogen will increase. Such a trend indicates air intrusion into the system and adjustments should be made to reduce the gas extraction rate. Alternatively, if the methane and carbon dioxide concentrations are consistently in the middle to upper end of the ranges presented in Table 1, then the gas extraction rate could be increased.

The composition of the LFG with respect to methane, carbon dioxide, and oxygen contents is read using the "Read Gas Levels" option on the GEM-500 or 2000 instrument. The gas sample is obtained by the instrument through the static pressure port. The instrument provides a readout in percent of each of the three gases: methane, carbon dioxide, and oxygen, and percent of the remaining or balance gas.

4.1.2 Flow Rates

The gas extraction flow rates will be different at each extraction point and will vary with changes in atmospheric pressure as well as landfill cover condition (i.e., geomembrane cap or intermediate cover). Likewise, the cumulative extraction rate at the blower will vary with time. The flow rates should be adjusted based on the concentrations of the various constituents as described above. As the operating record of the system becomes established over time, "normal" flow ranges for the individual extraction points as well as the system will become established.

The LFG flow rate is determined by reading the differential pressure. The GEM 500 can be programmed to directly correlate differential pressure to flow rate.

4.1.3 Pressures

The pressure of the LFG will vary throughout the system at any given time, and will also vary with varying extraction rates. The pressures at the extraction points should be negative (vacuum) to provide active extraction from that point. If the pressure is positive, adjustments should be made to increase the flow rate provided the gas constituent concentrations are within the normal ranges as discussed above.

The static pressure at various ports in the piping at the gas extraction points and along the transmission piping is read using the "Read Gas Levels" option on the GEM-500 instrument. Tubing is provided with an external filter/water trap assembly to connect between the static pressure port on the GEM-500 and the static pressure ports on the LFG system.

4.1.4 Temperature

The temperature of the LFG at the extraction points is read directly from thermometers installed on the wellhead assemblies or via temperature probes connected to a GEM-500 or 2000.

5.0 5.0 MAINTENANCE AND TROUBLESHOOTING

5.1 Wellfield and Collection System Maintenance

Wellfield maintenance involves the following:

- Repairs to the collection piping due to damage caused by accident, settlement, environmental factors and aging;
- Repair or replacement of system components (e.g., wellheads, access ports, flex hoses, valves, road crossings, condensate traps, etc.);
- Excavation for repair of damaged piping and components;
- Repairing and re-adjusting piping supports and anchors; and
- Re-sloping or re-leveling piping support earth berms and the landfill surface.

In many instances, repairing the collection system may require shutting down the blower-flare

facility. The duration of the shutdown should be kept to a minimum; where possible, the work should be scheduled to coincide with scheduled blower/compressor and flare shutdowns.

5.2 Landfill Surface

The cover and cap are an integral part of the system. Good landfill cover and cap maintenance practices are important for effective operation and performance of the LFG management system. Experience has shown that in most cases, good cap and cover maintenance will solve most landfill odor problems. A visual inspection is helpful in identifying cracks, fissures or bare spots in cover. Damaged areas should be investigated and repaired.

5.3 Transmission Piping

Over time, the collection piping may develop air leaks. Air leakage should be kept as low as possible and it is recommended that oxygen in LFG not exceed $3^1/_2$ percent by volume in the collection piping. Under normal operations the gas should contain no more than one percent oxygen.

Leaks can occur in above grade PVC piping systems due to piping separations caused by thermal contraction resulting in cooling at night and during a system shutdown. Separations or damage can occur to below grade piping due to differential settlement. Buried pipe is also subject to expansion and contraction, but to a lesser degree because of a more uniform temperature and the anchoring effect of the soil support within the trench.

The transmission piping should be installed at a minimum slope of 3 percent to limit the potential for ponding in the pipe due to differential settlement. However, condensate blockages in main and lateral headers may occur. These blockages can be evaluated by installing access ports for monitoring. With buried systems, it may be necessary to "pot hole" (i.e., perform exploratory excavation) with a backhoe to install access ports and conduct the monitoring. If the main header becomes blocked or restricted with condensate, it should be corrected by re-leveling the line or installing an additional drain trap.

5.4 Blower-Flare Facility Maintenance

A brief discussion of general maintenance requirements for specific equipment follows. For more detailed information refer to applicable manufacturer's information.

5.4.1 Pipe and Fittings

Process plant pipe and fittings commonly consist of both steel and thermoplastic. Both are durable long-lived materials, however, thermoplastic piping can be subject to damage from shock, strain, or heat. Thermoplastic piping should not be used near sources of extreme heat such as the flare. Carbon steel piping can erode and corrode. Stainless steel, cast iron and aluminum piping have all been used successfully.

LFG and condensate exhibit corrosive properties. The presence of oxygen, carbon dioxide, and

organic acids common to LFG dissolved into LFG condensate provides for substantial synergy in promoting corrosion. Steel piping may be corroded when exposed to the above mixture. The most common point of wear due to erosion or corrosion in steel piping at a LFG collection and control facility is typically pipe elbows and other fittings that are subject to erosion and where liquid condensate accumulates. The pipe should be inspected for evidence of corrosion (leakage, particularly at fittings). Where questions of pipe integrity exist, ultrasonic thickness testing may be performed.

5.4.2 Valves

Valve seats and stem seals may wear and eventually require replacement. Butterfly, gate and ball valves filled with elastometer seals, such as Buna-N or EPDM, may be affected by LFG. In such cases, it may be necessary to try other elastometer types to find a material more suitable to the service. Viton or filled Teflon™ valve seats in butterfly and ball valves respectively have had reasonably good wear performance.

5.4.3 Blower Maintenance

Consult the manufacturer's literature for detailed information on the maintenance of the blower.

Routine maintenance for blowers and motors consists of listening for signs of abnormal operating conditions, monitoring for excessive vibration or temperature, draining condensate from blower housing periodically and before startup (if not automatically drained). The blower drive belt tension and wear should be checked on a monthly basis. If belts are glazed or cracked they should be replaced. At least one spare set of matched belts should always be on hand. On direct drive machines, flexible coupling alignment should be checked on initial setup and periodically as recommended by the manufacturer (typically quarterly to annually). Bearings should be greased or repacked according to the manufacturers' recommendations, (typically quarterly to annually). The electric drive motor, if not equipped with sealed bearings, should also be greased. Blower seals and packing should be checked periodically for leakage. If blower seals continually leak or will not last, consult the manufacturer or try another type of seal or seal material.

5.4.4 Gas Inlet Automatic Block Valve

An automatic block valve shuts off the flow of LFG to the flare when the flare is not operating or when a fault or shutdown is initiated. This is a butterfly type valve and should be serviced only when a need is indicated. The valve is pneumatically operated using a high-pressure nitrogen cylinder with a pressure-reducing regulator to supply the driving gas. For the pneumatic actuator to function properly, the supplied drive gas must be clean, dry, and at the specified pressure. The pneumatic actuator should open and close the valve fully without sticking. The piping to the air motor and valve should not leak. The automatic block valve seat should maintain a gas tight seal whenever the valve is in the closed position. Refer to the manufacturer's literature for information on service.

5.4.5 Flame Arrester

A flame arrestor is present in piping to both the enclosed and open flares. A flame arrester is designed to prevent the migration of burning LFG from the flare backwards into the process piping. This condition can cause what is known as "detonation" (an explosion) or "flashback" within the piping. This is a dangerous condition, particularly in the case of high oxygen content. A flame arrester will only work properly if the velocity and pressure of the "flashback" in the pipe is within the allowable range and the flame arrester is properly assembled.

The pressure at the blower outlet should be checked during ~~bi-~~weekly monitoring. ~~The normal pressure is typically less than 12 inches of water column (w.c.).~~ If the differential between inlet and outlet pressures of greater than 2-3" ~~excessive pressure~~ is observed, the flame arrestor and/or LFG distribution manifolding (in the enclosed flare) should be serviced. To service a flame arrester, shut down the facility and block in the flame arrester upstream using the manual and automatic block valve (verify the valves do not leak.). Closely follow the directions in the manufacturer's literature for maintenance and re-assembly of the flame arrester element. It is important to note that a flame arrester's effectiveness is based upon a design spacing or gap in the flame arrester element. During maintenance and re-assembly, this spacing must be maintained according to the manufacturer's original specifications if the flame arrester is to function as designed. Ensure that all parts are returned and in the proper orientation when re-assembling the flame arrester. Similar care should be taken when servicing the gas manifold.

5.4.6 Enclosed Flare

A constant supply of LFG at the proper fuel supply pressure must be provided to the enclosed flare to ensure continuous operation. An enclosed flare is less influenced by environmental conditions such as wind speed and direction than an open flare. The primary maintenance concerns with an enclosed flare relate to ensuring that gas pipe manifolding is not restricted an allows for a free-flowing gas supply to the flare. Levels of nitrogen and propane in cylinders should be monitored to ensure that pneumatically operated valves and flare ignitors, respectively, operate effectively. Back pressure should be monitored downstream of the blowers to ensure that the flame arrestor and/or gas pipe manifolding (enclosed flare only) is not unduly restricting flow. Thermocouples should be routinely tested to determine proper operation and control of the blower delivery system. The thermocouple controls should be configured such that low temperature setpoints initiate a blower shutdown condition in the event that the flame is extinguished.

See the enclosed flare manufacturer's literature for specific component operation, maintenance, and troubleshooting information.

5.4.7 Open Flare

Operation and maintenance of the candlestick flare is straight forward and consists of maintaining proper fuel pressure, maintaining the ignitor system, and keeping the flare drained of any condensate build-up. Proper fuel velocity, quality, mixing and flame condition is key to performance. Also, to operate consistently, the flare burner assembly must be adequately

shielded from excessive wind. Problems with flame stability in a candlestick flare are usually caused by poor LFG methane quality.

The primary wear on flares is due to thermal stress. If the flare is operated in an imbalanced condition or at excessively high temperature, it will exhibit signs of accelerated thermal stress. This may be indicated by wear and deformation of the burner.

The flare may require burner adjustment or modification to achieve and maintain proper combustion performance. Adjustment of the flare may involve changing an orifice or burner ring, or moving or changing a plate. Consult the manufacturer or seek qualified assistance.

Gas velocity to the flare is adjusted at the blower-flare facility inlet. This is accomplished by balancing the distribution of the blower's total pressure so that there is sufficient fuel pressure at the flare. In severe cases where adjustment will not work, the flare burner or the blower may need to be modified or replaced. **Never modify the flame arrester to increase gas velocity.**

The flame safeguard sensor system consists of an electronic controller mounted in the control panel and a thermocouple mounted on the flare cup. At least one spare thermocouple should be kept on site.

A thermocouple can be checked independently with a voltmeter and thermocouple tables or with a digital thermocouple test meter or digital thermometer. Proper polarity must be observed when installing and monitoring a thermocouple. If the thermocouple is subjected to flame impingement, its life may be considerably shortened. Thermocouples can be mounted in protective sheathing, however, this will cause some delay in response to temperature changes.

See the flare manufacturer's literature for specific component operation, maintenance, and troubleshooting information.

The open flare spark ignitor is similar in appearance and function to an automotive spark plug. Monthly, or when the ignitor exhibits excessive wear, the spark ignitor should be inspected for cracking of the ceramic insulator, wear of the ignitor ground rod, short circuiting in the high voltage lead wire, and accumulation of moisture that may short out the ignitor causing it to fail to perform. It is important that a proper gap be maintained for a good spark between the spark ignitor ground rod and the burner head. As the spark ignitor is used the gap will increase and eventually may result in failure to spark. From time to time the gap may need to be adjusted. Spare spark igniters should be kept on site.

The spark ignition wire will also wear due to heat stress and UV exposure. If this wire shows cracks, deterioration or signs of excessive wear due to thermal stress, it should be replaced. Spark ignitor wire may also be damaged from heat when routed in conduit mounted on the flare body if not properly cooled or insulated. Another common problem with spark igniters is moisture, which will cause short-circuiting to ground and malfunctioning of the ignition system. If moisture is detected, check the ignition components and clean and dry all connections.

5.4.8 Electrical Equipment Controls and Instrumentation

Dust may accumulate in cabinets absorbing moisture from the air. Over sufficient time a conductive path can be created that can cause a failure. Connections may also become loose due to thermal expansion and contraction. Electrical service and control cabinets should be cleaned on an annual basis. Wire connections should be checked and tightened throughout the cabinets annually. Calibration and verification of instrumentation gages and thermocouples should be performed annually. Shutdown alarms and devices should be tested ~~and the results recorded in a log~~. Thermocouples for sensing flare stack temperature should be maintained, and replaced when they no longer perform properly. This is normally evident by failure of the temperature controller to properly read or control the flare stack temperature (usually due to an open junction) or by loose or corroded connection terminals at the temperature transmitter, connector block, or temperature controller.

Test and recalibrate instruments, fault protection and shutdown devices. Large breakers or fused disconnects should be disconnected under load. Ensure high voltage breakers or disconnects are "locked out" in accordance with 29 CFR 1910.147 and 1910.333 Subpart S before working on equipment associated with them. Fuses should be physically pulled to isolate equipment. When the facility will be down for major maintenance or stand down, large breakers should be locked out (i.e., physically separated and disconnected) and the fuses should be pulled.

5.4.9 Lubrication - General

Follow the manufacturer's recommendations for specific types and brands of lubricants. It is important to use the recommended type of grease and not to mix types or brands of grease. Do not over lubricate. Personnel who perform lubrication services should be knowledgeable in lubrication practices and should follow the manufacturer's instructions for lubrication requirements.

Establish an initial lubrication frequency based upon the equipment manufacturer's recommendation. It may be necessary to adjust the lubrication frequency interval based upon experience with the equipment.

5.4.10 Other Equipment Maintenance and Operating Tips

The system operator should be proactive, remain alert and develop a habit of observing equipment.

Equipment noises (such as bearings) may be monitored by using an equipment stethoscope or using a wrench or similar tool by placing it on the equipment and placing the opposite end of the tool against the bone in front of the ear to listen. It is important to develop a sense of what baseline conditions are for comparison. The smell of leaking LFG or burned lubricant can indicate a seal, component or lubricant failure.

When checking motors or other electrical devices for temperature by ~~feel~~ infrared thermometer, the back of the hand should be used. Approach the equipment slowly and feel for radiant heat

which would indicate a very high temperature. If the equipment is too hot to maintain hand contact, it is at or above a threshold of about 60 to 63°C (140 to 145°F) and may be considered excessive in many cases depending upon the equipment and service. The reason for using the back of the hand is that it is more heat sensitive and in the case of electrical fault to the casing, the natural reaction will be for the muscles of the arm to contract away from the device. This can prevent electrocution.

Operating personnel should wear all cotton clothing which provides some degree of protection in gas flash fires. Some synthetics such as polyester blends will melt readily, which can be fatal. Ties or loose items (e.g. identification badges hanging from or work around the neck, etc.) should never be worn around rotating or belt-driven equipment. Remove all watches, rings, identification bracelets, etc., when performing electrical testing or troubleshooting.

It is important that maintenance supplies, lubricants, and spare parts be inventoried on a frequent basis to ensure that adequate stocks are maintained for when they will be needed. Supplied should be reordered and restocked as used.

5.4.11 Condensate Handling Systems

The blower-flare facility is fitted with various traps, drains, and pumps for handling condensate. Condensate can be corrosive and the equipment will need to be checked carefully and frequently for the effects of corrosion. Seals, o-rings, slide valves and check valves are usually high maintenance items. Refer to the manufacturer's information for maintenance of individual equipment or components.

6.0 COLD WEATHER OPERATIONAL CONSIDERATIONS

Operation of the LFG system under cold weather conditions may cause freezing of condensate in exposed pipes and equipment or in below-grade pipes without adequate soil cover. Care must be taken to limit the amount of condensate allowed to collect in the LFG system at any time. The LFG is a source of heat for the system. If the system shuts down for a short period of time during winter months, condensate in the exposed portions of the system may freeze.

If freezing of condensate under normal operating conditions becomes a regular problem, heat trace and insulate the affected areas.

7.0 DATA COLLECTION

Data will be collected routinely using reading sheets from the blower-flare facility, the wellfield, migration monitoring probes, structures, etc. These "readings" become part of the facility operating record.

7.1 Data Assessment

During the initial start-up and operation of the LFG system, baseline data should be acquired. The data should be representative of normal (not unusual, imbalanced, or irregular) conditions.

These baseline data may be used in the future for comparison with current data. Parameters to be monitored include pressure, differential pressure, temperature, and flow, at various locations within the LFG system.

Pressure will change with changes in gas flow. Similarly, the temperature rise across a blower will change based on the flow through it.

With the above caveat in mind, equipment performance may be compared with past or baseline performance under similar operating conditions. Persons assessing the data should be aware of the normal operating range for each parameter and note any changes and assess the reasons for that change. Equipment deterioration that can be either sudden or very gradual may be indicated by an abnormal monitoring result. Such indications should be promptly investigated or reported. Facility data should fall within established parameters for normal operating ranges for that equipment based upon service conditions. Manufacturer's information and equipment operating experience along with judgment are required to assess facility data and determine these ranges.

Over the years a number of data assessment techniques for LFG wellfields have been developed including:

1. Comparing current performance data with baseline data;
2. Comparing data with tables of acceptable ranges and conditions cross-referenced with recommended adjustments;
3. Directly comparing monitoring data with target criteria (e.g., methane, oxygen, nitrogen residual, wellhead vacuum, flow, etc.);
4. Assessing individual well data parameters with subjective judgment (no specific analytical or mathematical method used);
5. Performing a summation of total wellfield flow and comparing with predicted or prior demonstrated acceptable wellfield flow. This may be used to develop a compensation factor to calculate individual well flow targets and readjust the wells;
6. Differentiating between air intrusion through landfill cover and waste mass, and collection piping leakage, and compensating accordingly (see No. 9 below);
7. Evaluating nitrogen residual by measuring nitrogen with a gas chromatograph or calculate nitrogen as a balance gas;
8. Comparing a summation of individual well data with total composite wellfield flow, while accounting for piping leakage and flow measurement error;
9. Performing a special analysis of the extraction well, monitoring probe and waste mass boundary; and
10. Presenting data trends in graphical and tubular formats.

These techniques should be used in conjunction with target criteria and established acceptable performance ranges for each extraction well.

7.2 Facility Log Book

Whenever the system is monitored for any reason, staff should make appropriate entries in the Log Book that will be stored in the landfill office or at NCES' Permits, Compliance and Engineering offices. As a minimum, log entries should include:

- Name of person making the entry;
- Date and time;
- Reason for the monitoring (e.g., routine, shutdown, specific monitoring or maintenance activity, etc.);
- Reason for any shutdown;
- Actions taken or adjustments made;
- Equipment status upon leaving; and
- Unusual observations made.

The log is used as a record of events regarding the facility and to communicate between operating personnel. The log entry also becomes part of the daily facility readings.

7.3 The Data Collection Routine

Data are collected manually in the field at the individual data points (i.e., at wells on the landfill, at migration monitoring probes surrounding the landfills, etc.). Data will be recorded on paper reading sheets.

The data collection routine involves walking or driving around the landfill from point to point.

Equipment used for data collection includes:

- GEM-500 or 2000 Gas Extraction Monitor;
- Calibration gases (use before going into the field);
- Data reading sheets;
- Clipboard and writing implement;
- Pocket calculator;
- Site map of the data points;
- Carrying tray, toolbox, or backpack, etc.;
- Tools needed to access the system components; and
- Spare parts for maintenance such as access ports, plugs, etc.

TABLES

TABLE 1
CONSTITUENTS OF LANDFILL GAS

COMPONENT	PERCENT VOLUME (All are stated on a dry basis except moisture.)
Methane (CH_4)	45 to 58%.
Carbon Dioxide (CO^2)	32 to 45%.
Oxygen (O_2)	Less than 1%.
Nitrogen (N_2)	0 to 3%.
Hydrogen (H_2)	Trace to 5% plus; generally less than 1%.
Carbon Monoxide (CO)	Trace; CO is an indicator of the possible presence of a subsurface fire.
Hydrogen Sulfide (H_2S) & Other Sulfur Components	Varies by landfill (nominally 10-200 ppm).
Moisture	Up to 14% (increases with gas temperature).
Volatile Organic Compounds (VOCs)	Less than 2%; typically ¼ to ½%.

Note: This table represents typical characteristics of landfill gas. A difference between characteristics in the gas from the NCES facility and the values tabulated above does not necessarily indicate a problem. However, a large disparity should be reviewed closely to determine the cause.

TABLE 2
MONITORING SCHEDULE

ITEM	FREQUENCY	PARAMETER
Condensate Tank	Weekly	• Liquid depth in tank; and • Presence of liquid in containment vault.
Well Heads	Weekly	• Condition of flex hose; • Valve position; • Gas flow rate; • Static Pressure; • Percent methane; • Percent carbon dioxide; • Percent oxygen; and • • Temperature of gas.
Blower	Weekly	• Throttling valve position (percent open); • Actuator solenoid valve gas pressure; (high pressure in the bottle and low pressure in the supply line); • Evidence of leakage anywhere on the assembly; • Amount of condensate removed from the fan housing drain; • Gas flow rate through the blower; • Percent methane; • Percent carbon dioxide; • Percent oxygen; • Gas temperature; • Abnormal noises or vibration in the motor or blower; and • Maintenance required.
Blower	Monthly	• Drive belt tension and wear; • Condition of ignitor system; and • Plumbness of stack.
Controls	Monthly	• Thermocouple and temperature control module; • Solenoid valve; • Actuated valve; • Liquid level sensors; and • Automatic telephone dialer.
Flame Arrester	Weekly	• Pressure at blower outlet.
Valves	Quarterly	• Exercised to confirm satisfactory operation.
Gas Probes and Gas Vents	Quarterly	• Presence of explosive gases.
Transmission Piping	Bi-Annual	• General condition of exposed pipe.
Electrical Cabinet and Controls	Annual	• Tightness of connections; • Calibration of gauges; • Thermocouple and alarms.

Note: In addition to the monitoring schedule outlined above mechanical components such as the blower and flare should also be monitored and serviced in accordance with the manufacturer's instructions.

TABLE 3

GAS EXTRACTION SYSTEM MONITORING CHECKLIST
GAS EXTRACTION POINTS

A. Prior to going out onto the landfill.

1. Calibrate the GEM-500 gas extraction monitor (meter) using methane, carbon dioxide, and oxygen. Refer to Appendix B.

2. Calibrate the pressure transducers by performing the "Zero Pressure" function.

3. Record the calibration procedure on the meter calibration data sheet contained in Appendix C.

4. Record the ambient weather conditions including:

   - Temperature;
   - Barometric pressure;
   - Wind speed and direction;
   - Precipitation amounts; and
   - Current observations (i.e., drizzling, raining, snowing).

B. At each gas extraction well head assembly.

1. Connect the Tygon tube with the external filter/water trap assembly from the static pressure/sampling port on the meter to the static pressure port on the well head assembly.

2. Connect the Tygon tubing between the impact pressure port on the meter and the impact pressure port on the wellhead assembly.

3. Perform the "Read Gas Levels" function on the meter. Follow instructions on the meter.

4. Record the following data on the data sheets or in the meter memory:

   - Station identification;
   - Percent methane;
   - Percent carbon dioxide;
   - Percent oxygen;
   - Percent balance;
   - Percent LEL;
   - The temperature of the gas stream;
   - Static pressure;
   - Differential pressure;
   - Gas flow rate; and
   - Control valve percent open.

5. Make adjustments to the flow rate by adjusting the wellhead control valve, if required.

TABLE 4

GAS EXTRACTION SYSTEM MONITORING CHECKLIST

BLOWER/FLARE ASSEMBLIES

A. Prior to going out onto the landfill.

1. Field check with calibration gas and, if necessary, calibrate the GEM-500 gas extraction monitor (meter) using methane, carbon dioxide, and oxygen. Refer to Appendix B.

2. Calibrate the pressure transducers by performing the "Zero Pressure" function.

3. Record the calibration procedure on the meter calibration data sheet contained in Appendix C.

4. Record the ambient weather conditions including:

   - Temperature;
   - Barometric pressure;
   - Wind speed and direction;
   - Precipitation amounts; and
   - Current observations (i.e., drizzling, raining, snowing).

B. At the blower assembly.

1. Drain condensate from the blower fan housing and other drain points in the system.

2. Read the gas flow rate using the in-line flow meter.

3. Perform the "Read Gas Levels" function on the meter. Follow instructions on the meter.

4. Record the following data on the data sheets or in the meter memory:

   - Station identification;
   - Percent methane;
   - Percent carbon dioxide;
   - Percent oxygen;
   - Percent balance;
   - ~~Percent LEL~~;
   - The temperature of the gas stream;
   - Static pressure;
   - Differential pressure;
   - Gas flow rate; and
   - Manual control valve percent open.

   (The manual control valve will normally be 100 percent open. The flow rate is adjusted using the control valves at the individual gas extraction points.)

5. Monitor the digital meter which indicates the current draw of the blower motor.

6. Test the control system by manually turning off the gas flow to the flare. Check to see that the pneumatically actuated shut off valve functions correctly, the thermocouple control module reads correctly, and the automatic telephone dialer calls out with the alarm condition.

7. Turn the gas back on and restart the system. Check the system to make sure it has restarted.

8. Grease blower or motor components as required by the manufacturer's recommendations.

9. Check manufacturer's literature for other maintenance items to be performed on the blower, motor, and valve components.

C. <u>At the flare assembly.</u>

1. Check for signs of corrosion on the flare stack and other sections of steel pipe.

2. Measure and record the differential pressure across the flame arrester following the same procedure listed in the previous section as steps 2, 3, 4, and 5.

~~3. Check the spark generators (open flare only) to make sure they are both functioning normally.~~

~~4. Clean the surface of the solar panels on the spark generators (open flare only).~~

5. Check the gas flame color (open flare) or opacity of flare emissions (enclosed flare) and note any irregularities.

D. <u>At the condensate tank</u>

1. Measure and record the level of condensate in the tank.

S:\data\a600files\1650\gas O&M\table4

APPENDIX A

GAS MONITORING PLAN

GAS MONITORING PLAN
North Country Environmental Services
Bethlehem, New Hampshire

1.0 INTRODUCTION

This gas monitoring plan has been developed per Env-Wm 2506.07 (c), to monitor for the presence of landfill gas between the limit of refuse and site property lines. The overall objective of this monitoring plan is to monitor the site so that the site remains within applicable regulatory and safety guidelines regarding control of gas migration.

2.0 MONITORING PROGRAM

The monitoring program described in this plan is directed toward monitoring methane levels around the perimeter of waste containment. This monitoring includes measuring methane levels between the limit of refuse and adjacent property lines. If the on-Site monitoring indicates the possibility of off-Site migration, additional monitoring will be performed to assess the extent of migration and also the potential for accumulation within nearby structures.

Routine gas monitoring at the facility will consist of quarterly monitoring of perimeter gas probes, GP-2, GP-4 through GP-7, GP-8A, and GP-11 through GP-15 installed for Stages I through III and additional probes GP-16, GP-17 and GP-18 installed in conjunction with Stage IV development. In addition, monitoring of subliner gas wells SGW-1 through SGW-6 is to be performed as is monitoring of gas vents GV-2 through GV-4, GV-8 and GV-10. Monitoring is to be performed on a quarterly basis by facility staff or more frequently if required by NHDES or determined necessary by NCES.

The gas probes were installed in boreholes typically drilled to a depth corresponding to an elevation which is approximately the base grade of the landfill or to groundwater. The gas probes consist of 1-inch slotted PVC pipe, installed from the bottom of the borehole to about 3 feet below the ground surface, and 1-inch solid pipe installed from the top of the slotted pipe to 2.5 to 3.0 feet above the ground surface. The annulus between the borehole wall and well screen is backfilled with 3/8-inch pea gravel or coarse sand. A granular filter layer will be placed above the pea gravel and cement/bentonite grout will be placed from the top of the granular layer to the ground surface. Vented locking protective casings have been installed over the probes. A detail of a probe is attached.

The subliner gas wells were installed during construction of Stage III and consist of high density polyethylene (HDPE) pipe installed in borings drilled to a depth corresponding approximately the groundwater table. The lower section of the wells were perforated while the upper portion of the well is solid pipe which was installed in a trench extending to just beyond the north corner of Stage III.

The gas probes, subliner gas wells and gas vents will be monitored for combustible gas concentrations using a dual range natural gas indicator that measures concentration as percent by volume of methane equivalence or the facility's GEM 500 meter. In addition to monitoring the composition of the gas at the gas vents, the gas pressure is also to be recorded.

3.0 DATA REPORTING AND EVALUATION

Monitoring results and observations will be recorded and copies of these monitoring records will be maintained at the facility. Where combustible gas concentrations exceed 50 percent of the lower explosive limit (LEL) at the property line:

- Take all necessary steps to ensure protection of human health and notify the Director of the Department's Waste Management Division ([WMD] Director) [This notification shall be deemed to have taken place when the Department's Project Manager in the Solid Waste Compliance Section 603-271-2925 is notified.];
- Notify the affected property owner of the results;
- Within seven (7) days of detection place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and
- Within sixty (60) days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Director that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.

Locations where gas concentrations exceed 50 percent of the LEL at the property line will be identified in a separate report which will be forwarded to WMD.

Should the combustible gas concentrations be determined to exceed 50 percent of the LEL at any permanent probe location, an evaluation will be made to determine whether the frequency of monitoring should be increased, and whether the monitoring network and type of monitoring should be modified to enhance detection. If continued monitoring indicates elevated levels of landfill gas at the property line, an appropriate plan to control gas concentrations, such as further expansion of the gas venting system, will be developed and submitted to the WMD for review.

If monitoring indicates that additional control measures are necessary, they will be installed so that:

1. Gas concentrations at the property boundaries will be less than 50 percent of the LEL; and
2. Gas concentrations at any structure will be less than 25 percent of the LEL.

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APPENDIX B

GEM-500 EXTRACTION MONITOR OPERATIONS MANUAL

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GEM-500 Gas Extraction Monitor

Operation Manual

Curt

~~Paul Little~~ 800-294-7795

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Chapter 1-Getting Started

Unpacking the GEM-500

The GEM-500 unit is normally shipped in a protective hard case with a foam interior. This offers excellent protection. When properly sealed, the case is watertight. There is a pressure relief valve by the handle on the case. Normally this is kept closed. If there is a change in elevation, the case may not open until the pressure is equalized by turning the pressure relief valve.

We strongly recommend that the GEM-500 be transported in its protective case. The hard case has room to store all the components for the GEM-500 and we recommend that they be kept together. When shipping a GEM-500 back to LANDTEC for calibration or service, always ship it in this hard case unless LANDTEC sends you a special protective Styrofoam shipping unit.

Carefully unpack the contents of the GEM-500, inspect and inventory them. The following items should be contained in your package:

- Hard carrying case (when opening the hard case, it may be necessary to open the pressure relief vent)
- The GEM-500 unit
- GEM-500 Operation Manual
- Warranty/Registration Card and other instructional information
- Soft carrying case with replaceable protective window and carrying strap
- External (striped) sampling hose assembly (5 ft.) with external filter/water trap assembly
- Clear 1/4" Tygon pressure tubing sampling hose (5 ft.)
- Spare internal filter element
- Chrome-plated brass male connector (hose barb) connects to clear tubing
- Polypropylene male connector (hose barb) connects to striped tubing
- Spare external filter element
- 110-volt Nickel-Cadmium battery charger with special charging plug
- [redacted]
- GEM-500 download software disk on 3 1/2 inch floppy disk (optional)
- RS-232 serial cable for computer/printer data downloading (optional)
- Temperature probe (optional)

Immediately notify shipper if the GEM-500 unit or accessories are damaged due to shipping. Contact LANDTEC if any items are missing. If you have any questions, please contact LANDTEC technical support at (800) 821-0496 or (213) 722-8202. Complete the Registration/Warranty Card and return it to LANDTEC. The model and serial numbers are located on the back of the GEM-500 unit.

Attaching the Hose Assembly

The GEM-500 hose assembly comes fully assembled but it needs to be connected to the GEM-500.

Connect the striped hose with the external filter/water trap assembly to the static pressure/sampling port on the GEM-500 (See Figure 1.1). The port on the top left corner of the GEM-500.

Connect the clear tubing to the impact pressure port on the GEM-500 (See Figure 1.1). This port is located on the bottom left corner of the GEM-500. As previously warned, DO NOT block the exhaust port (See Figure 1.1).

Quick Connect Fittings

The quick connect fittings will simplify the taking of wellfield readings. They are easy to install in your landfill gas extraction system and on perimeter probes. Many different types are available. LANDTEC carries fittings used on its equipment for your convenience.

The GEM-500 comes with quick connect fittings for the Accu-Flo™ wellhead. Connect the chrome male connector to the end of the clear tubing. Connect the polypropylene (the almond colored) fitting that has a male connector to the striped tubing.

Watch the GEM-500 Video

We strongly recommend that you watch the video provided—Using the GEM-500™ before proceeding.

Must Do's Before Using the GEM-500

Read Chapter 3 of this manual.

Proper operation of the GEM-500 requires the following functions to be completed before proceeding.

- Charge the unit with the battery charger
- Check the Time/Date
- Perform a Zero Pressure
- Field Calibrate the unit

Calibration Gases

Calibration gases are required to field calibrate the GEM-500. Portable Calibration Gas Kits and 12-unit cylinder cases are available from LANDTEC or can be obtained from a specialty gas company. (See Chapter 2-Field Calibration)

Special Keying Functions

Entering an ID code with Letters and Numbers

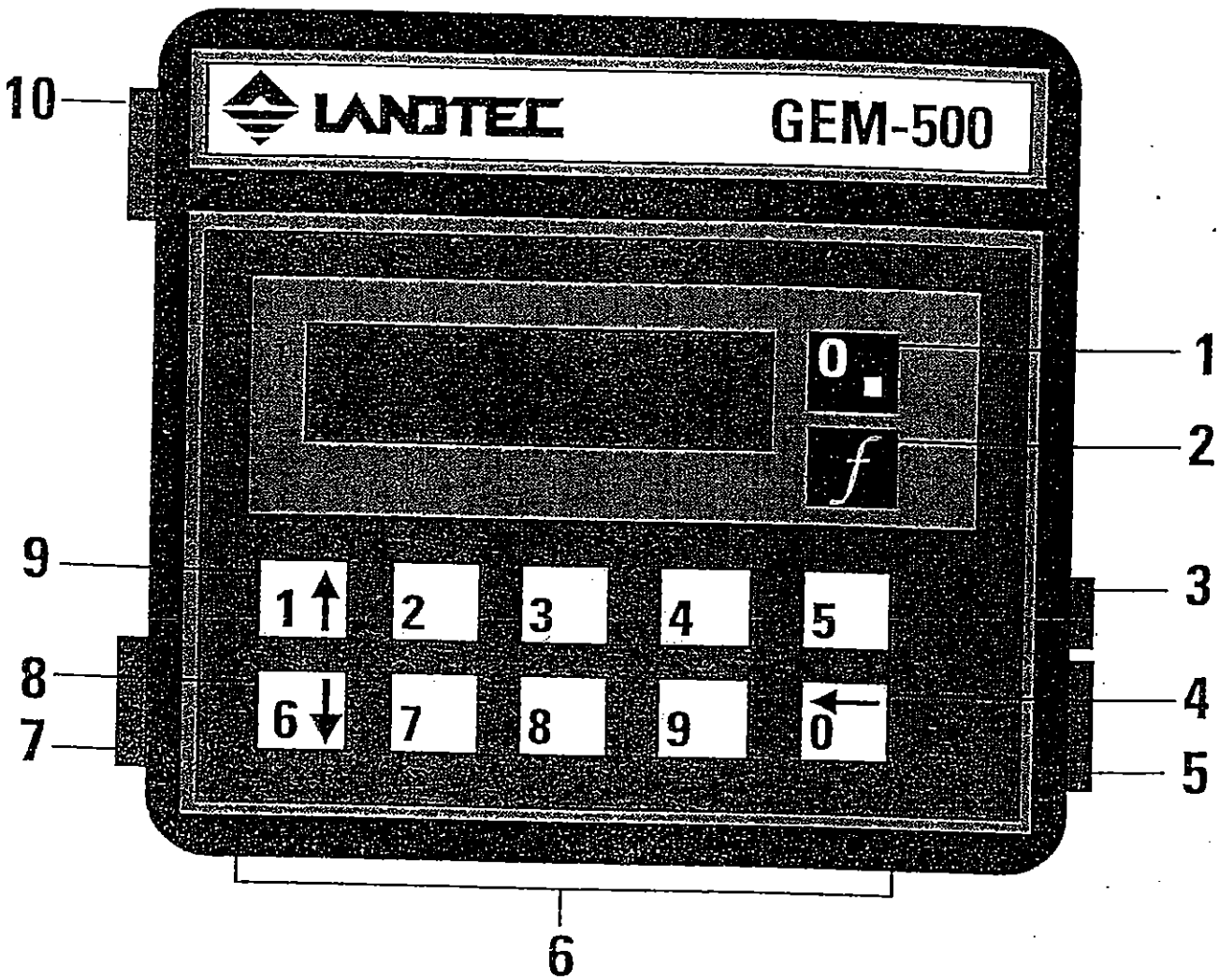
Use blue toggle key to shift back and forth between number mode and letter mode. When in number mode, use number KEYS to enter numbers. When first switched to letter mode, use arrow KEY 1-UP ARROW or KEY 6-DOWN ARROW to scroll to desired letter, then press KEY 0 to enter the letter on the display. Repeat this process for all letters. Before any new ID code can be entered, the first four character spaces will be filled with the characters used in the previous ID code. If different characters are desired, remove these characters by using the backspace function below.

Backspace Function

To change or correct an entry error use the KEY 0 as a backspace by holding it down for one second. In normal use, this key is quickly pressed and released.

GEM-500 Keyboard and Port Descriptions

Figure 1.1



1. Red On/Off Key—Turns unit on or off.
2. Blue Number/Letter Toggle Key—Enables well ID code to be entered by toggling between number and letter mode.
3. RS232 Port—Used for battery recharging, data downloading and temperature readings.
4. Backspace/Exit Key—Acts as backspace key when pressed and held for one second, to correct for user entry of wrong number/letter, returns to previous procedure or steps back one layer of menus, usually to the main menu screen. The last function of this key is similar to the escape key in many computer programs.
5. Exhaust Port—This port must be kept clear. If blocked while operating, over pressurization and damage to internal components and case could occur.
6. Numeral Keys—Enters numerals 1 through 9.
7. Impact Pressure Port—Measures impact pressure when connected to wellhead impact pressure port (upstream connection for orifice) by tubing.
8. Cursor-Down Key—Enters numeral 6, and scans lines of information or screens.
9. Cursor-Up Key—Enters numeral 1, and scans lines of information or screens by moving up or toward the beginning of a list or alphabet.
10. Static Pressure/Sampling Port—Measures static pressure when connected to wellhead static pressure port by tubing. Inlet for gas sampling instruments.

Chapter 2-Field Calibration

Field Calibration is menu-guided and can be completed in about ten minutes. The pump remains running during the calibration procedure to streamline the procedure and conserve calibration gas. The GEM-500 contains a calibration map which is accessed by its microprocessor for baseline reference data. This reference data was programmed into the GEM-500 during the factory calibration using various traceable gas mixtures in an environmental chamber. At any time, the GEM-500 can be reset by returning to the "factory settings." This clears the GEM-500 of any user calibration settings and restores the GEM-500 to its original factory calibration.

The factory calibration has been designed to give the best possible results over a wide range of conditions. However, the instrument's accuracy can be improved in specific operating ranges by performing a "field calibration."

Most field instruments are calibrated or adjusted prior to taking a series of gas or pressure readings. They may also be checked for calibration during the reading and after readings are taken in order to verify the accuracy of the data collected.

It is important to field calibrate the GEM-500 on-site after the instrument has stabilized at working temperature. For this reason, a GEM-500 that was calibrated in the cool of the morning may not read as accurately at the hottest part of the day.

Note: Field calibration of the GEM-500 will improve the data collected in the range of the calibration gases used. Less accurate readings of concentrations outside the calibrated range may occur. For example, a GEM-500 field-calibrated using 60% CH4 and 40% CO2 will give improved readings for the higher concentrations, but may provide less accurate readings at very low concentrations (which are not common in LFG).

Calibration Gas/Span Gases

Field calibration requires two calibration gas mixtures; a methane/carbon dioxide mixture (50% CH4 and 50% CO2) and a oxygen/carbon dioxide mixture of less than 6% oxygen (low levelsof oxygen.) As with methane, the closer the composition of the calibration gas to the expected conditions, the greater the accuracy. A 5/95 mixture of oxygen and carbon dioxide (5 % O2 and 95% CO2) is typical. Any calibration gas mixtures near the expected measurement range that is free of oxygen can be substituted for the first calibration gas mixture. Any calibration gas mixture with a 2% to 5% concentration of oxygen (O2) may be substituted for the second mixture.

Zero Methane

Calibration of the GEM-500 starts by establishing the bottom point of the methane gas curve. The methane (CH4) is zeroed prior to taking readings at the start of each day. To set a zero point, the GEM-500 is given a methane-free gas sample—often air is used. This establishes a zero point. This function significantly improves the GEM-500's CH4 accuracy over the entire range. It is essential that the gas analyzer be clear of CH4 at the time of zeroing. Care must be taken if the GEM-500 is to be zeroed on a landfill site because there are situations where methane, which is odorless and colorless, could be in the atmosphere.

After the Zero methane function, the GEM-500 recalculates 16 methane calibration points on its methane gas curve and stores the revised data in its memory. The GEM-500 does not need to be have the CH4 zeroed every time it is switched on because the most recent calibration data is stored in protected memory.

Span Methane

A field calibration spans the methane range prior to taking readings at the start of each day. The best results are obtained after the instrument has stabilized at its working temperature. The procedure alters the methane calibration at all concentrations and stores the revised data in protected memory. Depending on which CH4 range is spanned, sampling errors at a much higher or lower concentration may occur.

Note: The Zero Methane should be set before setting the Methane Span.

Span Carbon Dioxide

Field calibration spans the CO2. It should be spanned prior to taking readings at the start of each day after the instrument has stabilized at its working temperature. The procedure alters the calibration at all concentrations and stores the revised data in protected memory. Landfill gas contains high concentrations of CO2. As with methane, there are similar sampling errors outside the range spanned.

Zero Oxygen

This function is essential where low concentrations of oxygen are expected (below 6%). Normally there is very little oxygen in LFG. A procedure explained below zeroes the oxygen prior to beginning daily gas sampling. This establishes the zero point of an oxygen curve that is stored in the GEM-500's permanent memory.

Span Oxygen

The oxygen calibration map contains two span curves, one for oxygen below 7% and one for oxygen above 7%. The proper curve is automatically selected. If a calibration gas with less than 7% oxygen is used, the lower span curve is adjusted. If the calibration gas has more than 7% oxygen, the higher calibration curve is adjusted. Due to the resolution of the GEM-500's processor at higher concentrations, the GEM-500 may not display the exact concentration entered. As discussed below, this effect can be reduced by altering the entered value so that the displayed value is as close to the actual value as possible.

Note: The O2 Oxygen should be set before setting the Oxygen Span.

Equipment

To perform a field calibration, the following items are required.

1. Cylinder of 50/50 (50% CH_4 and 5B0% CO_2) calibration gas
2. Cylinder of 5/95 (5% O_2 and 95% CO_2) calibration gas
3. Pressure regulators for the above cylinders capable of regulating in the range of 0 - 5 psig fitted with connectors suitable for 1/4" Tygon tubing.
4. Regulator/flowmeter capable of measuring in the range 60 - 600 cc per minute maximum with fittings suitable for 1/4" Tygon tubing.
5. Interconnecting lengths of 1/4" Tygon tubing.

All this equipment is available from LANDTEC. Other types of tubing can be used but the connections must be airtight and secure. The equipment is set up as shown in Figure 2.1.

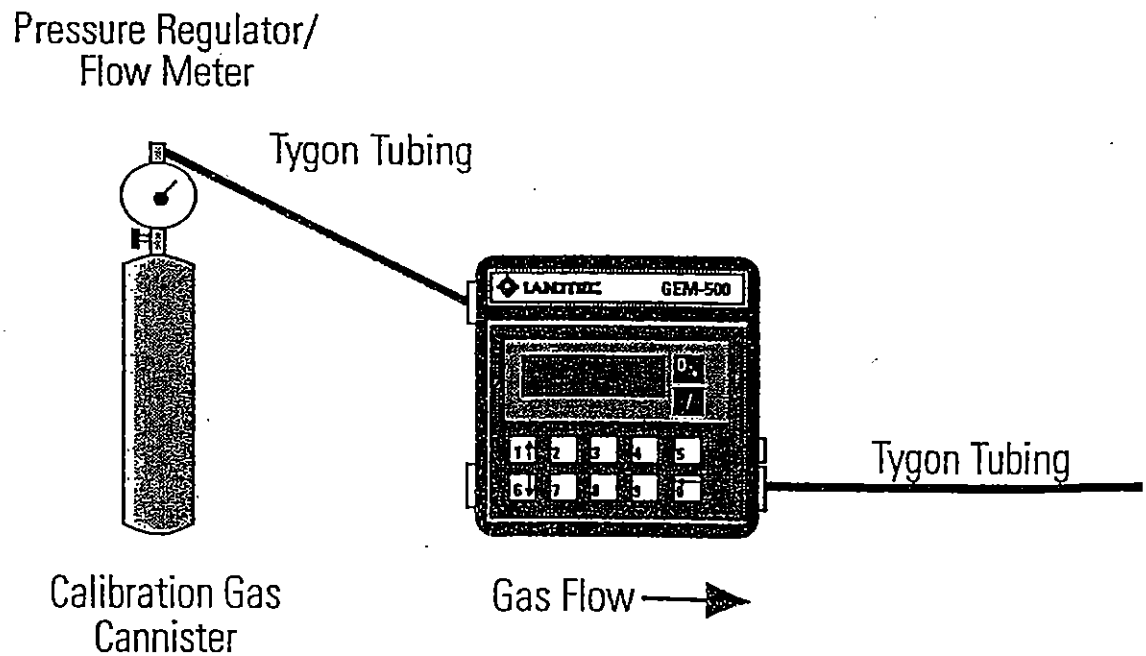


Figure 2.1

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Setting Up the Equipment

As described and shown in the Equipment Section, begin assembly of the GEM-500:

1. Connect the methane/carbon dioxide (CH_4 /CO_2) calibration gas cylinder to the pressure regulator.
2. Connect a 24" piece of 1/4" Tygon tubing to the flowmeter outlet. Do not attach this to the GEM-500 until instructed.
3. Connect a second 24" of 1/4" Tygon tubing to the exhaust nozzle of the GEM-500. Direct the exhaust away from you and out of the immediate area.

5. If the regulator has not been preset, set the pressure adjustment on the regulator off its lowest setting. Turn the calibration gas cylinder valve 1/4 turn. Adjust the regulator discharge pressure to 2 psig and the flow meter to 300 cc per minute. Block the discharge hose that will attach to the GEM-500. The regulator discharge pressure should not climb to over 3 psig. Turn off the cylinder valve.

Note: This procedure will be duplicated for the second span gas when Oxygen is calibrated. The Oxygen/Carbon Dioxide calibration gas cylinder will be substituted for the Methane/Carbon Dioxide calibration gas.

General Utilities KEY 5-Gas Calibration

The GEM-500 is factory calibrated. For greater accuracy, a Field Calibration can be performed. To improve accuracy, all standard landfill gas instruments are field calibrated and zeroed prior to every use . This function is done from the General Utilities Menu of the GEM-500 which is explained in Section 3. Because of the importance of Gas Calibration, this function has been made a separate section. To get to the General Utilities Screen on the GEM-500, see Section 3, Using the Menu Screens.

1. Press KEY 1-General Utilities at the Main Menu Screen (See Figure 2.2.).

Figure 2.2

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

2. The General Utilities Screen appears as shown in Figure 2.3.

Figure 2.3

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More          0-Exit
```

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3. The gas calibration function is not on the first General Utilities Screen. To reach this screen, press KEY 9-More and KEY 5-Gas Calibration (Figure 2.4). You could also select KEY 5 while at the General Utilities Screen to proceed directly to the gas calibration screen.

Figure 2.4

```
4-USA/Metric Units
5-Gas Calibration
6-Gas Alarms
9-More          0-Exit
```

4. After selecting KEY 5-GAS CALIBRATION on the General Utilities Sub-Menu Screen, the first Gas Calibration Screen appears as shown in Figure 2.5.

Figure 2.5

```
1-CH4 Calibration
2-CO2 Calibration
3-O2 Calibration
4-Factory Settings
```

5. There are four possible choices. The first choice field calibrates methane. The second choice calibrates carbon dioxide. The third choice calibrates oxygen. The fourth choice returns the GEM-500 from a field calibration established by the user to the original factory settings.
6. Each of these calibration options will now be reviewed in order.

Methane (CH4) Calibration - Zero CH4

1. Pressing KEY 1-CH4 Calibration on the Gas Calibration Screen brings up the Methane Calibration Screen (Figure 2.6).

Figure 2.6

```
1-Zero CH4
2-Calibrate CH4 Span
0-Previous Menu
```

2. Pressing KEY 1-Zero CH4 brings up the Zero Methane Screen (Figure 2.7). A methane percentage will not display until the IR Bench warms up. A plus or negative sign may appear on the far left of the display. This symbol can be ignored.

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Figure 2.7

+00.2 CH4 % Gas
1-Zero Level
5-Pump
0-Exit

Note: Do not perform this procedure in the presence of methane.

3. Press KEY 5-Pump. This turns on the sample pump in the GEM-500. There should be no calibration gas hoses attached to the GEM-500 during this procedure. The GEM-500 will be drawing in a sample of normal air—which must be free of methane. Allow the pump to run for FIVE MINUTES to stabilize the instrument to operating temperature and purge the sensors with air. (If the GEM-500 has already reached operating temperature by having been used and is at operating temperature, the pump can be operated for two minutes but when in doubt, let it run for the full five minutes.)

4. Press KEY 1 - Zero level and one of the following screens (Figure 2.8 or Figure 2.9) will be displayed for three seconds before returning to the Zero Methane Screen shown in Figure 2.7.

Figure 2.8

CH_4 Not Zeroed

Figure 2.9

CH_4 Zeroed

5. If the CH4 Not Zeroed Screen (Figure 2.8) was displayed, return to the Gas Calibration Screen by pressing KEY 0-Exit. Recheck that no methane was present and re-zero the methane. If problem continues, proceed to instructions contained in this section for Factory Settings.
6. If the CH4 Zeroed OK Screen (Figure 2.9) appeared, press KEY 0-Exit to return to the Methane Calibration Screen (Figure 2.10). Press KEY 2-Calibrate CH4 Span and proceed to the next section.

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Figure 2.10

```
1-Zero CH4
2-Calibrate CH4 Span
0-Previous Menu
```

WARNING: The GEM-500 is not certified as intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground and indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area. On the GEM-500, ensure that exhaust gas is safe, not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.

CH4 Calibration - CH4 Span

1. Read warnings above before proceeding with the next steps.
2. After selecting KEY 2-Calibrate CH4 Span on the Methane Calibration Screen, the following CH4 Span Screen appears (Figure 2.11).

Figure 2.11

```
                    1-Enter
                    gas con
+00.0% CH4 Gas      5-Pump
                    0-Exit
```

3. Connect the 1/4" Tygon tubing from the calibration gas regulator/flow meter to the GEM-500 gas sample/impact port (Figure 1.1). Attach, if not already attached, the Tygon tubing to the exhaust port of the GEM-500. Direct the exhaust away from you and out of the immediate area.
4. Press KEY 5-Pump if the pump is not already running, on the CH4 Span Screen shown above. This turns the GEM-500's pump on.
5. Turn on the calibration gas mixture of methane and carbon dioxide.
6. Check the calibration gas flow (300 cc) and pressure (2 psig) to make sure they are correct. (See Setting Up the Equipment)
7. Allow the calibration gas to flow into the GEM-500 for two minutes.
8. After two minutes, read the methane Gas Concentration on the screen. It should be stable and not changing more than a few tenths of one percent.
9. Press KEY 1-Enter Gas Con and input the methane concentration of the calibration gas from the keyboard of the GEM-500 (Figure 2.12). Enter the percentage as three digits XX.X%. 60% methane would be input as 600. The GEM-500 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0-Exit.

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Figure 2.12

```
Enter Concentration
of Calibration Gas
CH4 ?-.-%
                0-Exit
```

10. The next screen is the Caution Re-Calibrate Screen (Figure 2.13).

Figure 2.13

```
Caution Re-calibrate
Are you sure?

1-Yes          2-No
```

11. Press KEY 1-Yes and one of two messages will appear (Figure 2.14 or Figure 2.15). If the Calibration OK Screen appears proceed to step 13.

Figure 2.14

```
Calibration gas NOT
accepted. Refer to
operating manual.
Retry? 1-Yes 2-No
```

Figure 2.15

```
Calibration OK
```

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12. If the Calibration gas NOT Accepted Screen appears, several things could have happened. Press KEY 1-Yes and enter the percentage of methane in the calibration gas. It is possible the wrong percentage was input. If on a second attempt this has not worked, press KEY 0-No and return to the CH4 Calibration Screen. Start the procedure over again—Zero methane and then Calibrate methane. If there are still problems—proceed to the Factory Settings later in this section.
13. Press KEY 0-Exit and return to the CH4 Calibration Screen shown on the preceding page. If only CH4 is to be calibrated, the pump must be turn off. Press KEY 0-Exit again and step back to the Gas Calibration Screen. If CO2 is to be calibrated, go to the following CO2 calibration instructions. If no further calibration is required, perform step 14. The pump will remain running throughout the calibration procedure. You must return to the KEY 5-Pump screen to stop the pump.
14. Turn off the calibration gas cylinder. Remove the calibration gas hose attached to the gas sample/static pressure port on the GEM-500. Leave the exhaust port hose connected and turn on the pump and allow it to purge the GEM-500 with air for 60 seconds. Press KEY 5-Pump again. The pump will turn off and automatically return to the Calibrate Methane Screen.
15. Press KEY 0-Exit and return to the Gas Calibration Screen. You have successfully completed a methane Field Calibration.

Carbon Dioxide (CO2) Calibration

1. Because the carbon dioxide used in this calibration contains methane, the following warning must be adhered to before proceeding with the steps below.

> **WARNING: The GEM-500 is not certified as intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground and indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area . On the GEM-500, ensure that exhaust gas is safe, not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.**

2. Press Key 2 - CO2 Calibration on the Gas Calibration Screen (Figure 2.16).

Figure 2.16

1-CH_4 Calibration
2-CO_2 Calibration
3-O_2 Calibration
4-Factory Settings

3. There is no Zero CO2 function as there is in the methane or oxygen calibration procedures. The following CO2 Span Screen will appear (Figure 2.17).

Figure 2.17

+00.0% CO2 Gas
1-Enter gas con
5-Pump
0-Exit

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4. Press KEY 1-Enter Gas Con and the Enter Concentration Screen shown below appears. Input the carbon dioxide concentration of the calibration gas from the keyboard of the GEM-500 (Figure 2.18). Enter the percentage as three digits XXX%. 40% carbon dioxide would be input as 400. The GEM-500 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0 - Exit.

Figure 2.18

```
Enter Concentration
of Calibration Gas
CO2 ?-.-%
                0-Exit
```

5. The next screen, Figure 2.19, is the Caution Re-Calibrate Screen.

Figure 2.19

```
Caution Re-calibrate
Are you sure?

1-Yes           2-No
```

6. Press KEY 1-Yes and one of two messages will appear (Figure 2.20 or Figure 2.21). If the Calibration OK Screen appears go to step 9 below.

Figure 2.20

```
Calibration gas NOT
accepted. Refer to
operating manual.
Retry? 1-Yes 2-No
```

Figure 2.21

Calibration OK

7. If the Calibration gas NOT Accepted Screen appears, several things could have happened. Press KEY 1-Yes and enter the percentage of carbon dioxide in the calibration gas. It is very possible the wrong percentage was input. If on a second attempt this has not worked, press KEY 0-No and return to the Gas Calibration Screen and proceed to the Factory Settings section for additional instructions.
8. If O2 is to be zeroed, go to the following O2 Calibration step.
9. Press KEY 0-Exit and return to the CO2 Calibration Screen shown on the prior page.
10. Turn off the calibration gas. Remove the calibration gas hose attached to the gas sample/static pressure port on the GEM-500. Leave the exhaust port hose connected. Allow the GEM-500 to purge with air for 60 seconds. Press KEY 5-Pump and the pump will automatically turn off, then push KEY 0-Exit to return to the Gas Calibration Screen.
11. You have successfully completed a carbon dioxide Field Calibration. Immediately proceed to the next function, KEY 3-O2 Calibration.

Oxygen (O2) Calibration - Zero O2

1. There are two calibration gas mixtures used for the calibration of oxygen. The methane/carbon dioxide calibration gas previously used to calibrate the methane and carbon dioxide is used to Zero oxygen because there is no oxygen in the mixture. A second calibration gas with a mixture of oxygen and carbon dioxide will be used to set the oxygen level in the next section. Because the calibration gas used in this calibration contains methane, the warning below must be followed before proceeding with the following procedure.

> **WARNING: The GEM-500 is not certified as intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground and indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area . On the GEM-500; ensure that exhaust gas is safe, not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.**

2. Press Key 3-O2 Calibration on the Gas Calibration Screen (Figure 2.22).

Figure 2.22

1-CH_4 Calibration
2-CO_2 Calibration
3-O_2 Calibration
4-Factory Settings

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3. The Oxygen Calibration Screen will appear (Figure 2.23).

Figure 2.23

```
1-Zero O2
2-Calibrate O2 Span
0-Previous Menu
```

4. Pressing KEY 1-Zero O2 will bring up the Zero Oxygen Screen (Figure 2.24).

Figure 2.24

```
                    1-Zero
                      Level
+00.2% O2 Gas       5-Pump
                    0-Exit
```

5. Read the oxygen Gas Concentration on the screen. It should be very near 00.0 % and not changing more than a few tenths of one percent.

Note: Even if the screen displays 00.0% oxygen, proceed with step 11 below, the Oxygen must be zeroed anyway.

6. Press KEY 1-Zero level and the one of following screens (Figure 2.25 or Figure 2.26) are displayed for three seconds before returning to the Zero Oxygen Screen shown above. If the O2 Zeroed Screen was displayed proceed to step 13 below.

Figure 2.25

```
Level NOT Zeroed
Please refer to
Operating Manual
```

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Figure 2.26

O_2 Zeroed

7. If the Oxygen NOT Zeroed Screen was displayed, return to the Oxygen Calibration Screen. Recheck that the calibration gas contains no oxygen. The gas used should have been a mixture of methane and carbon dioxide only. Connect the correct gas and re-zero the oxygen. If the problem continues, proceed to instructions contained in this section for Factory Settings.
8. If the Oxygen Zeroed OK Screen appeared, turn off the calibration gas.
9. Remove the hose to the GEM-500 from the flow regulator. Let the pump run for at least 60 seconds to purge the instrument with air. Press KEY 5-Pump to turn off the pump.
10. Press KEY 0-Exit to return to the Oxygen Calibration Screen Shown below and proceed to the next section.

O2 Calibration - O2 Span

1. From the Gas Calibration Screen, press KEY 2-Calibrate O2 Span and the Oxygen Calibration Screen (Figure 2.27) will appear.

Figure 2.27

1-Zero O_2
2-Calibrate O_2 Span
0-Previous Menu

2. Press KEY 2-Calibrate O2 Span on the Oxygen Calibration Screen will appear (Figure 2.28).

Figure 2.28

+00.0% O2 Gas
1-Zero Level
5-Pump
0-Exit

Note: The calibration gas used in this procedure is a mixture of oxygen and carbon dioxide. The oxygen concentration by volume can be 2-5% with the remainder CO2.

3. Change the Calibration Gas mixture to Oxygen/Carbon Dioxide. Install the regulator/flow meter on the new Calibration Gas mixture as directed previously in the section Setting Up the Equipment. Check and adjust the gas flow to 300 cc and pressure to 2 psig. Turn off the gas.

4. Connect the 1/4" Tygon tubing from the calibration gas regulator/flowmeter to the GEM-500 gas sample/static pressure port (Figure 1.1). Attach, if not already attached, the Tygon tubing to the exhaust port of the GEM-500. Direct the exhaust away from you and out of the immediate area.
5. Press KEY 5-Pump on the O2 Span Screen shown above. This turns the GEM-500's pump on.
6. Turn on the calibration gas mixture of oxygen and carbon dioxide.
7. Check the calibration gas flow (300 cc) and pressure (2 psig) to make sure they are correct.
8. Allow the calibration gas to flow into the GEM-500 for two minutes.
9. After two minutes, read the oxygen Gas Concentration on the screen. It should be stable and not changing more than a few tenths of one percent.
10. Press KEY 1-Enter Gas Con and input the oxygen concentration of the CALIBRATION GAS (typically 5%) from the keyboard of the GEM-500 (Figure 2.29). Enter the percentage as three digits XX.X%. 5% methane would be input as 050. The GEM-500 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0-Exit.

Figure 2.29

```
Enter Concentration
of Calibration Gas
O2 ?-.-%
                0-Exit
```

11. The next screen to appear, Figure 2.30, is the Caution Re-Calibrate Screen.

Figure 2.30

```
Caution Re-calibrate
Are you sure?

1-Yes          2-No
```

12. Press KEY 1-Yes and one of two screens will appear (Figure 2.31 or Figure 2.32). If the Calibration OK Screen appears proceed to step 14.

Figure 2.31

```
Calibration gas NOT
accepted. Refer to
operating manual.
Retry? 1-Yes 2-No
```

Figure 2.32

```
Re-Calibrated OK
```

13. If the Calibration gas NOT Accepted Screen appears, several things could have happened. Press KEY 1-Yes and enter the percentage of oxygen in the Calibration Gas. It is possible the wrong percentage was input. If on a second attempt this has not worked, press KEY 0-No and return to the oxygen Calibration Menu. Start the procedure over again —Zero oxygen and then Calibrate oxygen. If there are still problems—proceed to the Factory Settings section in this section.
14. Press KEY 0-Exit and return to the Oxygen Calibration Screen shown on the following page.
15. Turn off the Calibration Gas. Remove the Calibration Gas hose attached to the gas sample/static pressure port on the GEM-500. Leave the exhaust port hose connected. Allow the GEM-500 to purge with air for 60 seconds. Press KEY 5-Pump and the pump will turn off.
16. Optional Step - The GEM-500 was just calibrated on 1-7% oxygen scale. The 7-21% scale can be calibrated using normal air. While on the Oxygen Calibration Screen press KEY 5-Pump and allow it to run for 60 seconds. The screen will appear as shown in Figure 2.33. Repeat steps 10 - 14 above. For step 10, enter an O2 concentration of 21.0% even though the screen will seldom reach more than 20.6%. You have just calibrated the upper oxygen scale.

Figure 2.33

```
                    1-Zero
                     Level
+20.6% O2 Gas       5-Pump
                    0-Exit
```

17. Turn off the pump by selecting KEY 1, KEY 2 or KEY 3 from the Gas Calibration Screen then press KEY 5-Pump and KEY 0-Exit to return to the Gas Calibration Screen. You have successfully completed an oxygen Field Calibration.

Factory Settings Calibration

As previously mentioned, the GEM-500 can be returned to its original Factory Settings Calibration. This procedure eliminates the field calibration done in the above procedures. It is sometimes necessary to bring the GEM-500 back to factory settings before trying to field calibrate the unit. If for some reason sampling conditions change radically, overall accuracy of the GEM-500 could improve by returning to the factory settings.

1. From the Gas Calibration Screen, Figure 2.34, press KEY 4-Factory Settings.

Figure 2.34

```
1-CH4 Calibration
2-CO2 Calibration
3-O2 Calibration
4-Factory Settings
```

2. The Caution Screen, Figure 2.35, shown below will be displayed. If KEY 0 - No is pressed, screen represented in Figure 2.36 will appear for two seconds and the Gas Calibration Screen will return.

Figure 2.35

```
CAUTION Return to
Factory Setting of
Calibration & Zero
1-Yes        2-No
```

Figure 2.36

```
Factory Setting
NOT Set
```

3. Press KEY 1-Yes and the screen shown in Figure 2.37 is displayed for three seconds before returning to the Gas Calibration Screen shown in step 1.

Figure 2.37

```
Factory Setting
Set OK
```

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4. After loading the factory setting, the methane and oxygen calibration **must be rezeroed prior to use.**

After Completing Gas Calibrations

Additional General Utilities functions should be addressed after the GEM-500 is field calibrated. These functions are available from the General Utilities Menu and include:

- Check Time/Date—to make sure the data collected is properly date stamped.
- Check Memory—to see if there is enough space in the GEM-500 for the reading you plan to do. Otherwise the memory will have to be cleared.
- Set Gas Alarms—if you wish to have the GEM-500 alert you to unusual gas conditions.

After completing the gas calibrations, you can begin to read gas levels. Go to Chapter 5-Read Gas Levels, of this manual.

Chapter 3-Using Menu Screens

Starting Up the GEM

This procedure is the same each time the GEM-500 is turned on by pressing the Red ON/OFF Key. The following steps will allow you to proceed to the Main Menu Screen of the GEM.

Note: If the GEM is turned on and no additional keys are pressed within 15 minutes, the unit will turn off automatically to save power. No stored data will be lost.

1. Turn unit on by pressing the RED KEY-On/Off .
2. The Warning Screen will appear for five seconds. This is a reminder that the GEM-500 is not to be used in confined areas such as vaults, excavations or indoors. An explosion could result causing serious injury or death.

Figure 3.1

```
WARNING! DO NOT
use in confined
spaces-UNIT
not certified
intrinsically safe
```

3. Service Contract Screen may appear for five seconds if activated by LANDTEC. Otherwise the Not Covered Screen can be displayed. The GEM-500 is a portable scientific field instrument that does require factory maintenance and calibration at recommended six month intervals under normal landfill usage.

Figure 3.2

```
This Analyzer is not
covered by a
Service Contract
Next Service due:
```

Figure 3.3

```
This Analyzer has a
Service Contract
Next Service due:
(date)
```

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The LANDTEC/Contrast Screen follows and allows the user to adjust the contrast of the characters on the liquid crystal display screen. Press and hold KEY 1-Cursor-Up Arrow to increase contrast. Press and hold the KEY 6-Cursor-Down Arrow to decrease the contrast. Adjust the contrast as necessary. Press the KEY 0 to exit to the next screen.

Figure 3.4

```
LANDTEC
GEM-500
(800) 821-0496
↑↓ -Contrast   0-Exit
```

4. Following is the Main Menu Screen. All the GEM-500's functions are accessed from the Main Menu Screen. All future instructions about GEM-500 functions will start with from this screen.

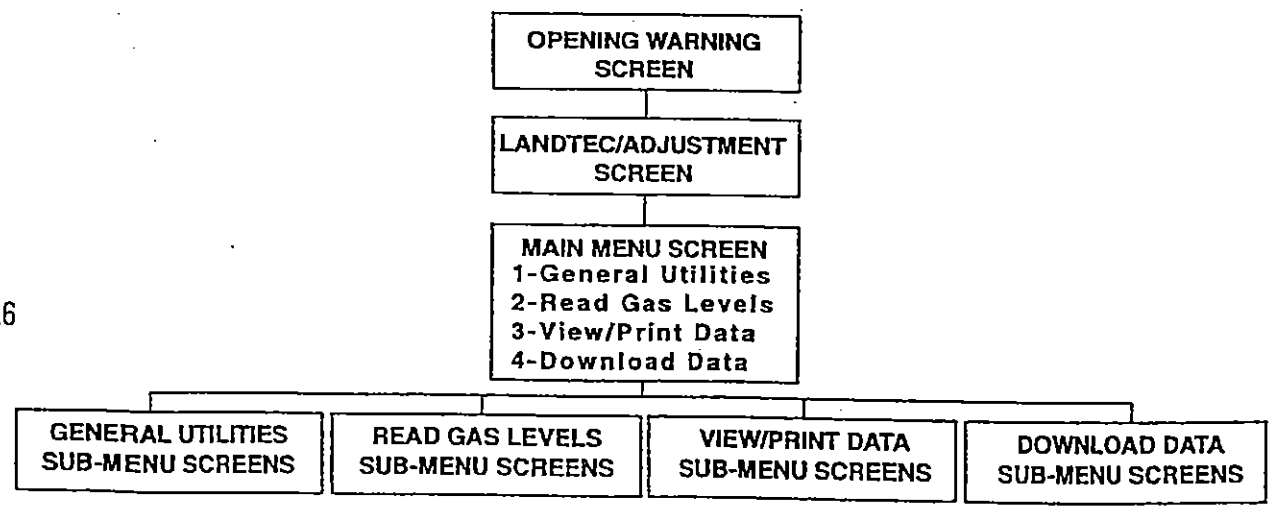
Figure 3.5

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

GEM-500 Menu Screens Tree

The overall menu screens structure is displayed below:

Figure 3.6



Review of the Main Menu and Sub-Menu Screens

The Main Menu Screen has four major functions which have the following specific actions:

General Utilities

Refer to Chapter 4 for further information. The General Utilities function has sub-menu screens that allow housekeeping and other maintenance including:

1. CHECK TIME/DATE: Used to check or set time and date.
2. ZERO PRESSURE: Zeros pressure transducers.
3. MEMORY: Check memory available and clears all data and ID information.
4. USA/METRIC UNITS: Select either USA standard or metric measurement units.
5. GAS CALIBRATION: Allows methane, carbon dioxide and oxygen to be field calibrated by the user with calibration gas mixtures for increased accuracy (Discussed in Section 2).
6. GAS ALARM: Sets gas alarm levels.
7. ID MAINTENANCE: Used to view, edit or delete existing ID information and to enter new ID information.

Read Gas Levels

Refer to Chapter 5 for further information. Read Gas Levels function allows gas, pressure, flow and BTU readings to be viewed and recorded. Sub-menu screens include:

1. Read GAS with Existing ID code - has three linked screens.
2. Read GAS without ID code.

View/Print Data

For further information, refer to Chapter 6. View/Print Data function allows previously stored data to be scanned on the GEM display screen, individually displayed or printed via the optional RS-232 cable to a serial printer.

Download Data

The Download Data function allows stored data to be downloaded via the optional RS-232 cable to a personal computer in a format that can be uploaded into other programs including spreadsheets and LANDTEC's data base management program. See Chapter 7 for further information.

Note: The KEY 0-Backspace will act as an exit or escape key at the end of each sub-menu and return you to the main menu screen.

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Chapter 4-General Utilities Functions

Read Chapter 3 on how to get to the Main Menu Screen. Also see the GEM-500 Menu Screen Tree which is a diagram located in Chapter 3.

Press KEY 1-General Utilities on the Main Menu Screen. There are seven options available that are displayed on three sub-menu screens as shown below: Select the desired function by pressing the appropriate key. The desired option does not need to be displayed in order to select it. For example, if the first screen is displayed, entering KEY 5 will bring up the Gas Calibration Sub-Menu which is located on the second screen. From any of these Sub-Menus, if the KEY 0-Exit is pressed, then the Main Menu Screen will re-appear (Figure 4.1).

1. CHECK TIME/DATE: Used to check or set time and date.
2. ZERO PRESSURE: Zero's pressure transducers.
3. MEMORY: Check memory available and allows clearing of all data and ID information.
4. USA/METRIC UNITS: Select either USA standard (Imperial) or metric (SI) measurement units.
5. GAS CALIBRATION: Allows methane, carbon dioxide and oxygen to be field calibrated by the user with a special gas mixture for increased accuracy.
6. GAS ALARM: Sets gas alarm levels.
7. ID MAINTENANCE: Used to view, edit or delete existing ID information and to enter new ID information.

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

Figure 4.1

General Utilities Menu

By pressing KEY 1 on the Main Menu Screen, the General Utilities Menu Screen (Figure 4.2) will appear.

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More      0-Exit
```

Figure 4.2

As shown, three General Utilities functions are shown on each General Utilities Menu Screen. By pressing KEY 9, the next screen of utility functions is displayed (Figure 4.3).

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Figure 4.3

```
4-USA/Metric Units
5-Gas Calibration
6-Gas Alarms
9-More        0-Exit
```

Press KEY 9 again for one more screen of General Utilities functions (Figure 4.4). As previously mentioned, any function number can be pressed while any screen is displayed. Pressing KEY 9 displays the list of functions again. Pressing the KEY 0 returns you to the Main Menu Screen.

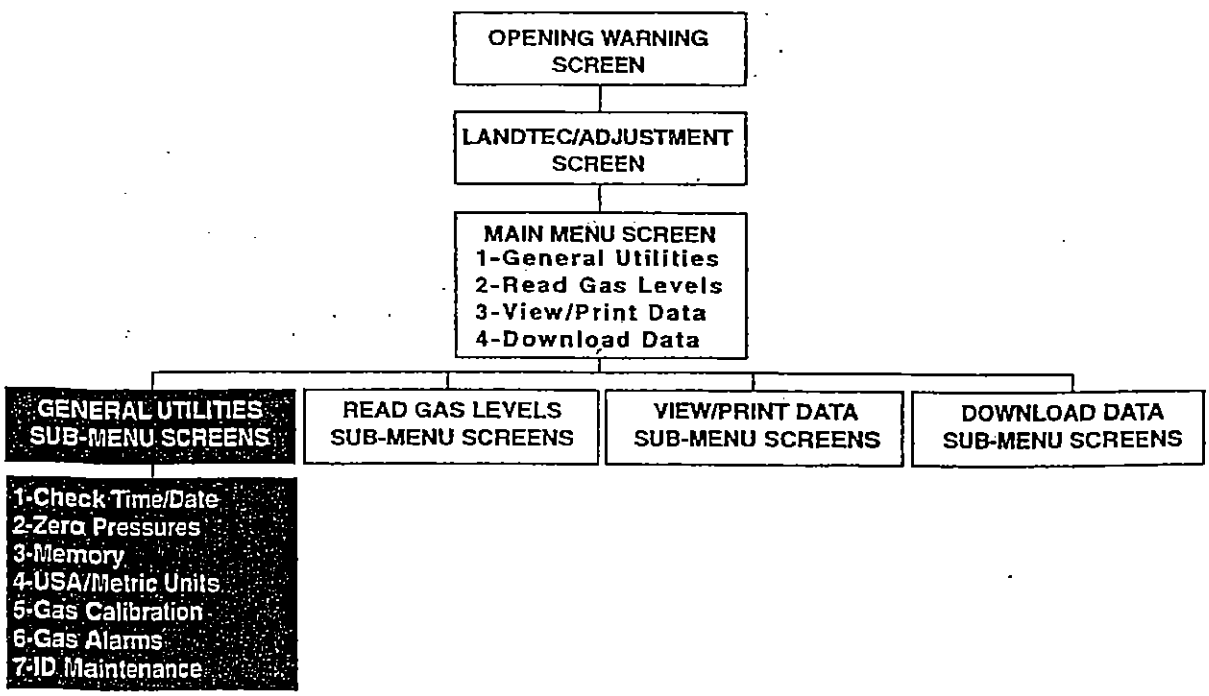
Figure 4.4

```
7-ID Maintenance

9-Back        0-Exit
```

General Utilities Screen Tree Diagram

Figure 4.5



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General Utilities KEY 1-Check Time/Date

There is an internal clock and calendar in the GEM-500 unit which is powered by a secondary battery. This maintains the clock function even when the GEM-500 is off. The battery can only be changed by an authorized factory service representative.

As each reading is stored in the GEM-500, it is time and date stamped. Both the clock and calendar are set by LANDTEC, however, they should be set to the local time zone the first time and checked weekly thereafter.

1. Press KEY 1 on the Main Menu Screen for the General Utilities Sub-Menu Screen. This takes you to the General Utilities Sub-Menu Screen (Figure 4.6). Press Key 1 on the General Utilities Sub-Menu Screen as shown below for the Check Time/Date function.

Figure 4.6

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More      0-Exit
```

2. The following Set Time/Date Screen is displayed (Figure 4.7). Press KEY 1 to proceed.

Figure 4.7

```
15:46:07    09/07/93

1-Set Time/Date
                0-Exit
```

3. The time and date are displayed on the top line of the screen. A 24-hour clock is used. If after 12 noon, add 12 to the hour to convert it to a 24-hour format. Example: 3 p.m. is 12+3= 15 00 hours. The time format is Hours: Minutes. Seconds. The date format used in the example is in U.S. calendar format (see note below).
4. If CHECK TIME/DATE is ok, end procedure by pressing KEY 0-Exit and returning to the General Utilities Sub-Menu Screen. Otherwise if CHECK TIME/DATE is wrong, press KEY 1, and set CHECK TIME/DATE in the next step.
5. Set the time and date as shown on Figure 4.8 by entering numbers from the GEM-500 keyboard. Press the KEY 0-Set when done.

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Figure 4.8

```
?h:mm:ss  mm/dd/yy

Enter New Time/Date
                0-Set
```

NOTE: If necessary to correct an entry error, use 0 KEY (exit) as Backspace Key by holding it down for 1 second. In normal use, 0 KEY is quickly pressed and released. In above screen for time: hh = hours, mm = minutes, ss = seconds and date: mm = months, dd = days, yy = years. CHECK TIME/DATE is in U.S. calendar format.

6. One of two screens will be displayed. Both are shown below. If the date is valid, Figure 4.9 will display for three seconds. If the time or date is invalid the second screen will appear as shown on Figure 4.10. The Time/Date is invalid when impossible numbers are entered into a field. For example mm=15 is an invalid month. Return to step 5 above and re-enter the correct time and date as instructed.

Figure 4.9

```
Time/Date Set OK
```

Figure 4.10

```
Invalid Time/Date
Please enter again
```

General Utilities KEY 2-Zero Pressure

The GEM-500 measures atmospheric pressure as part of the LFG flow calculation. To properly measure pressure and the vacuum used in landfill gas extraction systems, the pressure transducers must be reset to zero before using the GEM-500. This is done to compensate for atmospheric pressure changes due to local weather conditions and changes in elevation.

This procedure should be done prior to doing any READ GAS LEVELS as shown in Chapter 5 unless the static and differential pressures read 00.0. The ZERO PRESSURE function is also contained on the READ GAS LEVELS Sub-Menu Screen. Whenever the pressure transducer readings are not zero and you know they should be, use this procedure. As a general rule this procedures should be done each time the GEM-500 is used.

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1. Press KEY 1-General Utilities at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Press the KEY 2 for Zero Pressure on the General Utilities Sub-Menu Screen as shown in Figure 4.11.

Figure 4.11

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More        0-Exit
```

3. Figure 4.12 displays the current readings of the Static and Differential pressure transducers. If both pressures do not read 00.0 DISCONNECT ANY HOSES IF ATTACHED TO A WELLHEAD and press KEY 1-Zero Pressures.

Figure 4.12

```
     Static  +00.2"H20
Differential -0.30"H20
1-Zero Pressures
                0-Exit
```

Note: Units displayed will be inches of water column or MB depending on measurement unit selected (USA or metric).

4. After the pressures have been zeroed, Figure 4.13 will appear for three seconds. Then the Zero Pressure Screen in step 3 appears.

Figure 4.13

```
Zeroed OK
```

5. Press the KEY 0 - Exit to end procedure and return to General Utilities Sub-Menu Screen.

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General Utilities KEY 3-Memory

Caution: This function can erase all stored data.

Each GEM-500 ID point and all readings taken at that ID point are stored in the GEM-500's memory. Eventually the memory becomes full. After each day's readings are completed, the memory function should be checked. Normally the readings for the day are Downloaded to a PC or are printed out (see functions 3 & 4 on the Main Menu in Section 3). If the memory becomes full, a MEMORY FULL message is displayed. When this happens, the memory must be cleared.

The GEM-500 can store many ID points. It is therefore possible to use it on several landfills. As stated in the warning above, once cleared, the data cannot be restored.

1. Press KEY 1 at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the KEY 3 for Memory on the General Utilities Sub-Menu Screen (Figure 4.14).

Figure 4.14

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More        0-Exit
```

3. The following screen—Number of Free Readings Screen, allows for two choices: Press KEY 1 - Clear Readings to erase all gas/etc. data readings or Press KEY 2 - Clear ID Info to erase All ID Code Numbers and Flow Data that have accumulated in the GEM-500 from ID MAINTENANCE and READ GAS functions.

   Press the KEY 0 - Exit to escape from the procedure and return to the General Utilities Sub-Menu Screen without clearing any information.

Figure 4.15

```
 0479 Free Readings
1-Clear Readings
2-Clear ID Info
                0-Exit
```

4. After making your choice of 1 or 2 on the screen above, the following screen appears. As a final safety check, you must input the numeric value 0102 from the GEM-500 keyboard to clear the memory. IF YOU DECIDE NOT TO CLEAR THE MEMORY AT THIS POINTùTURN THE GEM-500 OFF BY PRESSING THE RED ON/OFF KEY. Do Not Input 0102 unless you want to proceed.

   Caution: This step erases stored data. You may want to print the memory out or download the data first so it is not lost.

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Figure 4.16

```
CAUTION!
DATA WILL BE LOST
Enter 0102 to clear
?
```

5. Enter 0102 from the keyboard and press the KEY 0 - Exit. The Clearing Memory Screen appears for 3 seconds if the memory was erased.

Figure 4.17

```
Clearing Memory
```

After displaying the above, the Number of Free Readings Screen shown in Step 4 above is re-displayed. Press the 0 Key to Exit to the General Utilities Menu Screen.

General Utilities KEY 4-USA/Metric Units

The GEM-500 can display and story data in 2 units of measureùMetric (SI) or Imperial (USA). This function allows for the setting of the unit of measure. Normally once set, it does not need to be changed.

1. Press KEY 1-General Utilities at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Since function 4-USA/Metric Units is not on the first General Utilities Screen, press the KEY 9-More for the next screen.
3. Press the KEY 4-USA/Metric Units on the General Utilities Sub-Menu Screen as shown in Figure 4.18.

Figure 4.18

```
4-USA/Metric Units
5-Gas Calibration
6-Gas Alarms
9-More      0-Exit
```

4. The Measurement Units Screen appears as shown in Figure 4.19. Press the KEY 1 to change from one unit to the other. (It acts a toggle switching from one to the other.) If the GEM-500 is currently displaying USA measureme nt units (Imperial — Btu's, Standard Cubic Feet, Fahrenheit temperatures, etc.) it switches to Metric. When done, press the KEY 0-Exit Key to return to the General Utilities Sub-Menu Screen.

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Figure 4.19

```
Measurement Units
Set to Metric (USA Std)
1-Change to Metric (USA)
                0-Exit
```

General Utilities KEY 5-Gas Calibration

Please refer to Chapter 2-Field Calibration for all information and instructions relating to the Gas Calibration function.

General Utilities KEY 6-Gas Alarm

The GEM-500 has two alarm options that can warn the operator if a gas sample contains concentrations of Methane below established levels or Oxygen above preset levels. If the alarms are activated, there is a beeping and the affected gas blinks when displayed on the Read Gas Levels Screens.

1. Press KEY 1 at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the KEY 9-More. Press the KEY 6-Gas Alarms on the General Utilities Sub-Menu Screen as shown in Figure 4.20.

Figure 4.20

```
4-USA/Metric Units
5-Gas Calibration
6-Gas Alarms
9-More      0-Exit
```

3. The following screen is displayed (Figure 4.21). Chose one or two to change the methane gas or oxygen level. If no change in gas levels is required press the KEY 0-Exit to return to the General Utilities Sub-Menu Screen.

Figure 4.21

```
Methane Below 00.0%
Oxygen Above  22.2%
1-Change Methane
2-Change Oxygen
```

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4. If KEY 1-Change Methane is pressed the following screen will appear (Figure 4.22). Using the numbered keys on the GEM keyboard input the new 3 digit level for methane (CH4). All three digits must be entered (XX.X%), the decimal point is automatically inserted. Press KEY 0-Exit.

```
CH4 Level is   00.0%
Level Required ?.0%

Enter level
```

Figure 4.22

Note: Screens shown in steps 4 and 5 display current alarm levels of methane (CH4) and oxygen (O2). During the Read Gas Levels procedure, if the GEM receives CH4 gas at or below these levels, or O2 gas at or above these levels, then an audible warning sound will occur to alert operator.

5. If KEY 2-Change Oxygen is pressed Figure 4.23 will appear. Using the numbered keys on the GEM keyboard input the new three digit level for oxygen (O2). All three digits must be entered and the decimal point is automatically inserted. Press KEY 0-Exit.

```
O2 Level is    00.0%
Level Required ?.0%

Enter level
```

Figure 4.23

Note: In steps 4 or 5, if necessary to correct an entry errors, use KEY 0-Exit to backspace by holding the key down for one second. In normal use, KEY 0 is quickly pressed and released to exit.

6. Press the KEY 0-Exit which returns you to the screen shown in Step 3 above. Press the KEY 0-Exit which will return you to the General Utilities Sub Menu Screen.

General Utilities KEY 7-ID Maintenance

The ID maintenance function allows each monitoring point on a site to be assigned a unique ID code. This code must be eight characters long. The characters can be any combination of letters and numbers. Typically, the landfill name or an abbreviation is used for the first four characters. After an ID code is entered (Step 4), you must also select the type of flow device (Accu-Flo, pitot tube, orifice plate) used at that ID location (Step 5). Depending on the flow device selected, you must also enter either: no data, pipe ID (inner diameter), or both orifice and pipe ID size.

1. Press 1 KEY at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the 9 KEY for More and because function 7 is not displayed press the 9 KEY one more time. Press th e 7 key - ID Maintenance on the General Utilities Sub-Menu Screen as shown in Figure 4.24.

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Figure 4.24

```
Please Enter ID
Numbers/Letters
ID xxxx?
                0-Enter
```

3. The screen represented by Figure 4.25 is displayed. Press KEY 2-Enter New ID and go to Step 4. Press the KEY 1-View/Edit/Select to see, change or delete ID information. Go directly to Step 10 . Press the KEY 0-Exit.

Figure 4.25

```
ID Maintenance
1-View/Edit/Delete
2-Enter New ID
                0-Exit
```

4. After pressing KEY 2- Enter New ID the following screen (Figure 4.26) appears to allow the inserting of letters or numbers in the ID code.

Figure 4.26

```
Please Enter ID
Numbers/Letters
ID xxxx?_ _ _
                0-Enter
```

5. Enter the new ID code as shown on the above screen using number or letters:
   For numbers press Number KEYS.
   For letters, press arrow KEY 1 or KEY 6.
   Enter each letter by pressing KEY 0.
   Use the BLUE KEY to switch between letters and numbers.
   (See Keyboard Information in the Getting Started Section at the beginning of this Manual.) After the final digit is inserted the KEY 0-Enter is displayed. Press if ready to enter, otherwise press and hold the KEY 0 and use it as a Backspace Key.
6. WHEN AN EXISTING ID CODE IS ENTERED, THE SCREEN SHOWN IN FIGURE 4.27 WILL APPEAR. Press the KEY 1-Yes to proceed. If KEY 2 -No is selected, the GEM returns to screen shown in step 3 above.

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```
IDxxxx xxxx Already
Exists, Overwrite?

1-Yes          2-No
```

Figure 4.27

7. The next screen displayed after step 5 is shown as Figure 4.28. It allows for the selection of a flow device. This choice is necessary for the GEM to calculate flow when readings are taken. The following choices are possible:
   Accuflo - 1V (1 1/2" Accuflo Model 150 Vertical Wellhead)
   Accuflo - 1 H (1 1/2" Accuflo Model 150 Horizontal Wellhead)
   Accuflo - 2V (2" Accu-Flo Model 200 Vertical Wellhead)
   Accuflo - 2H (2" Accu-Flo Model 200 Horizontal Wellhead)
   Accuflo - 3V (3" Accu-Flo Model 300 Vertical Wellhead)
   Accuflo - 3H (3" Accu-Flo Model 300 Horizontal Wellhead)
   Orifice Plate (Orifice diameter and pipe inner diameter are also required
   Pitot Tube - Pipe ID is required
   User Input (Orifice diameter and Pipe ID also required)

   Note: User input allows user to input flow in SCFM if known. A user without a flow device could use this screen to record velocity or other relevant data. (If using a Kurz meter, for example.)

```
Select Flow Device
Accuflo-1V
↑-Scroll Up
↓-Scroll Down     0-Cont
```

Figure 4.28

8. Press the KEY-0 to Continue. If an Orifice Plate, Pitot Tube or User Input flow device is selected, additional information will be required. If the pipe or orifice diameter screen appears, input the required size as necessary. Use the number keys on the GEM keyboard. The decimal point is automatically placed. Insert XX.XX inches or centimeters depending on the units selected. Press the KEY 0 to continue.
9. The ID Stored OK Screen is displayed for three seconds (Figure 4.29). The GEM then returns to the screen displayed in step 3 for additional ID input.

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Figure 4.29

```
ID Stored OK
```

10. To view ID information, press KEY 1 to scroll through stored ID codes and data.

Figure 4.30

```
ID ABCD1234        2-Edit
Accuflo-2V         3-Del
                   ↓↑-Scan
                   0-Exit
```

11. Press the arrow KEYS 1 and 6 to select desired ID codes (if not displayed).
    Press KEY 2-Edit to change flow data. Go to Step 7.
    Press KEY 3-Del to erase the ID code and its flow data. Go to step 11.
    Press KEY 0-Exit to return to ID Maintenance menu.

Figure 4.31

```
Delete ID?
ABCD0001
1-Yes        2-No
```

Note: In Step 10 the left side of screen displays an eight character ID code, with its related flow data below. Use arrow KEY 1 or KEY 6 to see all stored ID codes (and data) when more than one code is in memory. When a unique ID code is displayed, pressing KEY 2 (edit) allows that code's flow device and pipe/orifice data (if any) to be altered. Once KEY 2 is pressed the original "flow data" information is erased and new data must be entered. KEY 3 (del), is used as the initial command for the complete erasing of ID code and its flow data.

12. If the ID Data was erased by selecting the KEY 3-Del in the screen above the following screen will ask for confirmation. Press the KEY 1-Yes and the KEY 2-No.

13. The screen shown below will appear for three seconds before returning to step 10 if the KEY 1-Yes was pressed.

Figure 4.32

ID Deleted

Chapter 5-Read Gas Levels

This section instructs the operator in how to use the GEM-500 to collect data from LFG extraction system wells and other monitoring points. Several things should be done prior to beginning to collect data readings with the GEM.

The operator should be familiar with the following:

- Check the TIME/DATE (See General Utilities - 1)
- Charge the unit's nickel cadmium batteries (See Chapter 8 - Maintenance)
- Perform a ZERO PRESSURE (See General Utilities - 2)
- Perform a Field Calibration on the unit (See Section 2 - Field Calibration)

If the distance to the site where it will be used is great, put the GEM-500 in its protective hard case and secure it well. If the site is nearby, the soft case will offer enough protection. The GEM-500 is a sensitive measuring instrument. Vibration, shock and great temperature changes can alter the field calibration. It is suggested that the field calibration be performed just before using the instrument at the site. Additional calibration is sometimes necessary in the field during the day.

Warning

Review the warnings given in the beginning of this manual. The GEM-500 is NOT to be used in dangerous, explosive or confined atmospheres. Do not use it inside vaults, manholes, trenches or indoors. Do NOT block the exhaust port. If it is blocked while the pump is operating, the pressure could force the unit to over-pressurize and damage internal components and the case.

GEM-500 Hose and Wellhead Connection

The proper hoses must be connected from the GEM-500 to the wellhead in order to collect data. As mentioned in the Getting Started Chapter, the black striped Tygon hose with the external filter/water trap assembly was attached to the static pressure port on the GEM-500 (Figure 5.1). The almond-colored male quick connect goes on the end of this tubing to read the static pressure on the Accu-Flo Wellhead.

The clear Tygon hose is connected to the impact port of the GEM-500. A chrome plated brass male fitting was put on the end of the clear tubing. This chrome fitting is used to measure the impact pressure at the wellhead.

On the following page are examples of the Accu-Flo Wellhead, both vertical and horizontal models. Note the locations of the Static Pressure Port, Impact Pressure Port, Temperature Gauge, and Gas Sample Port.

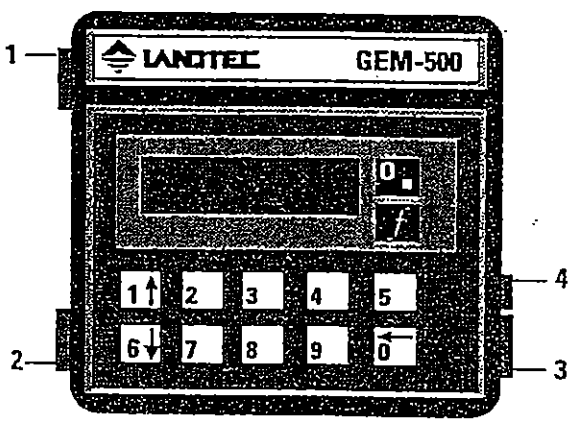

Figure 5.1

1. Static Pressure/Sampling Port—Measures static pressure when connected to wellhead staticpressure port by tubing.
2. Impact Pressure Port—Measures impact pressure when connected to wellhead impact pressure port by tubing.
3. Exhaust Port—This port must be kept clear. If blocked while operating, over pressurization and damage to internal components and case could occur.
4. RS-232 Port—Used for battery recharging, data downloading and temperature readings.

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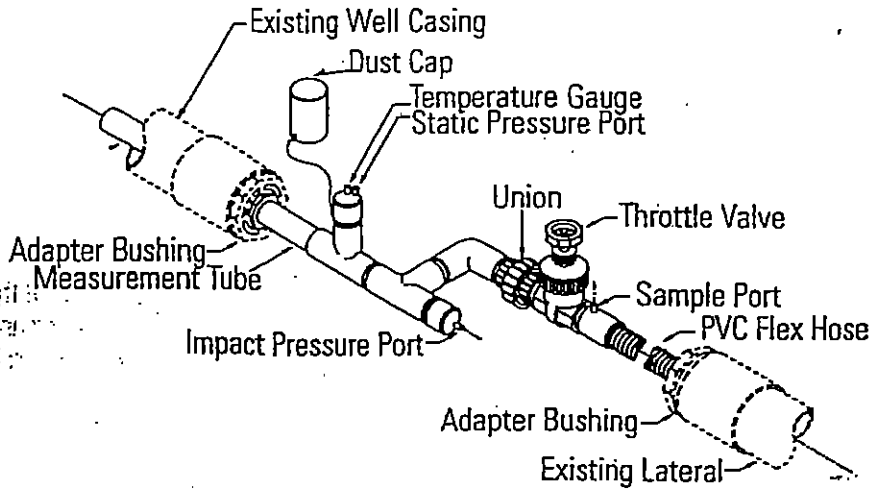
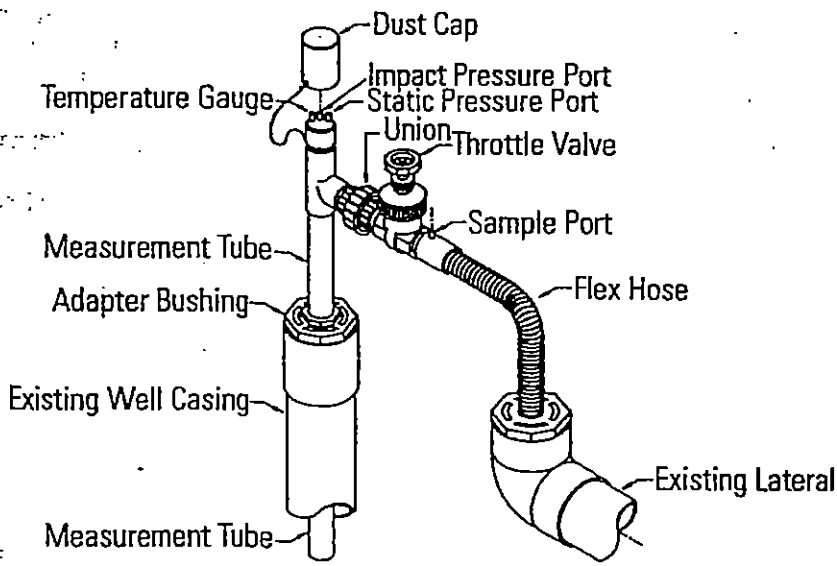
LANDTEC Horizontal Accu-Flo Wellhead

Figure 5.2



LANDTEC Vertical Accu-Flo Wellhead

Figure 5.3



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Read Gas Levels Screen Tree Diagram

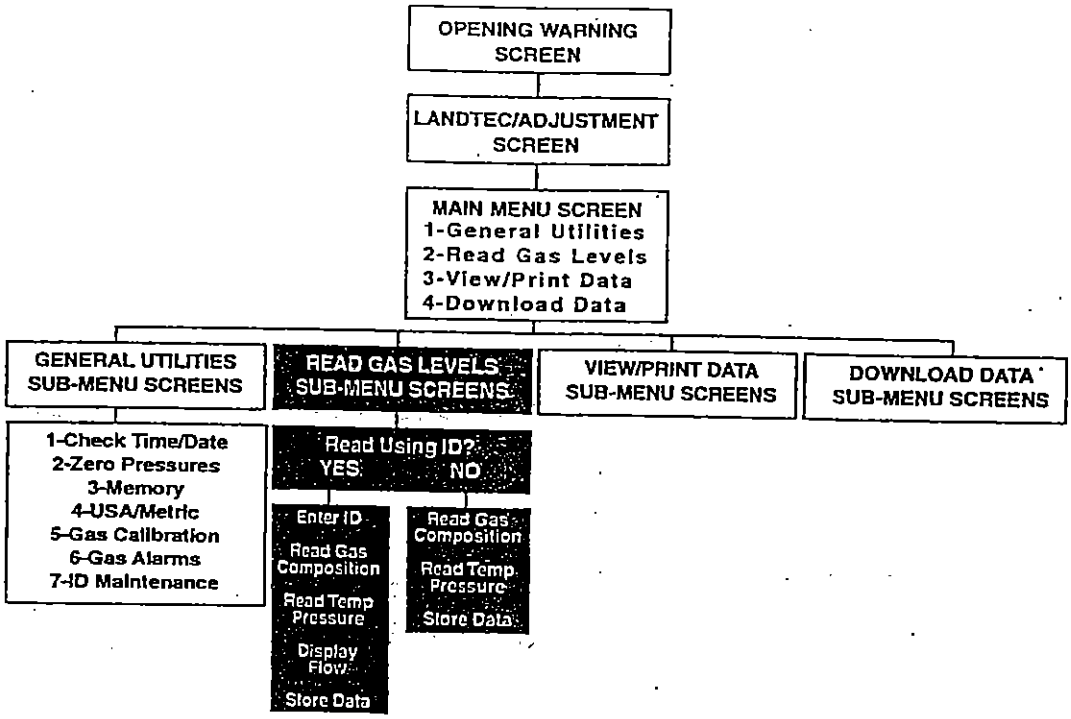

Figure 5.4

As shown in the screen tree diagram (Figure 5.4), there are two paths depending on whether or not an ID has been defined and stored in the GEM-500. Without the flow device, which is stored with the ID, it is not possible to calculate and display flow or store the data. IDs can be added during this procedure at several other points.

Read Gas Levels Menu

1. Press KEY 2 at the Main Menu Screen (Figure 5.5) for the Read Gas Levels Screen.

Figure 5.5

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

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2. The Read Gas Levels Screen is displayed as shown in Figure 5.6.

Figure 5.6

```
Read Using ID?

1-Yes  2-No  0-Exit
```

3. The normal response to this screen is KEY 1-Yes. If the KEY 2-No is selected, gas flow cannot be calculated and the data cannot be stored because there is no ID with which to associate the data. By pressing KEY 0-Exit, the user is returned to the Main Menu Screen. Press the KEY 1-Yes and the Enter ID Screen (Figure 5.7) is displayed. If KEY 1-scroll is selected, the second screen below will appear (Figure 5.8). Press KEY 1 or KEY 6 to scroll through the ID information and press KEY 2 to select the desired ID. Selecting KEY 2-Manual will present the third screen (Figure 5.9). Note the arrow step and KEY 0-Enter only appear if letters have been selected.

Figure 5.7

```
Manually enter ID or
scroll through?

1-Scroll   2-Manual
```

Figure 5.8

```
1) ID XXXX XXXX
↓↑ - Scroll
 2 - Manual      0-Exit
```

Figure 5.9

```
Please Enter ID
Numbers/Letters
ID XXXX ?
↓↑  - Step      0-Enter
```

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4. An ID allows each monitoring point on a site to be assigned a unique identification. This code must be eight characters long. The characters can be any combination of letters and numbers. Typically, the landfill name or an abbreviation is used for the first four characters and one letter and three numbers for the second four characters. The well IDs and data displayed is used for example purposes only on the Enter ID Screen.
5. Enter ID code using number and/or letter mode:
   For numbers, press Number KEYS
   For letters, press KEY 1-Cursor-Up and or KEY 6-Cursor-Down.
   Enter each letter by pressing KEY 0 Enter.
   Use Blue Number/Letter Toggle KEY to switch between numbers and letters.
   (See Chapter 1, The Keyboard Section for further information)
6. After the ID is input, one of two screens will appear. The No Reading for ID Screen (Figure 5.10) appears when the ID is not found (or because the correct ID was not entered). To re-enter the ID information, press KEY 1. Press KEY 2 to retry and re-enter to ID number. KEY 0-Abort returns you to the General Utilities Menu. When the ID is found in the GEM-500's memory, the screen in Figure 5.11 is displayed. Assuming the correct ID was found, press the KEY 1-Read to continue. If the ID codes is incorrect, press KEY 2-Retry and re-enter the information as described previously. To make corrections, press KEY 3-Edit and follow the procedures described in the ID maintenance section.

Figure 5.10

```
No Reading for ID
     XXXX XXXX
1-Enter ID info
2-Retry        0-Abort
```

Figure 5.11

```
ID ABCD1234   1-Read
Accuflo-2V    2-Retry
              3-Edit
              0-Abort
```

7. Press the 1 KEY- Read Gas Levels and Figure 5.12 will appear.

Figure 5.12

```
CH4  00.0% | 1-LEL 2-Cont
CO2  00.0% | 5-Pump On/Off
O2   00.0% | 9-Last Data
BAL  00.0% |        0-Exit
```

8. Press KEY 5-Pump to turn pump on and draw a gas sample from the wellhead into the GEM-500. Allow readings on left side of screen, to become stable before pressing KEY 2-Continue. A timer is located on the screen to monitor time pump is running. This will automatically turn off the pump. If you want to turn off the pump without proceeding to the next screen, press the KEY 5-Pump again and the pump will be turned off. Press KEY 1-LEL to display the Lower Explosive Limit Screen. Exit from the LEL Screen by pressing KEY 0-Exit.

Figure 5.13

00.0 % CH4 Gas	5-Pump ON/OFF
00.0 % CH4 LEL	0-Exit

The LEL screen is shown in Figure 5.13. The lower explosive limit of methane by volume in air is 5%. This means a five percent concentration is explosive. For safety reasons, some rules require that methane levels do not exceed 1% methane or 20% LEL or 1 1/4% methane which is 25% LEL. A 5% methane level is 100% of LEL. Press KEY 0-Exit to return to previous screen.

9. From the Read Gas Levels Screen (Figure 5.12) press KEY 2-Continue for the Temperature Screen (Figure 5.14). Press KEY 1-Enter Temperature as shown on the following screen (Figure 5.15). This is read from the temperature gauge on the Accu-Flo Wellhead. Enter the three digit temperature value using the Number KEYS. (XXXo F or C depending on units selected.) For example, if the gas temperature is 95 degrees enter 095. Note all digits must be entered. When done press KEY 0-Continue and return to the screen shown in Figure 5.14. Ensure the differential and static pressures are stabilized before continuing. Press the KEY 2 to continue.

Figure 5.14

T——°F	1-EnterTemp
SP+0.45"	3-ZeroPressure
DP-00.0"	9-Last Data
0-Back	2-Continue

Note: If the optional temperature probe is used, it should be plugged into the RS-232 port on the right side of the GEM. It will automatically display the gas temperature without having to enter it as shown below.

Figure 5.15

EnterTemp
?– °F

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10. Press the 3 KEY - Zero Pressure before proceeding. This is necessary because by taking a LFG sample in the prior step, you have pressurized the impact port pressure transducers. Warning Disconnect hoses before zeroing screen will appear (Figure 5.16). Disconnect all the hoses from the wellhead. Press any key to continue.

Figure 5.16

```
WARNING: Disconnect
hoses before zeroing

Press any key
```

11. The following screen, which is also used in the General Utilities function, 2 - Zero Pressure will appear (Figure 5.17). Press KEY 1 to zero pressure. The Zeroed OK Screen is displayed for 3 seconds and then returns to the above screen. Press the KEY 0-Exit. This returns you to the Temperature/Pressure Screen.

Figure 5.17

```
     Static  +00.2"H20
Differential -0.30"H20
1-Zero Pressures
                0-Exit
```

Note: The units displayed will be inches of water column or MB depending on USA or Metric measurements units selected.

12. Press KEY 1 to zero pressure. The Zeroed OK screen is displayed for three seconds and then returned to previous screen (Figure 5.17) Press KEY 0-Exit. The Temperature/Pressure screen will appear (Figure 5.14).

13. Connect hoses as instructed previously. Allow instrument to read and press KEY 2-Continue which proceeds to the Flow/ Btu Screen (Figure 5.18). If no well I.D. exists, you can store at this point.

Figure 5.18

```
SCFM 0000 Btu OOO3/h REF
SCFM 0000 Btu OOO3/h ADJ
6-Store          8-Log
                 0-Back
```

Note: The units displayed will be SCFM (Standard Cubic Feet per Minute) and Btu (British Thermal Units) only if USA units are selected, otherwise units will be displayed in metric.

14. At this point, if you want to change the flow, adjust the control valve on the wellhead. Within a few seconds, the new flow is shown. When satisfied with the flow adjustment press the KEY 6-Store to display the Wellhead Comments Screen

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(Figure 5.19). Press KEY 0-Back to return to the prior screens and review or re-take data.

Figure 5.19

```
Select Comments
      Flex Hose
↑-Scroll Up        2-Select
↓-Scroll Down      0-Cont
```

15. There are eight potential comments that can be noted on the Wellhead Comments Screen shown above: Flex Hose, Valve, Casing Height, Well Bore Seal, Labeling, Air Leakage, Water Blockage, and Other. These brief notations can be made to remind the operator of maintenance or problems encountered at or near this well ID. Press KEY 2-Select to add the condition displayed on the screen to the data that is stored when KEY 0-Store is pressed. The Readings Stored Screen (Figure 5.20) is displayed for three seconds before returning to Flow/Btu Screen.

Figure 5.20

```
Readings Stored
```

Read Gas -Logging Function

Automatic gas data logging is possible with a GEM-500 as long as the batteries are charged. The logging function requires that the well being logged have an ID stored in the GEM-500. The logging time interval is from five to 60 minutes.

1. The well to be logged must have an ID already stored in the GEM-500. See the General Utilities instructions for function KEY 7-ID Maintenance. ID's can also be input as shown above during the Read Gas function already discussed above.
2. The hose to the gas sample port to the GEM-500 must be connected.
3. The Logging Screen is accessed from the Flow/BTU Screen (Figure 5.21). Press KEY 8-Log.

Figure 5.21

```
SCFM 0000 Btu OOO3/h REF
SCFM 0000 Btu OOO3/h ADJ
6-Store            8-Log
                   0-Back
```

4. The Logging Interval Screen appears as shown in Figure 5.22. Input a time interval of five to 60 minutes between sampling intervals from the GEM-500 Keyboard. If an unacceptable time is input (i.e. less than five minutes or more than 60 minutes), an "Invalid Duration - Please Enter Again" message is displayed for three seconds before returning to Figure 5.22.

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Figure 5.22

Enter Required
Logging Interval
Min 05, Max 60 Mins
Interval = ??

5. The next screen (Figure 5.23) is used to select the running time of the GEM-500's pump. There are five choices ranging from 15 to 90 seconds as shown on the following screen (Figure 5.23). If an invalid time is input, an "Invalid Time - Please enter again" message will be displayed for three seconds before returning to the screen below. Input time and press KEY 0-Exit.

Figure 5.23

Select Running Time
for Pump
15, 20, 45, 60, 90 secs.
Time = ??

6. The Logging Screen is then displayed (Figure 5.24). Logging will continue as long as the battery power in the GEM-500 can power the pump. To end logging, press KEY 0-Stop Logging. When the logging function is ended, it returns to the Flow/BTU Screen (Figure 5.18). Note that unit will not operate accurately with charger plugged in and the last few readings before battery fails may be inaccurate.

Figure 5.24

LOGGING

0-Stop Logging

7. Press KEY 0-Stop Logging and the Flow/Btu Screen re-appears. Press KEY 0-Exit twice to return to the Main Menu.

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Chapter 6-View/Print Data

The GEM-500 can be connected to a standard 132-column serial computer printer and produce a hard copy of the data stored in the memory. An optional cable is required. The data can also be viewed on the GEM-500's screen. Normally the Print function is done daily or before the GEM-500's memory is cleared in the General Utilities function 3 - Memory.

Note: Never make data or electrical connections between the GEM-500 and printer, a computer or battery charger with the power on. Both units should be turned off and the connections made before turning them back on.

View Data

1. From the Main Menu, select KEY 3-View/Print Data from the Main Menu Screen as shown in Figure 6.1.

Figure 6.1

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

2. The Select Screen appears as shown in Figure 6.2. Choose KEY 1-View Data or KEY 2-Print Data. To return to the Main Menu Screen press KEY 0.

Figure 6.2

```
Please Select
1-View Data
2-Print Data
0-Main Menu
```

3. Press KEY 1-View Data from the Select Screen and the View Data Screen (Figure 6.3) appears. Press KEY 1 (With Specific ID) to see only one data point. Press KEY 5 to scroll through all the data.

Figure 6.3

```
VIEW DATA

1. With Specific ID
2. All Data
```

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4. To select a specific ID, press KEY-1. As shown below, scroll through IDs by pressing KEY-1 and scroll through IDs by pressing KEY-1 (Figure 6.4) or manually entering ID by pressing KEY-3 (Figure 6.5).

Figure 6.4

```
ID XXXX XXXX

↓↑ - Scroll
 2 - Select        0-Exit
```

Figure 6.5

```
Please Enter ID
F-Numbers/Letters
ID XXXX ----
```

5. Press KEY 1-View Data and the screen Enter existing ID code (already in memory) using number screen and/or letter screen:
   For numbers, press Number KEYS
   For letters, press arrow KEYS 1 or 6.
   Enter each letter by pressing KEY 0 (enter)
   Use Blue KEY to switch between letters and numbers.
   Press KEY 0 - Continue after entering ID.

6. If the data is not found, the following screen (Figure 6.6) is displayed.

Figure 6.6

```
No Reading for
XXXX XXXX

1-Another ID    O-Exit
```

7. If KEY 1 (With Specific ID) or KEY 5-All Data is selected in step 4 (above), the following screen (Figure 6.7) is displayed. Use KEYS 1 and 6 on the Keyboard to move up or down the data displayed. Press KEY 5 to toggle between the two screens of data available for each ID as shown previously.

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```
USE: ↓↑-Scan        0-Exit
2-Go First        7-Go Last
5-Change data screen
Any key to continue
```

Figure 6.7

8. There are two data screens for each ID as shown below (Figures 6.8 and 6.9). KEY 5 toggles between the two data screens. Press the KEY 1-UP Arrow or KEY 6-Down Arrow to scroll through the data. Press KEY 0 to exit.

```
      ID XXXX XXXX
TAKEN   09:45  06/10/92
CH4 45.3%    CO2 48.1%
O2  01.6%     BAL 5.0%
```

Figure 6.8

```
SP + 05.8"      DP  +0.00"
T  095°
Scfm 115   Btu 000/h ref
Scfm 435   Btu  000/h adj
```

Figure 6.9

Print Data

1. If data is to be printed, connect RS-232 cable (provided) from the GEM-500 RS-232 port to the printer converter. The converter should be connected so the arrows point towards the printer as indicated on converter label. Connect the converter to the 25-pin input port of 80 column printer (Figure 6.10). To support RS-232 communications, the printer should have the following settings selected: Baud Rate-2400, Data Bits-8, Parity-none, one stop bit. Turn printer on. Turn GEM-500 on.

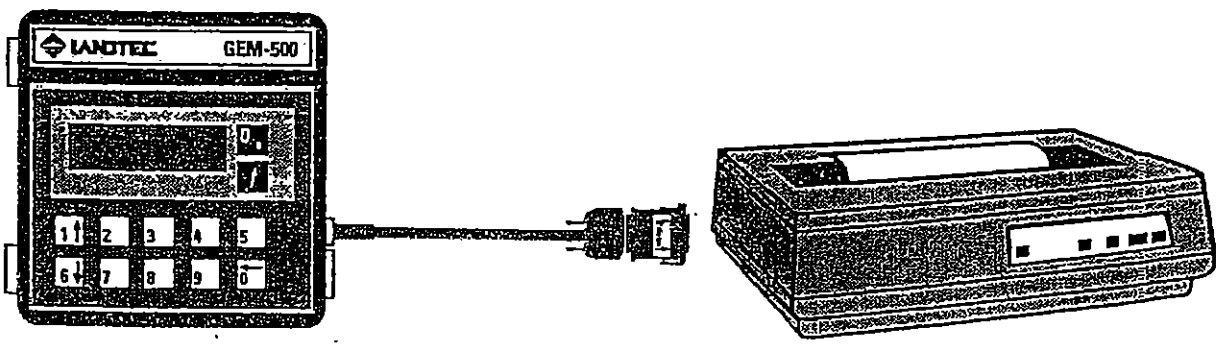

Figure 6.10

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2. From the Main Menu Screen select KEY 3-View/Print Data from the Main Menu Screen.

3. The Select Screen appears as shown below (Figure 6.11). Choose KEY 1-View Data or KEY 2-Print Data. To return the Main Menu Screen press KEY 0.

Figure 6.11

Please Select
1-View Data
2-Print Data
0-Main Menu

4. Press KEY 2-Print Data and the next screen will appear (Figure 6.12). Press KEY 1-With Specific ID to print only one data point. Press KEY 5 to print all the data.

Figure 6.12

PRINT DATA

1. With Specific ID
2. All Data

5. The next screen (Figure 6.13) shows the results if KEY 1 is pressed. To scroll through the ID list, press KEY-1 or KEY 2 to manually enter the ID.

Figure 6.13

Manually Enter ID or Scroll Through?

1-Scroll 2-Manual

6. If KEY-2 is pressed, the following screen (Figure 6.14) is displayed. Enter existing ID code (already in memory) using number screen and/or letter screen.

For numbers, press Number KEYS
For letters, press arrow KEYS 1 or 6.
Enter each letter by pressing KEY 0 (enter)
Use Blue KEY to switch between letters and numbers.
Press KEY 0 - Continue after filling in ID.

Please Enter ID
Numbers/Letters
ID XXXX----

Figure 6.14

Note: In the steps below, if the printer cannot print (no paper, etc.) a printer-error screen will appear on the GEM-500. Press KEY 6-RETRY or press KEY 0-Exit to end

7. If KEY 5-All Data is selected in step 2, the following screens are displayed depending on the stage of printing (Figures 6.16, 6.17 or 6.18).

Printing-Please Wait

Figure 6.16

Printing Aborted

0-Exit

Figure 6.17

Printing Complete

0-Exit

Figure 6.18

Output - Print Report Format

The report format is shown below. The stored data is sorted by time, date, and ID

Time	Date	ID	CH4	CO2	O2	Bal	Pressures		Old			Adjusted	
		%	%	%	%	Stat	Diff	Temp	Flow	BTU	Flow	BTU
						" H2O	" H2O	_F	Scfm	/cf	Scfm	/cf

Chapter 7-Download Data

This procedure covers the electrical connection of the GEM unit to IBM PC compatible host computer via an RS-232 cable, installation of the GEM software program (contained on READ_GEM floppy disk) into a file on the compatible host computer, calling up the file on the host computer's screen, and then downloading data from GEM unit into host computer by following instructions on the GEM's screen and on the computer.

Information is normally downloaded after each days' readings are taken. The stored data is also downloaded before the GEM's memory is cleared because it is full (see General Utilities -3 Memory).

Note: Never make data or electrical connections between the GEM and printer, a computer or battery charger with the power on. Both units should be turned off and the connections made before turning them back on.

The optional RS-232 cable is plugged into the GEM using a special plug. The temperature probe, battery charger and RS-232 cable all use the same input plug. Do not try and substitute any other cables or plugs than ones provided by LANDTEC. The plug end of the RS-232 cable that goes into the host computer is a standard serial cable. Plug it into the serial port when the computer is turned off.

Installing the Download Program on the Host Computer

LANDTEC's UNI-DOWN program software converts the binary data from the GEM-500 to ASCII format. Data in ASCII format can be imported into LOTUS* 1-2-3TM, Excel*TM and many other programs that accept comma delimited data files. LANDTEC is currently developing a pc based landfill data management system that will upload the GEM files into a database to produce management and regulatory reports.

1. Turn on host computer and go to DOS (Disk Operating System) prompt.
2. Insert LANDTEC's GEM download floppy disk into host computer floppy drive.
3. Install the GEM software into a sub-directory of your choice, using the drive of your choice, by typing the following instructions in bold face (assuming drive A was the floppy where the source diskette is located and C was chosen as the destination drive).
   C:\>MD GEM <ENTER>
   C:\>CD GEM <ENTER>
   C:\>GEM> COPY A:*.* <ENTER> C:\GEM<ENTER>
4. Remove the diskette in drive A. Store it in a safe place. You may want to make a duplicate of it as a backup.
5. GEM software program is now installed on the host computer.

Starting the Download Program on the Host Computer

1. Turn off the computer and attach the serial connector to COM Port 1 or 2 of the computer. Plug the RS-232 connector into the GEM and connect the remaining end of connector to the RS-232 connector as shown in Chapter 6, Figure 6.10. Turn on the host computer.
2. At the C> prompt on the host computer, change to the GEM sub-directory by typing:
   C:\> CD GEM <Enter>
   C:\> READ_GEM<Enter> If connected to COM Port 1
   or READ_GEM COM2 <Enter> If connected to COM Port 2.
   or READ_GEM SPLIT <Enter> If time/date field to be split (see below)
   or READ_GEM SPLIT COM2 <Enter> If time/date field to be split on COM Port 2
   The preferred version is READGEM SPLIT.
3. The next screen to appear is shown as Figure 7.1. The screen is somewhat confusing. The message on the right side is discussing a feature in the software which selectively downloads data by ID Code, by time or by date. If the GEM contains data from two different landfills, OTAY and OXND, by filling in the first part of the code below with OXND XXXX, only the data from OXND will be downloaded.

Note: If only the data taken on a specific day were desired, by filling in the date in the proper field, would download only that data from the GEM. This might be in response to a request for listing all the reads taken on a specific day. It is similar for selecting a specific time. Various fields may be combined in any manner for a selective sort of GEM data on this screen.

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GEM Readings Transfer Utility Version 1.1	09/06/93
Please prepare to download readings from the GEM readout: 1) Switch on the GEM. 2) Connect RS-232 link to COM 1. 3) Press KEY 0. 4) Select option 4-Download data by pressing KEY 4. 5) Wait for data to be received. WAITING	Press RETURN to download all data from the unit. Press "?" to examine data. It is also possible to store only data based on the following: Code, Time, Date. Using the arrow keys, position the cursor then enter the correct digit. Only files where the data entered corresponds to the data in a file will be downloaded. Where "X" equals any digit. Code Time Date **** **** **.** **/**/**
Landfill Control Technologies	
Press ESC to exit.	

Figure 7.1

4. When done with any selective sorting discussed in step 3, press the Enter Key on the host computer and proceed as follows.

5. Turn on the GEM after the RS-232 Cable has been connected to both the computer and the GEM. Press the RED ON/OFF switch on the GEM. After the normal Warning Screen the RS-232 MODE Awaiting Instruction Screen appears (Figure 7.2). Press KEY 0 to proceed to the Main Menu Screen. Press KEY 4 - Download Data and the screen shown below appears on the GEM.

RS-232 MODE

Awaiting Instruction from computer

Figure 7.2

6. Meanwhile, the host computer's screen appears as shown in step 3 above. A message appears on the right side saying Reading Download xxx. As each record is read the xxx digits keep increasing until all the data is read into a temporary file in the host computer.
7. By pressing the Shift, the data can be scanned on the host computer (Figure 7.3). The data scan screen is shown below. The down cursor arrow (or up cursor arrow) can be used to scroll through each ID record that was downloaded.

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Figure 7.3

```
GEM Readings Transfer Utility Version 1.1        09/06/93

  ID: OTAY0809      13:00 08/09/93
 CH4: 40.6%
 CO2: 28.0%         Static: -3.5"H20
  O2: 0.2%
 Cal: 31.2%         Diff'l: +.34"H20
Temp: 96°F

      Old Flow: 21 Scfm
      Adj Flow: 19 Scfm
    Old Energy 140 Btu/cf
    Adj Energy: 129 Btu/cf

              Landfill Control Technologies
Press ESC to exit.
```

8. This step is CRITICAL. Press the <Enter> key on the host computer. A box is displayed and a file name of up to eight characters plus three character extension must be input. Press <Enter> after inputting file name. Otherwise, the temporary file in the host computer is not saved. An example is shown as Figure 7.4.

Figure 7.4

```
GEM Readings Transfer Utility Version 1.1        09/06/93

Please prepare to download readings      Press RETURN to download all data
from the GEM readout:                    from the unit. Press "?" to examine
1) Switch on the GEM.                    data. It is also possible to store only
2) Connect RS-232 link to COM 1.         data based on the following: Code,
3) Press KEY 0.                          Time, Date. Using the arrow keys,
4) Select option 4-Download data         position the cursor then enter the
   by pressing KEY 4.                    correct digit. Only files where the data
5) Wait for data to be received.         entered corresponds to the data in a
                                         file will be downloaded. Where "X"
      WAITING                            equals any digit.
                                            OTAY0809.PRN
              Landfill Control Technologies
Press ESC to exit.
```

9. The GEM can be turned off after the data is downloaded. It can now be unplugged and returned to service or re-charged with the battery charger as required.
10. By pressing the ESC key SEVERAL TIMES on the host computer. You can back out of the download program to the DOS C> prompt.
11. A daily back-up or download is strongly recommended.

Chapter 8-GEM-500 Well ID Manager

This software allows ID information to be sent to and from the GEM readout. ID information can be entered on a computer, stored to disk, and transferred to the GEM. ID information in the GEM can be downloaded to the computer, edited, stored to disk, and sent back to the GEM.

User Control

The software is controlled from a menu of options. The user selects the option using the cursor keys. A detailed description of the menu appears at the bottom of the screen. Main menu options include:

- Well ID Function
- User Defined Comments
- Clear Function
- Show GEM Memory Statistics
- Configure
- Exit

Connecting the Computer to the GEM

Connect the RS-232 download lead to the desired COM port of your computer, and connect the 'Lemo' connector to your GEM. Select option 4-Download from the main menu of the GEM.

Installing the software on a hard disk

Insert the disk in drive A: and create a directory on the hard disk for the software, and copy the program file on to the hard disk:

C:\> MD GEM	[Enter]	Create a directory
C:\> COPY A:*.* GEM	[Enter]	Copy the files
C:\> CD GEM	[Enter]	Change to the directory
C:\> IDBRIDGE	[Enter]	Run the software

Select the Set default COM port option from the menu on the PC software. Select either COM1 or COM2. The software is now ready for communications.

Well ID Functions

Create New ID Set

This option allows a completely new ID set to be created ready for transfer to GEM or storage to disk. The Well ID Functions window is displayed. You may now enter well ID information. See the Edit ID Information section for details about entering and editing ID data.

Edit ID Information

The option also ID data to be edited using the computer, ready for saving to disk or transfer to GEM. The currently loaded ID set is displayed. If there are more IDs than fit in the screen the user can scroll through the list using the Page Up and Page Down keys. All ID codes must have 8 characters and the characters must be either A..Z or 0..9. To select a flow type use the left or right cursor keys to select the flow type field. A list of available flow types is displayed, use the up and down cursor keys to select the desired type and the press Enter or left/right cursor key to store the selection. It is only possible to move the cursor on to a different ID when a valid entry has been made. A beep sound is made if an ID entry is invalid. Correct the mistake before continuing. Press F2 to store the changes to the ID information into the computer's memory. You will now need to either select Save IDs to disk or Send IDs to GEM option.

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Send IDs to GEM

This option allows the currently loaded (from GEM or disk) ID set to be transferred to the GEM. The user will be prompted to select option 4-Download on the GEM if this has not already been done. The data will then be sent to the GEM. The ID codes will be displayed as they are transferred.

Receive IDs from GEM

This option allows IDs already stored in the GEM to be downloaded to the computer for storage to disk or editing. The software will prompt the user to select option 4-Download if this has not already been done. The ID code for each GEM ID will be shown as the computer receives it. Once all of the IDs have been read they will be shown in the edit screen. You can now edit the data, or press Esc to return to the main menu. To store the data to disk select the Save IDs to disk option. For editing ID data see the description under Edit ID Information.

Save IDs to Disk.

This option will store to disk, in an 'ASCII' file, the currently loaded ID information. Cursor must be under last code entered (use arrow key) to save ID. A file selector is displayed for the user to select a file. Enter a new filename or select a previously saved file. Then press enter, the file has now been stored. The files are stored to disk in an ASCII format. The file can be edited using any ASCII text editor, i.e. one that does not introduce control characters into the file. When editing these files manually it is important to note that the flow types must be one of the following, and must be entered correctly. Also for Orifice Plates the first value is the Pipe Inside Diameter.

Flow Types
ACCUFLO-1V
ACCUFLO-1H
ACCUFLO-2V
ACCUFLO-2H
ACCUFLO-3V
ACCUFLO-3H
ORIFICE PLATE
PITOT TUBE
USER INPUT

Note: The file name entered should always have the extension .IDM. unless the user specifically enters something different, however only files with the IDM extension are displayed in the file list.

Load IDs from Disk

This option allows previously saved data to be loaded into the computer for editing or transfer to GEM. The software will display a file selector showing all files with the filename extension IDM (all ID files must have this extension). Use the cursor keys to select the desired file and press Enter. If you know the filename you may type the name directly. Once the file is loaded, the Edit option shows the ID information. You can press Esc to return to the main menu.

Note: If an ID that already exists is sent to the GEM, the one in the memory of the GEM will be overwritten. If the ID does not already exist it will be appended to the list in the GEM. Transfer will be aborted if there is insufficient memory in the GEM to store all ID codes and an error message will be displayed on the PC.

Clear Functions

Clear IDs in GEM

This option will delete the ID information in the GEM. Select the option and press F1 to delete the ID information.

Clear readings in GEM

This option will delete the readings in the GEM. Select the option and press F1 to delete the all readings.

Clear User Defined Comments in GEM

Erases user defined comments in GEM.

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Show GEM Memory Statistics

This option shows how much unused memory the GEM has, also the amount of memory used by IDs and by readings. The available memory is shared between readings and IDs, so the more IDs in the GEM, the less memory is available for data.

NOTE: If changes have been made to the ID information the computer will warn the user before either Exiting, Loading IDs from disk, or receiving IDs from the GEM. This option should be used with caution as it is not possible to retrieve the data once it has been deleted.

Configure

Configuration File

The configuration file contains the default parameters for Data Directory, COM port, and Units (metric or imperial).

File Format (GEM.INI)
[GEM ID Manager]
Path=directory name
Port=n
Units=type
where, n is either 1 for COM1 or 2 for COM2
type is either 'metric' or 'imperial'

Set Units to Imperial/Metric

This option is swaps between metric and imperial units when editing the ID information. The state of this option is stored to disk in a configuration file and so will be used the next time the software is loaded.

Set Data Directory

The default data directory is used to define which path name is used for Load IDs from disk and Save IDs to disk options. The path name is stored in a configuration file and is used next time the software is loaded.

Set default COM Port

This option allows either COM1 or COM2 to be used for RS-232 communications. Press '1' for COM1 or '2' for COM2. This setting is stored in a configuration file.

Sort Well IDs

Option On/Off enables well IDs to be sorted alphabetically after being received from the GEM.

User Defined Comments

1. Create new comments. Create new set of user defined comments.
2. Edit Comments.
3. Send comments to GEM.
4. Receive comments from GEM.
5. Save comments to disk.
6. Load comments from disk.

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Chapter 9-Maintenance

Servicing

The unit has been electronically and functionally tested before leaving the factory. It is recommended that with normal usage, the GEM-500 be serviced every six months for routine factory servicing, maintenance and re-calibration.

Cleaning

The polycarbonate membrane panel may be wiped clean with soapy water and a damp cloth if required. We do not recommend any other cleaning agents. Protect the GEM-500 by keeping it in its protective soft case.

Sunlight and Heat

The unit should not be left out in direct sunlight for long periods of time as this will raise the temperature inside the case which could cause damage to components. The GEM-500 may not operate or may operate erratically if it gets too hot. Let it cool before trying to use it.

Dustcaps

Always keep the protective dust caps in place when ports and connectors are not in use.

Filters

The unit is equipped with two filters. One filter is external to the GEM-500. It is in-line in the sample hose. The filter is easily accessed by unscrewing the filter holder. A second filter is inside the GEM-500 and is located just inside the sample port inlet. This filter can be accessed by unscrewing (counter-clockwise) the port using a screwdriver or a small coin. Both filter holders are sealed with o-rings. Periodically inspect the o-rings to check their condition. Replace the o-rings if they become nicked, cut, swelled or otherwise damaged. The GEM-500 unit is shipped with a spare filter of each type. Only genuine LANDTEC filters should be used.

Replace the filter when the sample pump has difficulty drawing a sample of gas into the unit and a "Flow Fail" message appears on the screen and a continuous audible warning is heard.

If the filter becomes wet a "Flow Fail" message appears on the screen and a continuous audible warning also be heard.

Storage and Travel

Store the GEM-500 in its protective hard case when taking it from site to site. This offers maximum protection and brings along all the required accessories for the GEM-500. The GEM-500 is a delicate instrument. When charging the battery overnight, the GEM-500 can be stood upright or laid flat. If the unit is to be stored for a long period, charge the internal batteries prior to storage. Re-charge the unit every two months during storage and store flat or the oxygen sensor may ultimately dry out. This condition can be corrected with normal use.

Battery Charging

Please follow these instructions carefully.

1. The internal battery pack of the GEM-500 is designed to be recharged many times but as with all nickel-cadmium cells, certain rules should be observed or the batteries will not provide their full power or operating time.
2. Let the batteries almost fully discharge before re-charging. Do not top off an almost full battery charge or memory patterns will be established and the battery will not provide its full capacity.
3. When charging the batteries, let them charge at least 12 hours, 14 hours is preferred.
4. Never let the batteries charge for more than three or four days.
5. Disconnect the charger from the GEM-500 after the batteries have charged.
6. Never try to operate the GEM-500 while the batteries are re-charging.

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Warning: Only charge a GEM-500 with a LANDTEC Battery Charger (provided with the unit).

Note: Heat from the battery compartment makes the front of the GEM-500 (where the GEM-500 label is located) warm to the touch while the batteries are charging.
Note: If the GEM-500 is repeatedly given small "top-off" charges, the battery capacity can be reduced. To restore the battery to full capacity, totally discharged the unit and then charge it for a full 14 hour period. Prior to recharging the unit, run the pump to completely discharge the battery.

Battery Shut-Off

A circuit within the GEM-500 continuously monitors the battery voltage. If the battery voltage falls below a predetermined level, the unit will automatically shut itself off in order to prevent memory loss. If the unit shuts itself of, the unit requires a full charge of 14 hours to restore the battery to its maximum level.

Battery Low Symbol

There is a Battery Symbol used on the top right corner of the GEM-500's display screen. It displays as the battery capacity reaches about 10% of full charge. There are only about 30-45 minutes of full pump power left in the GEM-500 when the symbol is displayed.

Automatic Power-Off

The GEM-500 has an automatic power-off timer to conserve battery power. If no key is pressed for 15 minutes, the unit will automatically switch itself off (no stored readings will be lost).

Emergency Battery Power

In emergencies, the GEM-500 may be operated with 6 "C" sized alkaline batteries. To use alkaline cells, remove the nickel-cadmium battery pack by using a Phillips screw driver on the back battery compartment of the GEM-500. Insert the alkaline battery "C" cells.

WARNING: Do not use the battery charger for standard alkaline batteries—they can explode if recharged.

Chapter 10-Troubleshooting

The GEM-500 does not turn on or operates erratically

The unit may be too hot

Do not leave in car trunks or expose to high temperatures.

The batteries are so low that they will not display any screens

This is done to protect the GEM-500's memory. Recharge the unit for 14 hours.

The GEM-500 Displays ****** or >>>> in Some Fields

The GEM-500 substitutes the symbols because there is no valid information to display. Typically a temperature needed to be input or a pressure reading is required to calculate flow. If data is missing the symbols are substituted.

The Screen Says "FLOW FAIL" With a Continuous Audible Warning

One or more of the GEM-500's filters are blocked and need to be changed. The filters may be dirty or wet. Change the filters as instructed in Section 8 - Maintenance.

The Carbon Dioxide Readings Drift Erratically

Leave the GEM-500 in its soft case. Do not place a heat source (including placing the GEM-500 on very hot soil, or the palm of your hand being placed on the back of the GEM-500) on the back of the GEM-500 below the battery compartment. If it persists after the above problems have been corrected, perform a Field Calibration.

The Readings Taken by GEM-500 are Not What is Expected

Use Calibration Gas to test your GEM. With its known composition, you will immediately know the if the GEM-500 is in calibration. Field Calibration may be necessary. Once you have extablished the accuracy of the GEM-500 on calibration gas, you should accept the results it is providing.

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Chapter 11-Measurement Units and Specifications

Measurement Units

Screen 1

Type	Displayed As	USA (Imperial)	Metric (SI)
Methane	CH_4%	% by volume	% by volume
Carbon Dioxide	CO_2%	% by volume	% by volume
Oxygen	O_2%	% by volume	% by volume
Balance	BAL	% by volume	% by volume

Screen 2

Type	Displayed As	USA (Imperial)	Metric (SI)
Methane	CH_4%	% by volume	% by volume
Lower Explosive Limit	CH_4% LEL	% of 5% CH_4	% of 5% CH_4

Screen 3

Type	Displayed As	USA (Imperial)	Metric (SI)
Static Pressure	SP"	"w.c. (H_2O)	mb (millibar)
Differential Pressure	DP"	"w.c. (H_2O)	mb (millibar)
Temperature	T °F/°C	°F (degrees Farenheit)	°C (degrees Celsius)

Screen 4

Type	Displayed As	USA (Imperial)
Old (past) BTU	BTU OLD	per cubic foot
Old (past) BTU	KJ OLD	per cubic meter
Old (past) Gas Flow	scfm Feet	std. cubic feet per min.
Old (past) Gas Flow	scfm OLD	std. cubic meters per min.
Adj. (present) BTU	BTU ADJ	per hr.
Adj. (present) BTU	KJ ADJ	per hr.
Adj. (present) Gas Flow	scfm ADJ	std. cubic feet per min.
Adj. (present) Gas Flow	scfm OLD	std. cubic meters per min.

Operating Temperature

10 to 104° F/-10 to 40° C

Range and Resolution

	Sensor Range Imperial	Resolution Imperial
Methane	0-100%	0.1
Carbon Dioxide	0-50%	0.1
Oxygen	0-25%	0.1
Pressure-Differential	0-10 "w.c.	0.01
Pressure-Static	0-100 "w.c.	0.1

Accuracy

Concentration	% Methane by Volume	% Carbon Dioxide by Volume	% Oxygen by Volume
5% (LEL CH_4)	0.5%	0.5%	1.0%
15% (UEL CH_4)	1.0%	1.0%	1.0%
100%	3.0%	3.0%	n/a

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Chapter 12-Field Operations

Landfill Gas Generation

A brief overview of the theory of landfill gas generation and methane recovery follows.

Initially, when decomposable refuse is placed into a municipal solid waste landfill, the refuse is emplaced with air from the surrounding atmosphere. Through a natural process of bacterial decomposition the oxygen from the air is consumed and an anaerobic (oxygen free) environment is created within the landfill. This anaerobic environment is one of several conditions necessary for the formation of methane.

If oxygen is reintroduced into the landfill, those portions are returned to an aerobic (oxygen present) state and the methane producing bacteria population are destroyed. A period of time must pass before the productive capacity is returned to normal. Since there is some methane of a given quality within the landfill void space, a decline in methane quality is only gradually apparent depending upon the size of the landfill.

Carbon dioxide is also produced under either an aerobic or anaerobic conditions. Under static conditions, the landfill gas will be composed of roughly half methane and half carbon dioxide with a little nitrogen.

As air is introduced into the landfill, the oxygen is initially converted to carbon dioxide and a nitrogen residual remains. Measurement of residual nitrogen is usually a good indicator of the anaerobic state of the landfill, however, it cannot be directly measured. It can however be assumed and estimated, using a subtraction basis, as the balance gas. Hence, measurement of carbon dioxide is an intermediary step. Because carbon dioxide levels may fluctuate depending on the changing concentrations of the other constituent gases, carbon dioxide levels are not evaluated directly but are considered in light of other data.

In evaluation of residual nitrogen, allowances must be made if there has been any air leakage into the gas collection system or if there has been serious overpull. If enough air is drawn into the landfill, not all oxygen is converted into carbon dioxide and the oxygen is apparent in the sample. It is ideal to perform routine analysis of individual wells, as well as an overall well field composite sample, by gas chromatograph. This is not always practical at every landfill.

Under some conditions there may be a small amount of hydrogen in the LFG, (about 1 percent, usually much less). This may affect field monitoring response factors, but otherwise it can be ignored.

Subsurface Fires

If very large quantities of air are introduced into the landfill, either through natural occurrence or overly aggressive operation of the LFG system, a partly unsupported subsurface combustion of the buried refuse may be initiated. Subsurface fire situations are difficult to control or extinguish once started, present health and safety hazards, and can be quite costly. Therefore, prevention by good operation of the collection system and maintenance of the landfill cover is the best course of action. The presence of carbon monoxide is an indicator of poorly supported combustion within the landfill.

Techniques for Controlling Landfill Gas

There are many techniques for controlling landfill gas extraction. These techniques represent tools which are used together to control landfill gas. The Accu-Flo™ Wellhead is designed to work with all of these techniques. Below is a discussion of the individual techniques, how to use them and their limitations. Reliance on only a few of the techniques discussed can lead to misinterpretation of field data and mis-operation of the wellfield. Later we will discuss the best use of these techniques to optimize landfill gas control.

Controlling by Wellhead Valve Position

Unless the valve handle is calibrated for a given flow rate, this method is unreliable. The position of the valve handle alone does not provide sufficient information about the wellfield to control it. It is useful to note the relative position of the valve, and essential to know which valves are fully open or closed.

Controlling by Wellhead Vacuum

This technique relies on the relationship of well pressure/vacuum to flow for a given well. Reliance upon this method, however, can be misleading. This is because the square root relationship between flow and pressure is difficult to relate to while performing day-to-day wellfield adjustments. As decomposition, moisture, and other conditions change this method shows itself to be inadequate and imprecise.

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Controlling by Gas Composition

This method determines methane, nitrogen (balance gas) and other gas composition parameters at wellheads and at recovery facilities using portable field instruments and sometimes analytical laboratory equipment. Complete knowledge of gas composition (i.e., major fixed gases: methane, carbon dioxide, oxygen and nitrogen) is desirable. It is also necessary to check other gas parameters such as carbon monoxide to fully evaluate the condition of the wellfield. Reliance on this information can lead to mis-operation of the wellfield. Indications of excessive extraction often do not show up right away. This method often leads to a cycle of damage to the methane producing bacteria population and then to overcorrection. This cycling of the well and producing area of the landfill is not a good practice. It leads to further misinterpretation of the condition of the wellfield and has a disruptive effect on the operation of the wellfield. The use of analytical laboratory instrumentation such as a gas chromatograph is a valuable supplementary tool to verify gas composition. This normally requires collection of samples at the wellhead and analysis at some fixed location where the equipment is located. The drawbacks of this method as a primary means of obtaining information for wellfield adjustment are time expended, cost, and probably most important, responsiveness to the needs of the wellfield for timely adjustment. The laboratory analysis ownership of the equipment required is also costly. Some analysis is recommended for verification of field readings from time to time. A monthly sample of the composite gas composition at the inlet to the flare/gas recovery facility is recommended.

Controlling by Flow Rate

This is a more exact technique for determining and adjusting gas flow at individual wells. It requires using a fixed or portable flow measurement device at each wellhead to obtain data needed to calculate volumetric (or mass) flow rates. It is normally convenient to use cubic feet per minute, or per day, as a standard unit of measure for volumetric flow. It is important to distinguish between the volumetric quantity of landfill gas and the volumetric quantity of methane extracted from each well and the landfill in total. The two variables are somewhat independent of each other and it is the total quantity of methane extracted which we are interested in. It is possible for the total quantity of landfill gas extracted to increase while the total quantity of methane extracted decreases. To monitor this we can calculate the quantity of methane extracted, (LFG flow x percent methane) or the quantity of BTUs, (British Thermal Units, a standard measurement unit of heat energy), recovered per hour, (LFG flow x percent methane x BTUs per cubic foot of methane x 60 minutes per hour). It is conventional to measure BTU's per hour as a unit of time. There are approximately 1012 BTUs of heat per cubic foot of pure methane (like natural gas), although this figure varies a little among reference texts.

Measuring flow is an essential part of monitoring and adjusting a wellfield. The well should be adjusted until the amount of methane recovered is maximized for the long term. A greater amount of methane or energy can usually be recovered over the short term, however, this ultimately leads to diminishing returns. This is seen in stages as increased CO_2 and gas temperature and later as increased oxygen from well overpull. In time, the methane will also decline. This is a result of a portion of the landfill, usually at the surface, being driven aerobic. In this portion of the landfill, the methane producing bacteria will have been destroyed (due to the presence of oxygen). With the methane-producing capacity of the landfill reduced, the pore space in the area no longer producing may become filled with landfill gas equilibrating (moving in) from an unaffected producing area. This leaves the impression that more gas can be recovered from this area, and may lead to the operator opening the well or increasing flow.

Wellfield Monitoring

The frequency of LFG wellfield monitoring will vary depending upon field requirements and conditions. Normal monitoring frequency for a complete field monitoring session with full field readings (suggested normal and abbreviated field readings list follows) will vary from typically once a month to once a week. Well field monitoring should not normally be extended beyond one month. The importance of regular, timely monitoring cannot be overemphasized.

Typical Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH_4)
- Oxygen (O_2)
- Carbon dioxide (CO_2)
- Balance Gas (primarily nitrogen N_2)
- Wellhead gas temperature (flowing)
- Ambient temperature
- Static pressure (PS) (from GEM-500 or magnehelic)
- Velocity head (P or PT) (from GEM-500 or pitot tube and magnehelic)

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- Wellhead gas flow (from GEM-500, or pitot tube & magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment
- Calculation of each well's LFG and methane flow and sum total.
- Observations/comments.

Additionally, carbon monoxide (CO) or hydrogen sulfide (H_2S) readings may be taken if problems are suspected. Supplementary monitoring once to several times a week may be performed using an abbreviated form of field readings.

Abbreviated Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH_4)
- Oxygen (O_2)
- Wellhead gas temperature (flowing)
- Ambient temperature
- Static pressure (Ps) (from GEM-500, GA-90 or magnehelic)
- Velocity head (P or Pt) (from GEM-500 or pitot tube and magnehelic)
- Wellhead gas flow (from GEM-500, or pitot tube and magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment.
- Observations/comments

Line vacuums and gas quality may be taken at key points along the main gas collection header and at subordinate branches. This helps to identify locations of poor performance, excessive pressure drop or leakage. Perform systematic monitoring of the wellfield, taking and logging measurements at each wellhead and major branch junction in the collection system.

During monitoring, examine landfill and gas collection system for maintenance issues. Record needed maintenance or unusual conditions. Examples of unusual occurrences or conditions are: unusual settlement, signs of subsurface fires, cracks and fissures, liquid ponding, condensate/leachate weeping from side slopes, surface emissions and hot spots, and liquid surging and blockage in the gas collection system. Field readings should be kept in a chronological log as well as turned into management on a timely basis.

Wellfield Adjustment Criteria

There are several criteria used in wellfield adjustment. The primary criteria is methane quality. Methane quality is an indicator of the healthy anaerobic state of the landfill and thus proper operation of the LFG collection system. However, a decline in the healthy productive state of the landfill is usually not immediately apparent from methane quality. Because of this we must consider several criteria at once.

Following are wellfield adjustment criteria for consideration.

- Methane quality (ranging from 46 percent upwards)
- The degree to which conditions within the landfill favor methane production. Typical conditions include: pH, temperature, general cover quality, moisture conditions, waste stream characteristics, placement chronology, insulation characteristics, etc.
- Oxygen quality (ranging below 1 percent, preferably less then 1/2 percent)
- Landfill cover porosity and depth in the proximity of the well
- Landfill construction factors including type of fill, size and shape of refuse mass, depth of fill, compaction, leachate control methods
- Seasonal, climatic, geographical, and recent weather, or other considerations, including seasonally arid or wet conditions, precipitation, drainage, groundwater
- Surrounding topologic and geologic conditions
- Proximity of the well to side slopes (within 150 to 200 feet and less may require conservative operation of the well)
- Nitrogen (typically 8 to 12 percent and less)
- Temperature (between ambient and about 130 °F.)

APPENDIX C
DATA COLLECTION SHEETS AND INSPECTION REPORTS

TABLE 1

Summary of Landfill Gas Measurements in Monitoring Wells and Gas Probes
North Country Environmental Services Landfill
Bethlehem, New Hampshire
(Gas Measurements are percent by Volume)

Date											
Time											
Temperature (°F)											
Barometric Pressure											
Monitoring Wells											
B-102D	Time										
	CO_2										
	O_2										
	CH_4										
MW-401	Time										
	CO_2										
	O_2										
	CH_4										
MW-405U	Time										
	CO_2										
	O_2										
	CH_4										
MW-405L	Time										
	CO_2										
	O_2										
	CH_4										
MW-603	Time										
	CO_2										
	O_2										
	CH_4										
Gas Probes											
GP-2	Time										
	CO_2										
	O_2										
	CH_4										
GP-4	Time										
	CO_2										
	O_2										
	CH_4										
GP-7	Time										
	CO_2										
	O_2										
	CH_4										
GP-8A	Time										
	CO_2										
	O_2										
	CH_4										
GP-11	Time										
	CO_2										
	O_2										
	CH_4										
GP-12	Time										
	CO_2										
	O_2										
	CH_4										

TABLE 1

Summary of Landfill Gas Measurements in Monitoring Wells and Gas Probes
North Country Environmental Services Landfill
Bethlehem, New Hampshire
(Gas Measurements are percent by Volume)

Date											
Time											
Temperature (°F)											
Barometric Pressure											
GP-13	Time										
	CO_2										
	O_2										
	CH_4										
GP-14	Time										
	CO_2										
	O_2										
	CH_4										
GP-15	Time										
	CO_2										
	O_2										
	CH_4										
Subliner Gas Wells											
SGW-1	Time										
	CO_2										
	O_2										
	CH_4										
SGW-2	Time										
	CO_2										
	O_2										
	CH_4										
SGW-3	Time										
	CO_2										
	O_2										
	CH_4										
SGW-4	Time										
	CO_2										
	O_2										
	CH_4										
SGW-5	Time										
	CO_2										
	O_2										
	CH_4										
SGW-6	Time										
	CO_2										
	O_2										
	CH_4										

Notes:

1. Each monitoring well and gas probe was monitored for CO2, O2, and CH4 using a Landtec Gem-500 Gas Extraction Monitor. Calibration was checked daily. Monitoring procedures consisted of recording any gas levels during the first 1 to 2 minutes that the well/probe was opened and a second reading after a minimum of 20 minutes open venting.

TABLE 2
Summary of Landfill Gas Measurements in Selected Gas Vents
North Country Environmental Services Landfill
Bethlehem, New Hampshire
(Gas Measurements are percent by Volume)
(Pressure Measurements are inches of Water)

Date											
Time											
Temperature (°F)											
Barometric Pressure											
Gas Vents											
GV-2	Time										
	CO_2										
	O_2										
	CH_4										
	Pressure										
GV-3	Time										
	CO_2										
	O_2										
	CH_4										
	Pressure										
GV-4	Time										
	CO_2										
	O_2										
	CH_4										
	Pressure										
GV-8	Time										
	CO_2										
	O_2										
	CH_4										
	Pressure										
GV-10	Time										
	CO_2										
	O_2										
	CH_4										
	Pressure										

Date:				**Leachate injection system**				
				Weekly inspection report				
A. Measure and record:								**PSIG**
1.	Primer pump inlet pressure							
2.	Primer pump outlet pressure							
3.	Injection pump pressure							
B. Routine maintenance:							**Date Completed**	**Due Date**
1.	Change injection pump oil			(Service interval 500 hrs./ 3 weeks)				
2.	Change injection pump seals			(Service interval 1500 hrs./ 2 months)				
3.	Change injection pump inlet/outlet valves				(Service interval 3000 hrs./4 months)			
4.	Clean basket strainers							3-5 PSIG
								Pres. Drop
5.	Lubricate injection pump wicks							Weekly
6.	Nozzle change							Non-uniform
								spray pattern
7.	Heat tracing operational							Weekly
8.	Thermocouples						Top	Weekly
							Middle	Weekly
							Bottom	Weekly
Comments:								
Spare parts inventory				#	Reorder			
Injection pump parts								
	Viton seal kit (6 in each)			1				
	Valve kits (3 in each)			2				
	Oil			8				
Unloader				0				
Nozzle parts								
	Cap and body (303 SS)			2				
	Orifice insert (303 SS)			2				
	Aluminum gasket			4				
	Core			2				
Thermocouples				3				
Thermowells				2				
Submersible pump				1				
Loctite 77164 Nickel anti-sieze/galling				1				

Weekly Well Field Inspection Report

Date:

Time:

Technician:

Weather conditions:

If any section has been recorded no, note in the comments section below what the problem is and what corrective action is needed to correct the problem

Well Heads	Yes	No	Well No.
Sample Ports in good working order			
Fernco fittings-no cracks or loose clamps			
Kana-flex hose in good condition			
Sample port caps in placed			
8 inch well casing in good condition-no visible cracks or other damage			
4 inch vacuum line in good condition			

Comments and corrective actions:

Weekly inspection report for gas extraction system

Date:
Time:
Weather:

Technician:

Indicate that inspection has or has not been completed for each item.
Indicate if repairs are or are not needed. If repairs are needed, describe the corrective action to be taken or that has been taken.

Items to be inspected weekly	Inspection completed	Repairs needed
Landfill gas collection system		
A. Measure and record		
1. Gas flow rate, composition,temperature, and pressure at well heads		
B. Remedial actions		
1. Adjustments and minor repairs(as needed)		
2. Re-balance the collection system(as needed)		
The condensate management system		
A. General inspection of:		
1. Condensate drip legs, collection points, pump stations, storage tanks		
2. Knockout pot pump		
3. Air compressor		
B. Remedial actions		
1. Clean out filtration media		
2. Drain condensate		
3. Adjustments and minor repairs(as needed)		
4. Drain air compressor tank		
The LFG meter and blower assembly		
A. General inspection of:		
1. Blower, flow meter, and related piping, wiring and controls		
B. Measure and record:		
1.Gas flow rate, composition,temperature, and pressure at blowers		
C. Remedial actions:		
1. Clean out blower station		
2. Inspect and repair components(as needed)		
3. Replace blower motor belt(as needed)		
4. Replace recording media		
Flare assemblies		
A. Remedial actions:		
1. Adjust and repair(asneeded)		
2. Replenish control valve nitrogen		
3. Replenish propane for ignition system(as needed)		
4. Remove and clean flame arrestor		
Recording and documentation		
A. routine management reports		

Comments:

Site: North Country Environmental Services
Date: Totalizer:
Temp:
Barometric Pressure: Weather:

Flare temp:

Well Number	CH4	CO2	O2	Bal.	Vac.	SCFM	Adjusted SCFM	Gas Temp.
Flare/ Raw								
Flare/ Diluted								
GW-1								
GW-2								
GW-3								
GW-3A								
GW-4								
GW-4A								
GW-5								
GV-5								
GW-6								
GW-6A								
GW-7								
GW-8								
GW-9								
GW-10								
GW-11								
GW-12								
GW-13								
GW-14								
GW-15								
GW-16								
GV-16								
GW-17								
GW-18								
GW-19								
GW-20								
GW-21								
GW-22								
HORZ. A								
HORZ. B								
HORZ. C								
S.E.-CO								
S.W.-CO								
P.2								
P.3								
P.4								
Flare/Post								

Comments:

Bi-Weekly Inspection Report

DATE:

TIME:

WEATHER:

TECHNICIAN:

Indicate that the inspection has or has not been completed for each item. Indicate if repairs of each item are needed or not. If repair is needed describe the corrective action to be taken or that has been taken.

Bi-weekly inspections, monitoring, and remedial action	Inspection completed	Repairs needed
Landfill Gas Collection System:		
A. General Inspection:		
1. Extraction well heads		
2. Visible portion of laterals, headers and passive vents		
3. Header control valve(main gate valve)		
Landfill Meter and Blower Assembly:		
A. Remedial actions:		
1. Lubricate blower bearings		
2. Lubricate combustion air blower bearings		
Flare Assemblies(including point flares):		
A. General Inspection:		
1. Visible connections, control valves, enclosures, flame		
arrestor, and ignition system		
B. Measure and record:		
1. LFG Flow rate, composition, temperature, and pressure		
2. Control valve nitrogen supply		
3. Propane level for ignition system		
4. Back pressure at the flame arrestor		
C Remedial actions:		
1. Clean out flare station		

Comments and corrective actions:

Schedule date of next bi-weekly inspection:

Appendix E
Confined Space Entry Plan

INDUSTRIAL
HYGIENICS
CORPORATION

North Country Environmental Services

CONFINED SPACE PROGRAM

PRESENTED BY:
Industrial Hygienics Corporation
13 Dorset Lane
Williston, Vermont 05495
1-802-879-2711

13 DORSET LANE
WILLISTON, VT 05495
(802) 879-2711

CONFINED SPACE ENTRY
PROGRAM

North Country
Environmental Services

Confined Space Program

2 CONFINED SPACE ENTRY PERMIT AND SAFETY BRIEFING REPORT

3 PERMITTED AND NON-PERMITTED CONFINED SPACE LOCATIONS

4 CERTIFICATION OF TRAINING

5 RESERVED

Presented By:

Industrial Hygienics Corporation
13 Dorset Lane
Williston, VT 05495
(802) 879-2711

SECTION 1 Permit Required Confined Space Entry Program

INTRODUCTION

Conditions that are immediately dangerous to life or health (IDLH) are of utmost concern to **North Country Environmental Services**. Confined space entry is one such operation that if not approached in a safe manner, poses a serious threat to the health and well-being of our employees and may even cause death. The definition of Confined Space is:

1. A space which is large enough and so configured that an employee can bodily enter it and perform assigned work.
2. Has limited or restricted means for entry and exit.
3. Is not designed for continuous employee occupancy.

Confined spaces include, but are not limited to; storage tanks, compartments of ships, process vessels, pits, silos, vats, hoppers, storm drains, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines.

The Occupational Safety and Health Administration (OSHA) establishes minimum requirements for employers whose employees will be entering confined spaces and performing work. Managers/Supervisors who supervise employees who will be entering confined spaces shall familiarize themselves with the Permit-required Confined Space standard 29 CFR 1910.146.

IDENTIFICATION OF CONFINED SPACES

An evaluation of the workplace was conducted by **North Country Environmental Services** to identify all permitted and non-permitted confined spaces. All permitted confined spaces, both off site and on site have been identified and assigned a control number in the Confined Space Database. **It is the policy of North Country Environmental Services that no North Country Environmental Services employee will enter a permit required Confined Space. North Country Environmental Services permit required Confined Spaces will be entered only by subcontractors following these Confined Space entry Procedures. The *Facility Manager* will advise the subcontractor as to the hazards associated with North Country Environmental Services' Confined Spaces.**

Non-permitted confined spaces are confined spaces that do not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm. All non-permitted confined spaces, both off site and on site have been identified and assigned a control number in the Confined Space Database.

GENERAL SAFETY GUIDELINES

1. All confined spaces requiring a permit for entry are identified by a sign which reads:

   "DANGER - PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER"

2. It is the policy of **North Country Environmental Services** that all permitted and non-permitted confined spaces be atmospherically evaluated prior to entry and, periodically during entry according to an established frequency, which is dependent on the space and

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the initial evaluation. Prior to entry, test the atmosphere first for oxygen, second for combustible gases and vapors, and finally for toxic gases or vapors. If the oxygen content is at or below 20.9%, oxygen is being displaced and the space may require ventilation. **NOTE: Any reading below 20.9% could indicate the displacement of O_2 by some other agent and should be questioned.** If ventilation does not provide for an increase in oxygen, employees are required to wear supplied air respirators while in the area. If toxic levels of chemicals are present, appropriate ventilation or respiratory protection will be necessary. **Note: If respirators are worn by company employees, a** Respiratory Protection Program **will be implemented. Further, if respirators are worn for a period of 30 days or more, a** Medical Evaluation Program **will be implemented.** If combustible gas levels are above 10% of the LFL (lower flammable limit), entry will be delayed until the level falls below 10%. **NOTE: Any reading of the combustible gas indicator below 10% LEL, may indicate a toxic atmosphere and should be evaluated accordingly. Below 10% LEL OSHA permits entry only from a flammability nature and does not imply the space is not toxic.** Forced ventilation can be used to lower the concentration of toxic or combustible gases and raise the oxygen level. However, identifying the chemicals to be removed from the space and determining how they will be disposed of must be accomplished prior to starting ventilation.

3. A system to mark a confined space unsafe, should tests indicate it is unsafe to enter, has been established. These markings will remain in place until tests indicate entry is safe. Signs, marker tape, flags, and/or barricades will be used for identifying these areas.

4. Lockout, block, or otherwise disconnect all mechanical, electrical, liquid, and gas systems relating to the confined space that may create a hazard during entry if they are put in motion or otherwise activated. Lockout/tagout procedures shall be performed in accordance with **North Country Environmental Services'** written Lockout/Tagout Program.

5. Emergency procedures for rescue inside confined spaces have been coordinated with our local Fire Department. <u>At all times</u> there will be an attendant on standby outside the confined space to observe the worker and provide help in an emergency. **At no time is an attendant to enter a confined space for the purpose of rescue.**

   In the event emergency procedures have not been coordinated with the local fire department, a rescue procedure will be established. Rescue personnel will be trained and outfitted with the same protective clothing and equipment as the confined entry personnel.

   Additional training will be provided to rescue personnel as described under training below.

6. Prior to entering a confined space, the department manager/supervisor is required to review the following safety forms, which are completed and endorsed by the **Entry Supervisor**. All safety forms are to be kept in the job file for which they are filled out and retained a minimum of 1 year to facilitate review of the confined space entry program. It is the responsibility of the **Entry Supervisor** to see that all forms are filled out and filed

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accordingly. In addition, a copy of the confined space entry permit and if necessary the associated Safety Briefing Report, must be posted at the confined space entry point for review by all entrants, attendants, and rescue personnel.

Confined Space Entry Permit - provides the following information:

a. Permit number.
b. Permit date.
c. Duration of permit.
d. Job location.
e. Purpose of entry.
f. Name of person entering confined space, attendant and documentation of training.
g. Document the evaluation of the atmosphere for oxygen content, combustible gases and toxic levels of gases and vapors. Atmospheric testing shall be performed before and after forced air ventilation is introduced.
h. Document that all electrical and mechanical equipment leading to the confined space area has been locked out.
i. Document the levels of protective clothing and equipment needed.
j. Describe rescue procedures.
k. Name of person preparing permit.
l. Name and signature of entry supervisor.
m. Permit cancellation time and reason for terminating permit.

Confined Space Characterization Form – Is established in order to standardize the information necessary to adequately assess the hazards associated with particular confined spaces within the organization. This form shall be completed and the information entered into the Confined Space Database. This standardized information does not circumvent the need to physically evaluate each confined space before entry but is intended to act as a means to verify similar conditions or hazards that exist.

a. Job information
b. Safety topics
   - Chemical hazards.
   - Physical hazards.
   - Respiratory protective equipment.
   - Protective clothing.
   - Safety/personal protective equipment.
   - Specific instructions.
c. Emergency telephone numbers which include locations of the nearest telephone or other emergency communication equipment.
d. Employees' and supervisors' names and signatures documenting their understanding of all safety-related job instructions.
e. Emergency equipment available.

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7. All contractors/subcontractors must adhere to the Permit-Required Confined Space Entry Program requirements established under OSHA 29 CFR 1910.146.

TRAINING REQUIREMENTS

Prior to beginning confined space entry procedures, the following training will be provided for all affected employees and documented.

Authorized Entrants Shall:

1. Become knowledgeable of the hazards that may be present during entry, including information on the mode, signs or symptoms, and consequences of the exposure.

2. Become knowledgeable in the proper selection and use of personal protective equipment required for entry.

3. Learn to communicate with the attendant whenever:
   a. The entrant recognizes any warning sign or symptom of exposure to a dangerous situation.
   b. The entrant detects a prohibited condition.
   c. Need to monitor the entrants status.

4. Become knowledgeable in procedures for exiting a confined space including:
   a. Understanding an order to evacuate when given by the attendant or the entry supervisor.
   b. Understanding when an evacuation alarm is sounded.
   c. Recognizing any warning sign or symptom of exposure to a dangerous situation.
   d. Detecting a prohibited condition.

Attendants Shall:

1. Become knowledgeable of the hazards that may be present during entry, including information on the mode, signs or symptoms, and consequences of the exposure.

2. Become aware of the possible behavioral effects of hazard exposure an authorized entrant may exhibit.

3. Learn to maintain a continual accurate count of authorized entrants in the permit space and be able to accurately identify who is in the permit space at all times.

4. Understand the importance of maintaining a constant vigil outside the permit space during entry operations until relieved by another attendant.

5. Learn techniques for communicating with entrants as necessary to monitor entrant status and to alert entrants of the need to evacuate the space.

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6. Learn to monitor activities inside and outside the space to determine if it is safe for entrants to remain in the space.

7. Learn under what circumstances the entrant is to be ordered to evacuate the space. Such circumstances may include:
   a. If the attendant detects a prohibited condition.
   b. If the attendant detects the behavioral effects of hazard exposure in the authorized entrant.
   c. If the attendant detects a situation outside the space that could endanger the authorized entrants.
   d. If the attendant cannot effectively and safely perform his duties.

8. Learn when to summon rescue and other emergency services.

9. Learn what actions to take in the event unauthorized persons approach or enter the permit space while entry is underway. These actions may include the following:
   a. Warn unauthorized persons to stay away from the permit space.
   b. Advise unauthorized persons that they must immediately exit the permit space if they have gained entry into the space.
   c. Inform authorized entrants and the entry supervisor of any unauthorized entrants.

10. Learn to perform non-entry rescue procedures.

11. Understand that the primary duty is to monitor and protect the authorized entrants and, as such, never to perform duties that will interfere with this objective.

Entry Supervisors Shall:

1. Become knowledgeable in the proper selection and use of personal protective equipment and rescue equipment required for making rescues from permit spaces, and will be required to perform practice rescue drills a minimum of once annually.

2. Become knowledgeable of the hazards that may be present during entry, including information on the mode, signs or symptoms, and consequences of the exposure.

3. Gain thorough knowledge of the information required on the entry permit, and understand his/her role in verifying that tests, if applicable, have been conducted and that equipment is in place prior to endorsing the permit and allowing entry to begin.

4. Understand procedures for terminating entry and canceling the permit.

5. Understand procedures for verifying rescue services are available and means for summoning them are operable.

6. Understand procedures for removing unauthorized individuals from the area.

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7. Become knowledgeable and take responsibility for determining that entry operations remain, at all times, consistent with the terms of the entry permit and that acceptable entry conditions are maintained.

Rescue and Emergency Services Personnel Shall:

1. Become knowledgeable in the proper selection and use of personal protective equipment and rescue equipment required for making rescues from permit spaces.

2. Become knowledgeable under the requirements outlined for authorized entrants above.

3. Become knowledgeable in performing confined space rescue procedures.

4. Perform confined space rescue drills a minimum of once every twelve months. Drills will include simulated rescue operations using dummies, manikins, or actual persons from actual permit spaces or from representative permit spaces.

5. Become trained in basic first-aid and CPR, and have a minimum of one member of the rescue service holding current certification in first aid and CPR be made available for rescue services.

6. If outside services are called in, the employer will arrange to inform rescue service personnel of the hazards they may confront in performing rescue operations.
   a. Have access to all permit spaces from which rescue may be necessary for developing rescue plans and performing drills.

7. Become knowledgeable in retrieval systems or methods that may be employed for non-entry rescue, and understand when using such equipment may increase overall risk and hinder rescue operations.

ANNUAL REVIEW

An annual review of the permit required confined space program shall be conducted by the **Facility Manager**. Canceled permits kept on file shall be utilized to assess the effectiveness of the program. Upon completion of the annual review, the company Permit-Required Confined Space Program shall be updated as necessary.

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AIR MONITORING

INTRODUCTION

The purpose of this air monitoring program is to establish standard operating procedures that are implemented for the safety and health of employees involved in confined space entry operations. The proper selection of engineering controls, work practices and personal protective equipment is contingent upon obtaining accurate information concerning exposure to concentrations of hazardous substances in excess of permissible or published exposure limits. It is the responsibility of department Managers/Supervisors to ensure that appropriate hazard information is obtained prior to confined space entry in areas under their authority.

REQUIREMENTS

A. Prior to entry, representative air monitoring will be conducted to identify IDLH conditions, exposure over permissible exposure limits or published exposure limits; or other dangerous conditions such as the presence of flammable atmospheres or oxygen-deficient environments.

B. Periodic monitoring will be conducted whenever there is the possibility of an IDLH condition or flammable atmosphere developing or when there is indication that permissible or published exposure limits may be approached. This will include whenever:
   1. Work begins in a new location within a confined space.
   2. Contaminants not previously identified are detected.
   3. New operations are initiated.
   4. Employees are handling leaking containers or piping systems or are working in areas of obvious liquid contamination.

C. Monitoring will be performed by: ✓Subcontractor ____In-House Personnel

D. Direct-reading monitoring instruments will be used and include combustible gas indicators, oxygen meters, colorimetric indicator tubes, and organic vapor monitors. Results of air monitoring shall be documented and made available to all entrants. Monitoring shall be conducted in the following order:
   1. Oxygen
   2. Combustible Gas
   3. Toxic Vapors or Gas

E. Both acceptable and unacceptable entry and working conditions shall be determined based on air monitoring results and recorded on the Entry Permit. At no time will acceptable conditions exceed the established limits as required by OSHA or if more restrictive company policy. OSHA requirements are as follows:
   - Oxygen – 19.5% and 23.5%
   - Combustible Gas – 10% LEL
   - Toxic – PEL's (29 CFR 1910.1000 (Z-1 Tables), (Z-2 Tables), (Z-3 Tables)

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Unacceptable entry and working conditions are in most cases contaminant and confined space specific. Generally, any concentrations below normal concentrations should be unacceptable until verification or investigation can conclusively determine safe conditions.

Normal Concentrations: Oxygen = 20.9%
Combustible Gas = 0 % LEL
Toxic = 0 ppm

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North Country Environmental Services
CONFINED SPACE ENTRY PERMIT

Permit #: _____ Permit Date: _____
Job Location: _____
Time of Entry: _____ Duration of Permit: _____

Purpose of Entry: _____
Communication Procedures: _____
Hazards Identified: _____
Name of Person(s) Entering Confined Space: _____
Name of Attendant: _____

Atmospheric Testing

Time 1:	Time 2:	Time 3:	Time 4:	Time 5:
O_2: %	O_2 %	O_2 %	O_2 %	O_2 %
LEL: %	LEL: %	LEL: %	LEL: %	LEL: %
Toxic ppm	Toxic ppm	Toxic ppm	Toxic ppm	Toxic ppm
CO: %	CO: %	CO: %	CO: %	CO: %

Specify instrument(s) used, name of person who provided testing, and calibration procedures implemented: _____

Have all lockout/tagout procedures been followed to ensure that all electrical and mechanical equipment leading to the confined space areas have been rendered inoperable? ☐ YES ☐ NO
Was ventilation modified? ☐ YES ☐ NO If Yes Note the times when atmosphere was retested: _____
List all personal protective equipment issued for the purpose of confined space entry.
Personal Protective Clothing/Equipment: **Issued To:**
a. _____
b. _____
c. _____

Denote these minimum requirements have been completed:

Requirements	Date	Time	Requirements	Date	Time
Lockout/De-energize/Try out			Full Body Harness w/"D" ring		
Line(s) broken, capped, blanked			Emergency Escape Retrieval Equipment		
Purge-Flush-Vent			Lifelines		
Ventilation			Fire Extinguishers		
Secure Area			Lighting		
Breathing apparatus			Protective Clothing		
Standby Safety Personnel			Respirators (APR), Resuscitator/Inhalator		

Describe Rescue Procedures: _____

All measures as required under 29 CFR 1910.146(d) have been met and Permit # _____ is hereby granted. This permit is to be made available to all authorized entrants. The duration of this permit is not to exceed the time required to perform the job or 8 hours, whichever is less. This permit may be canceled by the Entry Supervisor whenever entry operations have been completed; or when a condition arises that is not allowed under this entry permit. Upon cancellation, it will be kept on file for one year.

Permit Granted on this _____ day of _____, Year _____

_____
Signature of Entry Supervisor Granting Permit

Permit Canceled on this _____ day of _____, Year _____
Time of Cancellation: _____

_____
Signature of Entry Supervisor Canceling Permit

Reason for Canceling Permit: _____

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North Country Environmental Services
CONFINED SPACE CHARACTERIZATION FORM

Confined Space #: _____

A. Site Description:
Date: _____ Location: _____

B. General Entry Objectives: _____

Confined Space Description: _____

Hazard Evaluation Description: _____

C. **Confined Space Type (Classification)**

☐ Permit Required ☐ Permit Required Section C5 ☐ Non-Permit Required

D. **Authorized Entry:**

☐ Company Personnel Authorized ☐ Contractor Personnel Authorized

E. **Hazard Evaluation**

The following substance(s) are known or suspected to be present. The primary hazard(s) of each are identified:

Substances Involved	Concentrations (if known)	Primary Hazards

F. **Personal Protective Equipment**

Based on the evaluation of potential hazards, the following personal protective equipment has been assigned for the applicable work area(s) and tasks:

Work Area	Job Function	PPE Assigned

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G. **Emergency Medical Care**

_____
(Insert Names of Qualified Personnel)

The medical facility closest to our company operations is as follows:
Medical Facility Name:_____
Address:_____
Telephone:_____
Ambulance Telephone:_____
Ambulance Response Time:_____

First Aid Equipment is available on site at the following locations:
First Aid Kit:_____
Emergency Eye Wash Station:_____
Emergency Shower:_____
Other:_____

Other Emergency Telephone Numbers are as follows:
Police:_____
Fire:_____
Hospital:_____
Public Health Advisor:_____
Poison Control Center:_____

H. **Environmental Monitoring**

The following environmental monitoring instruments shall be used on site (cross out if not applicable) at the specified intervals:

Combustible Gas Indicator:	☐ continuous	☐ hourly	☐ daily	☐ other_____
O_2 Monitor:	☐ continuous	☐ hourly	☐ daily	☐ other_____
Colorimetric Tubes:	☐ continuous	☐ hourly	☐ daily	☐ other_____
Photoionizing Detector	☐ continuous	☐ hourly	☐ daily	☐ other_____

I. **Emergency Procedures**

On-site personnel will use the following standard emergency procedures. The site safety officer shall be notified of any on site emergencies and be responsible for ensuring that the appropriate procedures are followed. The site safety officer for the above described operations is:

_____
(Insert Name of Site Safety Officer)

Personnel Injury Procedures (describe):_____

Fire/Explosion Emergency Procedures:_____

Personal Protective Equipment Failure Emergency Procedures:_____

Other Equipment Failure Emergency Procedures:_____

Emergency Escape Routes and Reassembly Routes are as follows:_____

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SECTION 2 Confined Space Permit and Safety Briefing Report

J. **Lockout/Tagout procedures for de-energizing was completed as described:**_____

K. **Ventilation is provided using the following means:**

L. **Area has been secured using the following means:**_____

M. **The following emergency equipment is available on site (check all that apply):**

_____Full Body Harness with Lockable "D" Ring

_____Emergency Escape Retrieval Equipment

_____Fire Extinguishers

_____Lifelines

_____Explosion Proof Lighting

_____Non-Sparking Tools

_____Winch/Tripod

_____Other (list)

Signature of Person Certifying Information in this Characterization Date

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North Country Environmental Confined Space Index

Confined Space ID#	*Confined Space Location*
1	Trash Containers
2	Platform Scale
3	Septic Tank
4	Septic Pump Tank
5	Shop Floor Drain Tank 6,000 Gallons
6	500 Gallon Metal Odorant Tank
7	1500 Gallon Fiberglass Odorant Tank
8	1500 Gallon Fiberglass Odorant Tank
9	500 Gallon Flare Condensate Tank
10	Stage 2 Phase 1 Pump Control Building Primary Pump Chamber
11	Stage 2 Phase 1 Pump Control Building Secondary Pump Chamber
12	Stage 2 Phase 1 Pump Control Building
13	Stage 2 Phase 2 Pump Control Building Primary Pump Tunnel
14	Stage 2 Phase 2 Pump Control Building Secondary Pump Chamber
15.	Stage 1 Phase 1 Primary Manway
16	Stage 1 Phase 1 Secondary Manway
17	Stage 1 Phase 2 Primary Sump
18	Stage 1 Phase 2 Secondary Sump
19	Stage 1 Phase 3 Primary Sump
20	Stage 1 Phase 3 Secondary Sump
21	Stage 1 Phase 4 Primary Sump
22	Stage 1 Phase 4 Secondary Sump
23	Contingency Leachate Storage Tank 20,000 Gallons
24	Stage 1 Phase 1 Primary Storage Tank, 15,000 Gallons
25	Stage 1 Phase 1 Secondary Storage Tank, 10,000 Gallons
26	Stage 1 Phase 2 Primary Storage Tank, 15,000 Gallons
27	Stage 1 Phase 2 Secondary Storage Tank, 10,000 Gallons
28	Stage 1 Phase 3 Primary Storage Tank, 15,000 Gallons

Confined Space ID#	*Confined Space Location*
29	Stage 1 Phase 3 Secondary Storage Tank, 10,000 Gallons
30	Stage 1 Phase 4 Primary Storage Tank, 15,000 Gallons
31	Stage 1 Phase 4 Secondary Storage Tank, 10,000 Gallons
32	Stage 2 Preload Storage Tank, 20,000 Gallons
33	Stage 2 Loadout Storage Tank, 20,000 Gallons
34	Stage 3a Storage Tank, 30,000 Gallons
35	Stage 3b Storage Tank, 30,000 Gallons
36	Stage 3 Loadout Valve Pit
37	Stage 3 Transfer Valve Pit
38	Stage 3 Pump Control Building
39	Stage 3 Pump Control Building, Primary Sump
40	Stage 3 Pump Control Building, Secondary Sump
41	Stage 3 Pump Control Building, Cleanout Sump
42	Evaporator Stack Lower Section
43	Evaporator Stack Upper
44	Evaporator Supply Tank, 1000 Gallons
45	Evaporator Knockout Pot

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 1

Confined Space Location: Trash Containers

Permit Required: No **Permit Required Sec C5:** Yes **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 2

Confined Space Location: Platform Scale

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 3

Confined Space Location: Septic Tank

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 4

Confined Space Location: Septic Pump Tank

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 5

Confined Space Location: Shop Floor Drain Tank 6,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 6

Confined Space Location: 500 Gallon Metal Odorant Tank

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 7

Confined Space Location: 1500 Gallon Fiberglass Odorant Tank

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 8

Confined Space Location: 1500 Gallon Fiberglass Odorant Tank

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump Outside Of Tank

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 9

Confined Space Location: 500 Gallon Flare Condensate Tank

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 10

Confined Space Location: Stage 2 Phase 1 Pump Control Building Primary Pump Chamber

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard: Pump Service

Hazard Introduced: Contact with Leachate

Method of Elimination: Personal Protective Equipment

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 11

Confined Space Location: Stage 2 Phase 1 Pump Control Building Secondary Pump Chamber

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard: Pump Service

Hazard Introduced: Contact With Leachate

Method of Elimination: Personal Protective Equipment

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 12

Confined Space Location: Stage 2 Phase 1 Pump Control Building

Permit Required: Yes **Permit Required Sec C5:** Yes **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation, continuous forced air.

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments: This space contains an atmospheric hazard. Before entering building, open the door and turn on the fan for 1 hour. The space may then be reclassified as a non-permit required confined space.

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 13

Confined Space Location: Stage 2 Phase 2 Pump Control Building Primary Pump Tunnel

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard: Servicing Pump

Hazard Introduced: Contact With Leachate

Method of Elimination: Personal Protective Equipment

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 14

Confined Space Location: Stage 2 Phase 2 Pump Control Building Secondary Pump Chamber

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard: Servicing Pump

Hazard Introduced: Contact With Leachate

Method of Elimination: Personal Protective Equipment

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 15

Confined Space Location: Stage 1 Phase 1 Primary Manway

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 16

Confined Space Location: Stage 1 Phase 1 Secondary Manway

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 17

Confined Space Location: Stage 1 Phase 2 Primary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 18

Confined Space Location: Stage 1 Phase 2 Secondary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 19

Confined Space Location: Stage 1 Phase 3 Primary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 20

Confined Space Location: Stage 1 Phase 3 Secondary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 21

Confined Space Location: Stage 1 Phase 4 Primary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 22

Confined Space Location: Stage 1 Phase 4 Secondary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 23

Confined Space Location: Contingency Leachate Storage Tank 20,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 24

Confined Space Location: Stage 1 Phase 1 Primary Storage Tank, 15,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 25

Confined Space Location: Stage 1 Phase 1 Secondary Storage Tank, 10,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 26

Confined Space Location: Stage 1 Phase 2 Primary Storage Tank, 15,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 27

Confined Space Location: Stage 1 Phase 2 Secondary Storage Tank, 10,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 28

Confined Space Location: Stage 1 Phase 3 Primary Storage Tank, 15,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 29

Confined Space Location: Stage 1 Phase 3 Secondary Storage Tank, 10,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 30

Confined Space Location: Stage 1 Phase 4 Primary Storage Tank, 15,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical Pump

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 31

Confined Space Location: Stage 1 Phase 4 Secondary Storage Tank, 10,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 32

Confined Space Location: Stage 2 Preload Storage Tank, 20,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 33

Confined Space Location: Stage 2 Loadout Storage Tank, 20,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 34

Confined Space Location: Stage 3a Storage Tank, 30,000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 35

Confined Space Location: Stage 3b Storage Tank, 30,000 Gallons

Permit Required: No **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** No

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 36

Confined Space Location: Stage 3 Loadout Valve Pit

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 37

Confined Space Location: Stage 3 Transfer Valve Pit

Permit Required: No **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** No

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 38

Confined Space Location: Stage 3 Pump Control Building

Permit Required: Yes **Permit Required Sec C5:** Yes **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** No

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 39

Confined Space Location: Stage 3 Pump Control Building, Primary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 40

Confined Space Location: Stage 3 Pump Control Building, Secondary Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 41

Confined Space Location: Stage 3 Pump Control Building, Cleanout Sump

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electrical

Method of Elimination: Lock Out Tag Out Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 42

Confined Space Location: Evaporator Stack Lower Section

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: Yes **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Blinding Supply Line

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Gas Pump Electrical

Method of Elimination: Lockout Tagout Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments: This is a permit required confined space. If the grating is removed and the gas deliver line is blinded and blanked out the space can be reclassified as a non-permit required space. Company employees can enter after reclassification.

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 43

Confined Space Location: Evaporator Stack Upper

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: No

Method of Elimination:

Entrappment Hazard: Yes

Method of Elimination: Remove grates

Other Serious Hazard: Gas delivery line, and related electrical

Method of Elimination: Lockout Tagout Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 44

Confined Space Location: Evaporator Supply Tank, 1000 Gallons

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Electric Pump

Method of Elimination: Lockout Tagout Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

North Country Environmental Services Confined Spaces

01-Feb-02

Facility: North Country Environmental Services **Confined Space ID#:** 45

Confined Space Location: Evaporator Knockout Pot

Permit Required: Yes **Permit Required Sec C5:** No **Non-Permit Required:** No

Company Entered Space: No **Contractor Entered Space:** Yes

Atmospheric Hazard: Yes

Method of Elimination: Ventilation

Engulfment Hazard: Yes

Method of Elimination: Pump Out

Entrappment Hazard: No

Method of Elimination:

Other Serious Hazard: Air Powered Pump

Method of Elimination: Lockout Tagout Procedures

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Task Introducing a Hazard:

Hazard Introduced:

Method of Elimination:

Comments:

Appendix F

Odor Complaint Form

Odor Complaint Form

Site: _____

Time and Date of Complaint: _____

Time and Date of Reported Odor: _____

Person Receiving Complaint: _____

Person Complaining: _____

Complaint: _____

_____

Climatic Conditions: _____

Verification of Complaint: _____

_____

Efforts used to mitigate odor: _____

_____

Waste Disposal Review: _____

Leachate Management: _____

Daily Cover & Operational Comments: _____

Trend Analysis & Recommendations: _____

_____

Follow-up on Complaint: _____

Notification of NHDES: _____

Appendix G

Current Facility Groundwater Permit

The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES

Thomas S. Burack, Commissioner

November 9, 2007

Eugene Martin, Project Manager
North Country Environmental Services, Inc.
3 Pitkin Court
Montpelier, VT 05602

SUBJECT: **Bethlehem** – North Country Environmental Services Landfill, 581 Trudeau Road
DES Site # 198704033, Project RSN # 1737

2007 Summary of Water Quality Monitoring and Groundwater Permit Renewal Application, prepared by Sanborn, Head & Associates, Inc., dated September 2007

Dear Mr. Martin:

Please find enclosed the Groundwater Management and Release Detection Permit Number GWP-198704033-B-005, approved by the Department of Environmental Services (Department). The permit is issued for a period of 5 years to monitor groundwater and surface water quality.

This permit includes minor revisions to the monitoring requirements pertaining to wells that are monitored at the subject site. Please note that assessment monitoring is ongoing at locations B-304, B-919, B-920 and B-921 due to intermittent detections of VOCs in some of the wells.

Special Condition # 14 requests quarterly reports on the progress of remedial activities related to S-1 (the Main Seep) and flowage from S-1. Special Condition # 15 requests quarterly reports on the scheduling and progress of remedial activities near well couplets MW-402 and MW-403 and the present/former leachate loading area.

All annual monitoring summaries and all required sampling results must be submitted to the Groundwater Release Detection Permits Coordinator at the address below. All correspondence shall contain a cover letter that clearly shows the Department identification number for the site (DES Site # 198704033).

Should you have any questions, please contact me at the Waste Management Division.

Sincerely,

John Cotton

John Cotton, P.G.,
Hazardous Waste Remediation Bureau
Tel.: (603) 271-0673
Fax: (603) 271-2181
E-mail: john.cotton@des.nh.gov

RECEIVED
NOV 15 2007
CASELLA WASTE SYSTEMS, INC.
PERMITS, COMPLIANCE & ENGINEERING

Enclosure: Permit GWP-198704033-B-005

cc: Michael Guilfoy, SWMB Administrator
Paul Rydel, P.G., Sanborn, Head & Associates
Board of Selectmen, Bethlehem
Stan Borkowski, Bethlehem Health Officer

The

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

hereby issues

GROUNDWATER MANAGEMENT AND RELEASE DETECTION PERMIT NO.

GWP-198704033-B-005

to the permittee

NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.

to monitor groundwater and surface water at the

NORTH COUNTRY ENVIRONMENTAL SERVICES LANDFILL
(Trudeau Road)

in BETHLEHEM, N.H.

via the groundwater and surface water monitoring system comprised of

39 monitoring wells, 4 springs, and 4 surface water sampling sites

as depicted on the Site Plans entitled

Exploration Location Plan

dated September 2007, prepared by Sanborn, Head & Associates, Inc., and

Groundwater Management Zone Plan for North Country Environmental Services, Inc.,

dated July 09, 2007, prepared by Alpine Land Surveying Co.

TO: NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.
3 PITKIN COURT
MONTPELIER, VT 05602

Date of Issuance: November 09, 2007
Date of Expiration: November 08, 2012

Pursuant to authority in N.H. RSA 485-C:6-a and 485-C:13, the New Hampshire Department of Environmental Services (Department), hereby grants this permit to monitor groundwater and surface water for five years at the above described facility subject to the following conditions:

(continued)

STANDARD PERMIT CONDITIONS

1. The permittee shall not cause groundwater degradation that results in a violation of surface water quality standards (N.H. Admin. Rules Env-Ws 1700) in any surface water body.

2. The permittee shall allow any authorized staff of the Department, or its agent, to enter the property covered by this permit for the purpose of collecting information, examining records, collecting samples, or undertaking other action associated with this permit.

3. The permittee shall apply for the renewal of this permit at least 90 days prior to its expiration date.

4. This permit is transferable only upon written request to, and approval of, the Department. Compliance with the existing Permit shall be established prior to permit transfer. Transfer requests shall include the name and address of the person to whom the permit transfer is requested, signature of the current and future permittee, and a summary of all monitoring results to date.

5. The Department reserves the right, under N.H. Admin. Rules Env-Or 600 and Env-Or 700, to require additional hydrogeologic studies and/or remedial measures if the Department receives information indicating the need for such work.

6. Issuance of this permit is based on the application for renewal of groundwater management and release detection permit dated September 27, 2007, the 2007 Summary of Water Quality Monitoring and the historical documents found in the Department file DES Site # 198704033. The Department may require additional hydrogeologic studies and/or remedial measures if invalid or inaccurate data are submitted.

STANDARD MANAGEMENT PERMIT CONDITIONS

7. The permittee shall not violate Ambient Groundwater Quality Standards adopted by the Department (N.H. Admin. Rules Env-Or 600) in groundwater outside the boundaries of the Groundwater Management Zone, as shown on the referenced site plan.

8. Within 30 days of discovery of a violation of an ambient groundwater quality standard at or beyond the Groundwater Management Zone boundary, the permittee shall notify the Department in writing. Within 60 days of discovery, the permittee shall submit recommendations to correct the violation. The Department shall approve the recommendations if the Department determines that they will correct the violation.

STANDARD RELEASE DETECTION CONDITIONS

9. The permittee shall not cause a regulated contaminant as defined in RSA 485-C to be introduced to the ground or groundwater.

10. The permittee shall notify the Department in writing within 10 days of discovery of any constituents in the detection monitoring with a concentration above the background value in any downgradient monitor well. Following the procedures in Env-Or 703.14, Assessment Monitoring, the permittee shall initiate assessment monitoring and, if necessary, submit to the Department a corrective action plan.

(continued)

MONITORING REQUIREMENTS

11. The permittee shall maintain a water quality monitoring program and submit monitoring results to the Department's Groundwater Release Detection Permits Coordinator no later than 45 days after sampling. Samples shall be taken from on-site monitoring wells and surface water sampling points as shown and labeled on the referenced site plan and other sampling points listed on the following table in accordance with the schedule outlined herein:

Monitoring Locations	Sampling Frequency	Parameters
Groundwater Management Wells:		
B-102S, B-102D, B-103S and B-103D	April, July and November each Year	Specific Conductance @ 25° C, pH, COD, Chloride, Nitrate, Bromide, TKN, Dissolved Iron, Dissolved Manganese, Static Water Elevation, and NHDES Petroleum & Hazardous Waste Remediation Full List of Analytes for Volatile Organics
MW-604	July each year	same as above
B-102S, B-102D, B-103S and B-103D	July each year	Arsenic, Barium, Cadmium, Chromium and Lead
Same as above	July 2010	*Acid/Base/Neutral Extractables
Release Detection Wells:		
MW-401, MW-402U&L, MW-403U&L, MW-603, MW-701, MW-801, MW-802, MW-803, B-304UR, B-304DR, B-901U, B-902U, B-903U, B-904U, B-913U&M, B-914U, B-919U&M, B-920U&M, B-921U&M	April, July and November each Year	Specific Conductance @25° C, pH, COD, Chloride, Nitrate, Bromide, TKN, Dissolved Iron, Dissolved Manganese and Static Water Elevation
Same as above	July 2009 and July 2011	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Lead, Nickel, Silver and Thallium
Same as above	July 2010	*Acid/Base/Neutral/Extractables
Same as above	April and November each Year	NHDES Petroleum and Hazardous Waste Remediation Full List of Analytes for Volatile Organics

(continued)

Monitoring Locations	Sampling Frequency	Parameters
Release Detection Wells: (continued)		
MW-801, MW-802, MW-803, B-914U, B-919U and B-919M	April and November each Year	Arsenic
B-901L, B-902L, B-903L, B-904L, B-913L, B-914L, B-919D, B-920D and B-921D	April, July and November each Year	Static Water Elevation
Same as above	July 2008, July 2010 and July 2012	Specific Conductance @25° C, pH COD, Chloride, Nitrate, Bromide, TKN, Dissolved Iron, Dissolved Manganese, and NHDES Petroleum & Hazardous Waste Remediation Full List of Analytes for Volatile Organics
Surface Water Sites		
S-1 (Main Seep) and SF-1 (surface flow from S-1)	April, July and November each Year	Specific Conductance @25° C, pH, COD, Chloride, Nitrate, TKN, Total Iron, Total Manganese, and NHDES Petroleum & Hazardous Waste Remediation Full List of Analytes for Volatile Organics
Springs S-101, S-108 & S-109	July each year	Same as above
Ammonoosuc River Sites AR-1, AR-2 and AR-3	July each year	Same as above
All surface water sites	July 2009	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Lead, Mercury, Nickel, Selenium, Silver and Thallium

*Note: If A/B/N's are above detection limits, further analysis will be required.

Sampling shall be performed in accordance with the documents listed in Env-Or 610.02 (e). Samples shall be analyzed by a laboratory certified by the U.S. Environmental Protection Agency or the New Hampshire Department of Environmental Services. All overburden groundwater samples collected for metal analyses shall be analyzed for dissolved metals; and thus must be field filtered (with a 0.45-micron filter) and acidified after filtration in the field. Surface water samples and samples collected from bedrock or water supply wells shall be analyzed for total metals, and shall not be filtered.

Summaries of water quality shall be submitted annually to the Department's Waste Management Division, attention Groundwater Release Detection Permits Coordinator, in the month of September, using a format acceptable to the Department. The Summary Report shall include the information listed in Env-Or 607.04 (a), as applicable.

(continued)

The Annual Report shall be prepared and stamped by a professional engineer or professional geologist licensed in the State of New Hampshire.

ADDITIONAL CONDITION FOR LANDFILLS

12. The permittee shall construct and maintain a capping system at the facility that meets the standards set forth in Env-Sw 805.10.

SPECIAL CONDITIONS FOR THIS PERMIT

13. The Groundwater Management Zone is shown on the referenced site plan entitled "Groundwater Management Zone Plan," dated July 9, 2007. Recorded property within the Groundwater Management Zone includes the lots as listed and described in the following table:

Tax Map/ Lot #	Property Address	Owner Name and Address	Deed Reference (Book/Page)
419/1	581 Trudeau Road Bethlehem, NH	North Country Environmental Services 25 Greens Hill Lane P.O Box 866 Rutland, VT 05702	2239/862
419/20	395 Laurel Lane Bethlehem, NH	North Country Environmental Services 25 Greens Hill Lane P.O. Box 866 Rutland, VT 05702	2239/862
419/26.1 and 26.2	285 Muchmore Road and 317 Muchmore Road Bethlehem, NH	Forest Acquisitions, Inc. 25 Greens Hill Lane P.O. Box 866 Rutland, VT 05702	2177/345
419/24 and 25	Muchmore Road Bethlehem, NH	Daniel C. Tucker 29 Congress Street P.O. Box 693 Bethlehem, NH 03574 George E. Tucker, III Bethlehem, NH 03574 (last known address) Anna Tucker Miner 501 Wildwood Drive Enterprise, AL (last known address)	1600/807

(continued)

14. Progress reports of remedial activities related to S-1 (the Main Seep) and flowage from S-1, including reduction of manganese and iron concentrations and elimination of associated deposits, shall be submitted to the Department every three months with the first report to be submitted by March 30, 2008.

15. Progress reports of remedial activities near monitoring well couplets MW-402 and MW-403 and the present/former leachate loading areas shall be submitted to the Department every three months with the first report to be submitted by March 30, 2008.

Carl W. Baxter, P.E., Administrator
Hazardous Waste Remediation Bureau
Waste Management Division

Under RSA 21-0:14 and 21-0:9-V, any person aggrieved by any terms or conditions of this permit may appeal to the Waste Management Council in accordance with RSA 541-A and N.H. Admin. Rules, Env-WMC 200. Such appeal must be made to the Council within 30 days and must be addressed to the Chairman of the Waste Management Council, c/o Appeals Clerk, Department of Environmental Services Legal Unit, 29 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095.

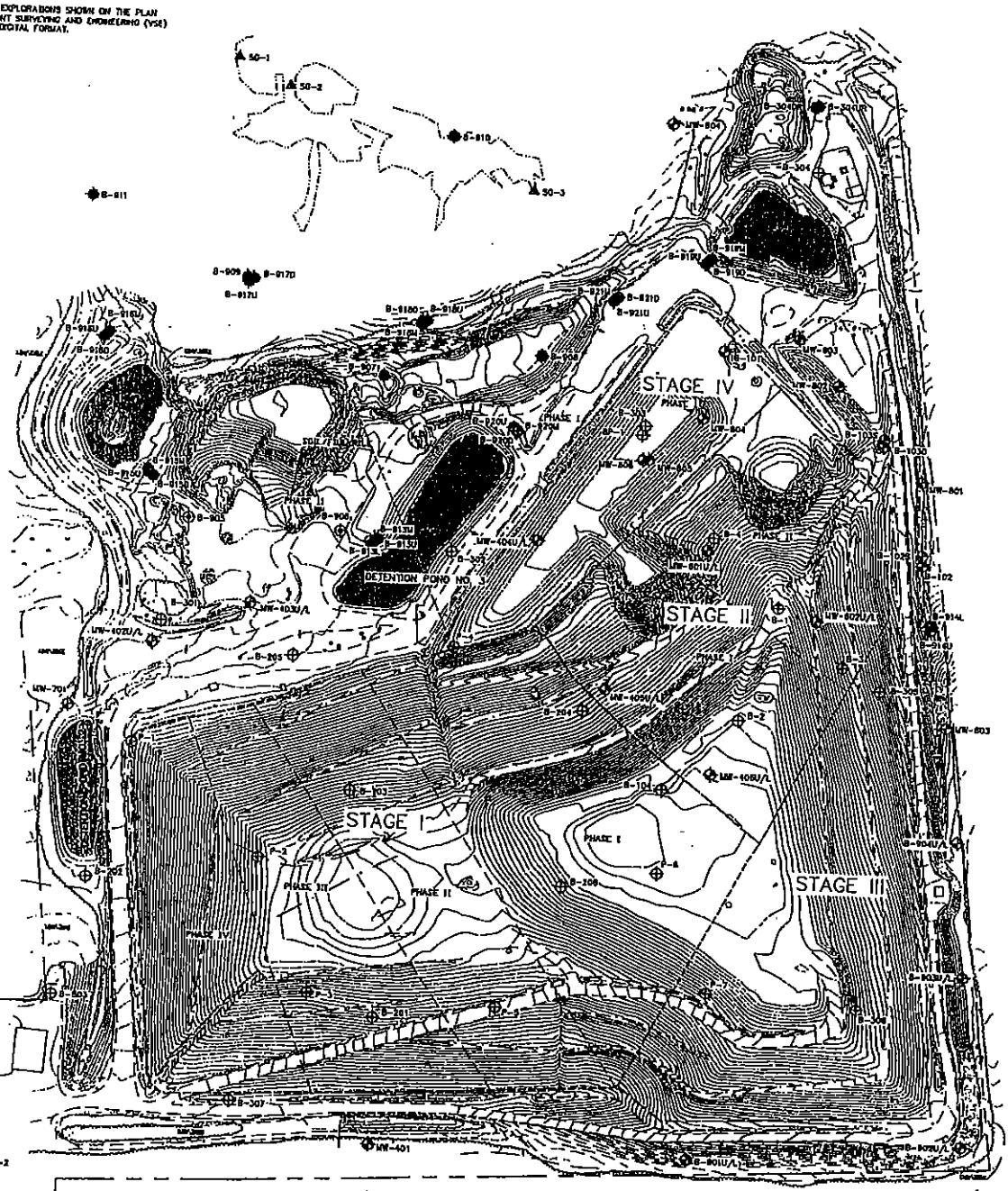
GWP-198704033-B-005

NOTES:

1. THE BASE MAP WAS PROVIDED TO SHA ON NOVEMBER 24, 2008 BY AN ELECTRONIC FILE NAMED "0431(30).DWG" CREATED BY EASTERN TOPOGRAPHICS OF WOLFEBORO, NEW HAMPSHIRE FOR NORTH COUNTRY ENVIRONMENTAL SERVICES, INC. MAPPING WAS COLLECTED FROM AERIAL PHOTOGRAPHY EXPOSED ON DECEMBER 4, 2004 AND COMPILED ON MARCH 11, 2005 USING DIGITAL TERRAIN MODELING METHODS WITH XLT ATLAS SOFTWARE. ORIGINAL SCALE 1" = 40'. HORIZONTAL DATUM IS BASED ON NAD 83 (1996) SPC NH (FEET). VERTICAL DATUM IS BASED ON NAVD 88 (FEET).
2. PROPERTY LINES WERE RECREATED BY METES AND BOUNDS FROM A PLAN ENTITLED "SUBDIVISION PLAN FOR HAROLD BROWN ET. AL. & ROY L. SANBORN ET. AL." CREATED BY GORDON E. ARNSWORTH & ASSOCIATES, INC. DATED FEBRUARY 7, 1985 AND INSERTED USING THE LOCATIONS OF TWO IRON RODS AS REFERENCE POINTS.
3. LOCATIONS OF B-1 THROUGH B-4, P-1 THROUGH P-7, BP-1, BP-2, AND B-200 SERIES EXPLORATIONS WERE DIGITIZED FROM A MARCH 1987 PLAN PREPARED BY GIA GEOENVIRONMENTAL, INC. OF MANCHESTER, NEW HAMPSHIRE ENTITLED, "SANBORN LANDFILL EXPANSION, BETHLEHEM, NEW HAMPSHIRE, EXPLORATION LOCATION PLAN."
4. LOCATIONS OF MONITORING WELLS MW-801 THROUGH MW-805 WERE SURVEYED BY NCES AND PROVIDED TO SHA.
5. TEST BORINGS/MONITORING WELL CLUSTERS B-915 THROUGH B-919 WERE DRILLED/INSTALLED BY CAPITAL ENVIRONMENTAL DRILLING SERVICES OF DUNBARTON, NEW HAMPSHIRE FROM NOVEMBER 13 TO DECEMBER 13, 2000 AND JULY 9 TO AUGUST 8, 2001. THE TEST BORINGS AND MONITORING WELL INSTALLATIONS WERE OBSERVED AND LOGGED BY SHA PERSONNEL. LOCATIONS SHOWN ARE BASED ON FIELD SURVEY PERFORMED ON AUGUST 23, 2001 BY ALLAN SURVEYING, INC. OF NEWPORT, VERMONT.
6. TEST BORINGS/MONITORING WELL CLUSTERS B-920 THROUGH B-921 AND B-304UR/DR WERE DRILLED/INSTALLED BY DUART-LONGYEAR COL-UR, MAINER DIVISION OF NORTH READING, MASSACHUSETTS FROM FEBRUARY 20 TO FEBRUARY 24, 2006. THE TEST BORINGS AND MONITORING WELL INSTALLATIONS WERE OBSERVED AND LOGGED BY SHA PERSONNEL. LOCATIONS SHOWN ARE BASED ON FIELD SURVEY PERFORMED IN APRIL 2006 BY ALPINE LAND SURVEYING INC., OF LITTLETON, NEW HAMPSHIRE (NOTE NO. 3).
7. LOCATIONS OF THE OTHER EXPLORATIONS SHOWN ON THE PLAN WERE SURVEYED BY VERMONT SURVEYING AND ENGINEERING (VSE) AND PROVIDED TO SHA IN DIGITAL FORMAT.

LEGEND:

- FACILITY MONITORING WELL
- NEW STAGE IV/PHASE I MONITORING WELL (INSTALLED FEBRUARY 2006)
- DECOMMISSIONED MONITORING WELL
- EXPLORATION CONDUCTED BEFORE 1988
- EXPLORATION WITH OBSERVATION WELL
- EXPLORATION WITHOUT OBSERVATION WELL
- SURFACE WATER STAFF GAUGE
- SURFACE WATER SAMPLING LOCATION
- U/M/L(D) INDICATES WELL CLUSTER WITH UPPER, MIDDLE AND LOWER (OR DEEP) WELLS
- WETLANDS DELINEATION



RECEIVED

NOTES:

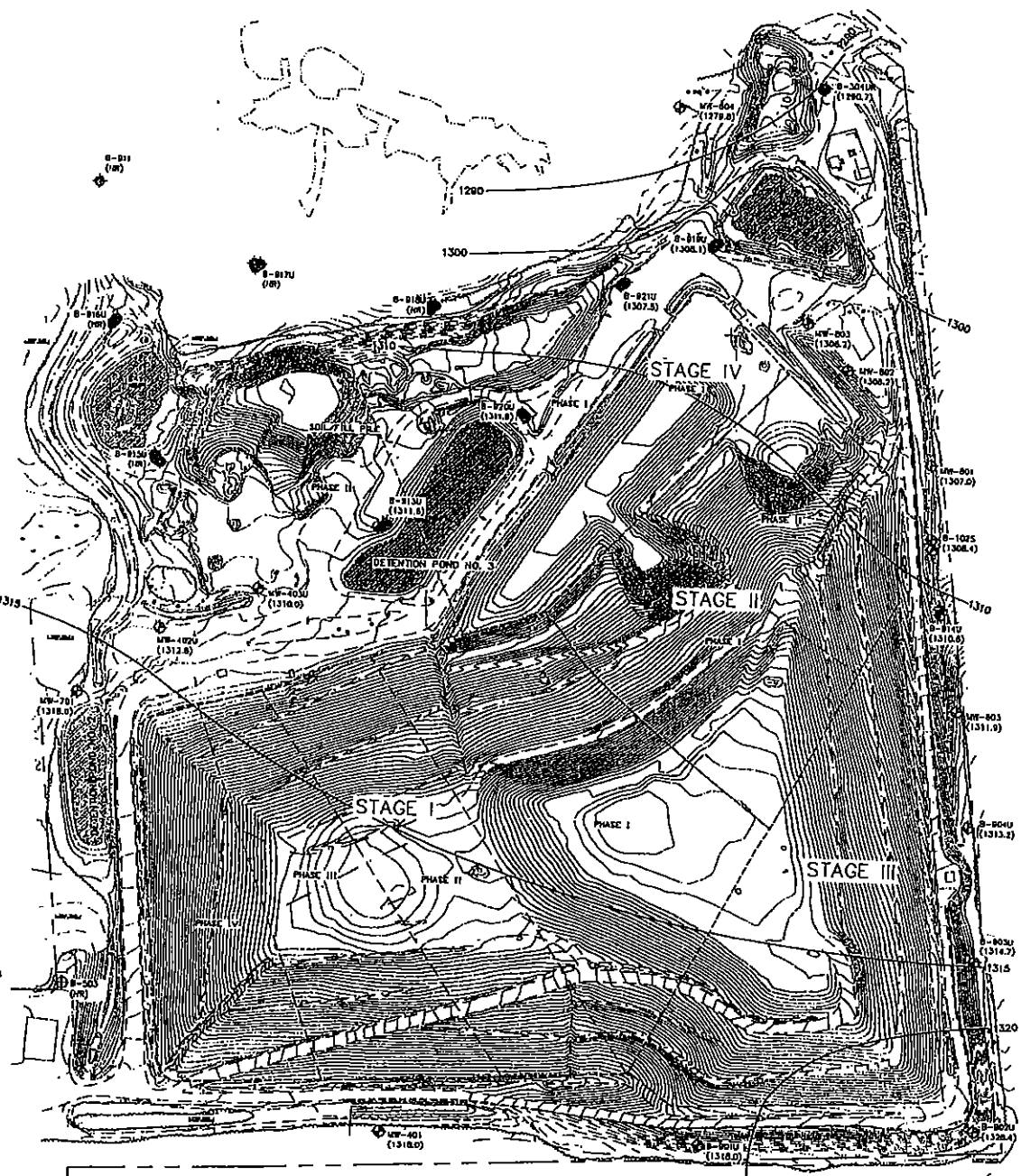
1. THE GROUNDWATER ELEVATION CONTOURS SHOWN ARE BASED ON GROUNDWATER LEVELS MEASURED BY SEA PERSONNEL IN WELLS SCREENED ACROSS THE WATER TABLE ON JULY 25-26, 2007.

2. GROUNDWATER ELEVATION CONTOURS WERE DEVELOPED USING GENERALLY-ACCEPTED HYDROGEOLOGIC PRACTICES, AND ARE INTENDED TO REFLECT TRENDS IN GROUNDWATER LEVELS CONSISTENT WITH THE AVAILABLE INFORMATION. VARIATIONS IN GROUNDWATER ELEVATIONS ARE EXPECTED TO OCCUR DUE TO CHANGES IN PRECIPITATION, TEMPERATURE, AND OTHER FACTORS NOT EVIDENT AT THE TIME WATER LEVEL MEASUREMENTS WERE OBTAINED. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN AND OTHER INTERPRETATIONS ARE POSSIBLE.

3. REFER TO FIGURE NO. 2 FOR ADDITIONAL NOTES.

LEGEND

- FACILITY MONITORING WELL
- EXPLORATION CONDUCTED BEFORE 1988
- EXPLORATION WITH AN OBSERVATION WELL
- SURFACE WATER STAFF GAUGE
- SURFACE WATER SAMPLING LOCATION
- U INDICATES UPPER WELL
- L INDICATES LOWER WELL
- S INDICATES SHALLOW WELL
- M INDICATES SCREEN AT MID-LEVEL BETWEEN UPPER AND LOWER SCREENS
- D INDICATES DEEP WELL
- (1302.04) GROUNDWATER ELEVATION RECORDED AT WELL LOCATION
- (NR) GROUNDWATER ELEVATION WAS NOT RECORDED AT WELL LOCATION
- 1300 GROUNDWATER ELEVATION CONTOUR (DASHED WHERE LESS CONSTRAINED)



LOCUS MAP
NOT TO SCALE

TAX MAP 419
NOT TO SCALE

AMMONOOSUC RIVER

HUGHES ROAD

TM 419 LOT 26.1
FOREST ACQUISITIONS, INC.
V. 2071 PG. 345

TM 419 LOT 26.2
FOREST ACQUISITIONS, INC.
V. 2071 PG. 343

TM 419 LOT 25
TUCKER, GEORGE W & DANIEL
MINER, ANNA
V. 1600 PG. 601

TM 419 LOT 24
TUCKER, GEORGE W & DANIEL
MINER, ANNA
V. 1600 PG. 601

TM 419 LOT 18
NORTH COUNTRY
ENVIRONMENTAL SERVICES, INC.
V. 2239 PG. 662
54000 S.F.
1.24 AC.
SEE PLAN REF. 1

TM 419 LOT 20
NORTH COUNTRY
ENVIRONMENTAL SERVICES, INC.
V. 2239 PG. 662
136400 S.F.
3.13 AC.
SEE PLAN REF. 1

TM 419 LOT 1
NORTH COUNTRY
ENVIRONMENTAL SERVICES, INC.
V. 2239 PG. 662
4506369 S.F.
103.429 AC.
SEE PLAN REF. 1 & 2

GROUNDWATER MANAGEMENT ZONE
27.4 AC. ±

POND

N 647369.8899
E 994424.9324

GRAPHIC SCALE
(IN FEET)
1 inch = 100 ft.

DETAIL
NOT TO SCALE

LEGEND

- FOUND MONUMENT
- SET MONUMENT
- CALCULATED POINT
- PROPERTY LINE
- GROUNDWATER MANAGEMENT ZONE BOUNDARY
- EDGE OF GRAVEL
- UTILITY POLE
- TREE LINE
- ABUTTER'S LINE OF TITLE

GENERAL NOTES

1. BEING OF MAY LINES SHOWN HEREON ARE BASED ON PLANS OF RECORD AND CORRESPONDING PHYSICAL EVIDENCE FOUND. B.M. BASIS OF MAY MAY EXTEND INTO THE SUBJECT PARCEL BEYOND THOSE LINES SHOWN HEREON.
2. BOUNDARY INFORMATION FOR PARCELS OWNED BY NORTH COUNTRY ENVIRONMENTAL SERVICES, INC. SHOWN HEREON CAN BE FOUND ON PLAN REFERENCE 1.

SURVEY NOTES

THIS MH URBAN SURVEY IS BASED ON A RAMSDEN, CLOSED LOOP TRAVERSE, WITH A TOPCON GTS-302 (SERIAL NO. D40253) TOTAL STATION. RAW TRAVERSE ERROR OF CLOSURE 1 FT. IN 12,000 FT.
BASIS OF BEARING IS PROJECT GRID.
ELEVATION DATUM IS BASED ON LOCAL U.S.G.S. SHEET.
DEED RESEARCH WAS COMPLETED BY JAJD. ON 3 JANUARY 2002
FIELD SURVEY WAS COMPLETED BY HJJB, A.JHD. ON 4 JULY 2007
MONUMENTATION WAS COMPLETED AS NOTED ON PLAN

OWNER:
NORTH COUNTRY
ENVIRONMENTAL SERVICES, INC.
[illegible]

NO.	DESCRIPTION OF REVISION	DATE

REVISIONS

ALPINE LAND SURVEYING CO.
BOUNDARY SURVEYS - SUBDIVISIONS - CONSTRUCTION STAKING
24 MORRISON HILL ROAD
LITTLETON, N.H.
603 444-0323 PHONE / 603 444-3778 FAX
EMAIL: alpinesrv@dolphin.net

JOB NO: [illegible]
FILE NAME: [illegible]
PLAN DATE: [illegible]
DRAWN BY: JMD

CERTIFICATION

"I CERTIFY THAT THIS SURVEY PLAT IS NOT A SUBDIVISION PURSUANT TO RSA 674:37, TITLE LXIV AND THAT THE LINES OF STREETS AND WAYS SHOWN ARE BEING OF PUBLIC OR PRIVATE STREETS OR WAYS ALREADY ESTABLISHED AND THAT NO NEW WAYS ARE SHOWN." RSA 676:18, IV

DATE: 30 AUGUST 2007 SEAL BROOKS L.L.S.

GROUNDWATER MANAGEMENT ZONE PLAN
FOR
NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.

TOWN OF BETHLEHEM, NEW HAMPSHIRE
COUNTY OF GRAFTON

BETHLEHEM TAX MAP 419 LOT 1

Appendix H

Leachate Breakout Repair Logs and Field Sketch

BREAKOUT REPAIR LOG
North Country Environmental Services, Inc.
Bethlehem, New Hampshire

Date:_____

Description of Breakout (Site and Location):

_____
_____
_____
_____
_____
_____
_____
_____

Steps to Repair Breakout:

_____
_____
_____
_____
_____
_____
_____
_____
_____

North Country Environmental Services Representative:_____

Signature

CMA
ENGINEERS
CIVIL/ENVIRONMENTAL ENGINEERS

)5 Bow Street
Portsmouth, New Hampshire
03801-3819
Phone: 603/431-6196
Fax: 603/431-5376

Lafayette Center
Storer Street Building, Suite 208
Kennebunk, Maine 04043
Phone: 207/985-8717
Fax: 207/985-5520

E-mail: info@cmaengineers.com

NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.

BETHLEHEM, NEW HAMPSHIRE

- FIELD SKETCH-

200 0 100 200 400

1 inch = 200 ft.

F:\CADD\PROJECTS\656\656.01\dwg\Preliminary\65601p0&M FIGURE.dwg 2/8/2007 12:53:23 PM EST

Appendix I

Operating Procedures for Segregating and On-Site Stockpiling and Processing of Construction and Demolition Debris

APPENDIX I

OPERATING PROCEDURES FOR SEGREGATING AND LOADING SELECT CONSTRUCTION AND DEMOLITION DEBRIS (C&D)

North Country Environmental Services, Inc. (NCES) may segregate certain C&D materials for off-Site management. Materials which may be segregated include wood wastes, metals and cardboard. Incoming loads of C&D which appear to have a large percentage of materials which may be recycled or further processed at off-Site facilities will be directed to discharge their load in an area within the landfill but outside the active working face. The materials which may be shipped off-Site for processing or recycling will be segregated. Metals and other materials may be removed by hand or by an excavator, cherry picker or other equipment such as a loader. When sufficient material has collected it is to be loaded into trucks using a loader or excavator.

The loaded truck is to be directed over the scale to track the quantity of material hauled from the Site. The destination of the material will be tracked by the facility. Not more than 100 tons of C&D and segregated material will be stockpiled at any one time. Residual materials are to be placed in a lift at the active.

Appendix J

Bird Control Plan

North Country Environmental Services, Inc.
Bethlehem, New Hampshire

BIRD CONTROL PLAN

1.0 OBJECTIVE

The objective of this plan is to prevent birds from foraging the landfill, thereby controlling the number of birds in the vicinity of the landfill to the population normally sustained in the area. This plan identifies personnel responsible to implement the plan, describes the bird control measures, and presents the monitoring program to be used to evaluate the effectiveness of the mitigation process.

2.0 PERSONNEL AND RESPONSIBILITIES

Implementation of this plan will involve a variety of personnel including the Landfill Manager, a Bird Control Officer, and other members of the landfill staff. All landfill staff will be familiar with the goals and methods presented in this plan. Staff will be made aware that nothing but maximum effectiveness of the bird control measures is acceptable. Specific responsibilities of persons responsible for implementation of this plan are described below.

2.1 Landfill Manager

The Landfill Manager has ultimate responsibility for implementation of the plan. The Manager will meet with staff regularly, periodically review procedures, and communicate regularly with corporate environmental engineering staff.

2.2 Bird Control Officer

The Bird Control Officer will be a designated landfill staff member who will devote his/her time on an as needed basis to bird control efforts. If necessary, a staff member whose sole responsibility will be bird control will be hired. The Bird Control Officer or a designated alternate will be on site at all times during landfill business hours. The Bird Control Officer should be reachable at all times by radio. Specific duties of the Bird Control Officer include:

- Assuring that equipment is in good working order and that adequate supplies are on site;
- Being responsible for the habitat management and bird dispersal methods being implemented;
- Recording data on bird control efforts and bird responses; and

- Communicating with the Landfill Manager and corporate engineering staff on a routine basis.

3.0 OVERALL BIRD MANAGEMENT STRATEGY

The overall bird management strategy will include a coordinated effort involving habitat management, dispersal techniques, exclusion techniques, and if necessary, lethal methods. The goal of the coordinated effort is to disrupt the daily pattern of feeding and loafing at the facility. These elements are discussed below.

3.1 Habitat Management

Habitat management is the primary effort in bird control. The effectiveness of the dispersal techniques discussed in Section 4.2 is limited by the attractiveness of the site to birds. All birds found at landfills, but especially gulls, prefer to loaf and wait for fresh waste to be dumped in level open areas where they have unrestricted visibility. Other conditions that attract birds include sources of drinking/bathing water and relatively large open areas devoid of vegetation or with mowed vegetation that provide a secure area for the birds to rest. Effective habitat management will involved:

- Limiting the active area where refuse is deposited to the degree practical;

- Applying adequate daily cover to bury the waste rendering the food source inaccessible to the birds. There is sufficient soil on site for use as daily/intermediate cover. responsibility of the Bird Control Officer will be to inspect the working face to see that the area is limited and that adequate cover material has been applied;

- Allowing vegetation to become established and maintained at a height of 10 to 12 inches or more over as much of the site as practical to limit areas birds find attractive for loafing. Mowed areas should be limited with mowing of open grassy areas taking place once a year, in the spring when the grass will recover quickly, and

- Assuring that the sedimentation ponds drain as designed after each rainfall event to limit the area of on site surface water where birds could drink or bathe.

3.2 Dispersal Techniques

Dispersal techniques are also a critical element of bird control. The objective of the dispersal techniques is to prevent birds that may still be attracted to the site from landing. Dispersal techniques must be varied so that the birds do not become used to the method being employed so that it loses effectiveness. Techniques which will be used to include the use of scare devices, human patrols, gull distress tapes and scarecrow of a dead gull. These are discussed below.

3.2.1 Scare Devices

Scare devices include shotcrackers or whistles that are non-lethal noise producing projectiles fired from a gun. Some have a time delay that allows them to travel nearer to gulls before exploding, while others whistle as the projectile passes through the air. The Bird Control Officer will maintain a supply of at least three different types of shotcrackers/whistles on site.

The noise producing projectiles should be used by the Bird Officer during daylight hours. The projectiles will be fired when the birds are on the ground or attempting to land. The type of projectile used should be varied so that the birds do not become habituated to the particular device and it loses effectiveness.

3.2.2 Human Patrols

The Bird Control Officer is responsible to patrol the site, to observe the effectiveness of the habitat management techniques, and to disperse birds. At least two patrols should be conducted each day the landfill is operating, one in the morning and the second in the afternoon. The afternoon patrol should generally be completed at the end of the day to observe that cover soils are placed over the waste and that bird control measures are being effectively employed. Other patrols should be performed as necessary to deter birds from the site. The Bird Control Officer will complete a form documenting observations made on the patrol such as the number of the birds noted, the methods used to deter the birds, such as number of projectiles fired, and the response of the birds to the dispersal technique. Improvements to the Habitat Management program or the need for exclusion techniques (discussed in Section 3.3) should be identified during the patrols. The daily patrol records will be maintained at the facility to document the day-to-day bird control efforts.

3.2.3 Gull Distress Tapes and Scarecrows

In addition to the use of projectiles, recordings of distressed gulls are available. These will be played from time to time and used in conjunction with shotcrackers and a scarecrow of a dead gull placed in areas where they are visible to birds attempting to land. As with other methods, the tapes should not be played continually and the scarecrows should be moved frequently to maintain their effectiveness.

3.3 Shooting

Lethal methods such as shooting may be employed if permitted by the U.S. Fish and Wildlife Department. This method would not be used as a means of control but, would be used to prevent gulls from becoming habituated to other methods such as shotcrackers.

NCES LANDFILL

BIRD PATROL SUMMARY

INSPECTORS: _____ DATE: _____

_____ TIME: _____

WEATHER CONDITIONS: _____

	YES	NO	NA	COMMENTS/ ACTIONS TAKEN
1. Is the active fill area limited?	____	____	____	_____
2. Are gulls or other birds loafing on the active fill area?	____	____	____	_____
3. Are birds present on the inactive portions of the landfill?	____	____	____	_____
4. Is there sufficient cover on inactive area?	____	____	____	_____
5. Are birds present in the open areas to the landfill?	____	____	____	_____

SUPPLIES USED:

_____

ADDITIONAL COMMENTS:

_____

_____

_____

_____ _____

SIGNATURE DATE

Section V

REVISED CLOSURE PLAN

REVISED CLOSURE PLAN

Stage IV Phase II Construction
North Country Environmental Services, Inc.
Bethlehem, New Hampshire

Prepared for:
North Country Environmental Services, Inc.

Prepared by:
CMA Engineers, Inc.
February 2009

REVISED CLOSURE PLAN

TABLE OF CONTENTS

	Section	Page
1.0	Facility Identification	1
2.0	Closure Schedule	1
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4.0	Notifications	2
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7.0	Record Keeping and Reporting	6
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9.0	Closure Cost Estimate	6

Attachment A – Final Grading and Closure System Details
Attachment B – Gas Extraction Plan and Detail
Attachment C – Closure and Post Closure Cost Estimates

Revised Closure Plan

1.0 FACILITY IDENTIFICATION

This Closure Plan describes the procedures and provisions for closing of the North Country Environmental Services, Inc. (NCES) Landfill under the assumption that NCES does not seek and obtain approvals for operations beyond Stage IV, Phase II. If NCES does obtain such approvals, the Closure Plan will have to be modified accordingly.

Closure of the facility will involve expanding the gas management system and constructing and maintaining a capping system. Design drawings referenced in this Closure Plan were prepared by CMA Engineers, Inc. (CMA).

Facility Name:	North Country Environmental Services, Inc.
Mailing Address:	P0 Box 9
	Bethlehem, NH 03574
Location:	581 Trudeau Road
	Bethlehem, New Hampshire
Permit No:	DES-SW-SP-03-002

2.0 CLOSURE SCHEDULE

It is anticipated that closure construction will take place in phases. The initial phase will involve expanding the gas system into remaining areas of the landfill, including Stage IV Phases I. (It is noted that existing capping system must be removed from portions of Stage I to construct the overlay liner system for operation of Stage IV, Phase II). The second phase will include placing final cover over those portions of the landfill that are filled to final intermediate cover grades, which are 2.83 feet below the approved final grades. A third phase of closure construction will take place after filling in Stage IV Phase II is completed, likely in 2017 and thereafter.

Based on an anticipated incoming refuse volume, it is anticipated that Stage IV Phase II portion of the landfill will be filled to capacity in about 10 years. It is expected that cap construction will also take place in 2016, 2017 and 2018 as the facility is filled to capacity. Disposal operations will cease when the facility is filled to final grades. Prior to that time, the gas management system will be expanded and final cover will be constructed over those areas which have not yet received final cover. It is anticipated that each phase of cap construction will take place in accordance with the schedule outlined below.

Work Item	Time Frame (in weeks)
Prepare construction plans for New Hampshire Department of Environmental Services (NHDES) review (to be completed by March 1st)	6
NHDES review and approval	4
Gas management system expansion. (Includes installation of gas wells and associated well heads, laterals, header piping and valves)	8
Fine grade intermediate cover	1
Placement of Gas Transmission Layer	2
Placement of Screened Till bedding	3
Installation of geomembrane, drainage geocomposite and granular soil cover	10
Placement of topsoil and hydroseeding	4

3.0 WASTE IDENTIFICATION

Waste materials to be accepted for disposal in the NCES landfill are identified in Section 2.0 of the Operating Plan and include municipal, residential, commercial, and industrial solid waste and demolition debris. Special non-hazardous solid wastes may also be disposed at the facility following receipt of NHDES approval for acceptance of such wastes.

4.0 NOTIFICATIONS

Those users with waste disposal contracts with the facility will be notified by registered mail at least 60 days prior to the time when it is anticipated that the facility will be filled to final grades. The Waste Management Division is to be notified with the filing of a Notice of Intent to Close. The Notice is to contain the information required by Env-Sw 1104.02 including, the date the facility intends to stop receiving waste, a reference to the approved Closure Plan, and the date the facility intends to commence closure activities.

5.0 CLOSURE REQUIREMENTS

The facility will be closed as final grades are attained and the final cover is placed. It is anticipated that cap construction will take place during the summer construction season. Proposed final grades and cover section details are shown on the attached Final Grading Plan and Closure System Details, Sheets A-1 and A-2. Technical Specifications for the work are provided in Appendix A of Section VI of the Stage IV Standard Permit Application. At least one month prior to the start of construction of the closure, construction plans are to be submitted to NHDES for review and approval.

Prior to construction of the final cover, the active gas management system will be extended in the area to be capped. The gas management system includes gas extraction wells and associated well heads which are connected by laterals to a ring header through which gas collected from the landfill is conveyed to the blower. Existing ring headers will be used as long as possible. A new ring header at a higher elevation may be required, and will be installed as necessary. Condensate drip legs will be provided to remove condensate which collects in the piping in the landfill. The

proposed locations of gas wells and appurtenances and the header pipe are identified on the attached Gas Extraction System Plans and Details, Sheet B-1. Typical details of gas system components are provided on Sheet B-4.

Prior to placing cover materials, the intermediate cover will be fine-graded. Next, a 6-inch layer of Gas Transmission Layer fill will be placed. This material is a granular soil with a silt content less than 8 percent. This Gas Transmission Layer fill will be overlain by a minimum of 6 inches of Screened Till bedding soil. The Screened Till is a fine-grained glacial till soil which is screened to provide a material with a maximum stone size of 1 inch. Intermediate swales will be shaped of the Screened Till. The geomembrane cap consisting of textured 40-mil linear low density polyethylene (LLDPE) will be installed over the subgrade and overlain by drainage geocomposite, 18 inches of Granular Soil Cover and 4 inches of topsoil which is to be seeded. A crushed rock drain is to be provided at the toe of slope to allow water in the geocomposite above the geomembrane cap to drain freely to the perimeter swale.

The cap drainage system includes intermediate swales typically spaced a minimum of 100 feet apart on the landfill slopes. The drainage geocomposite will pass through the intermediate swales and continue down the slope. A fabric-wrapped drainage pipe will be provided in the invert of the swale above the drainage geocomposite to provide an outlet for water drainage in the cover section. The intermediate swales will drain to the gabion-lined interceptor swales which convey stormwater off the cap to the landfill perimeter.

6.0 POST-CLOSURE REQUIREMENTS

Following facility closure, post-closure monitoring is to be performed. The purpose of post-closure monitoring is to observe that the physical integrity of the Site is maintained and to perform groundwater and landfill gas monitoring. Formal inspections of facility systems are to be performed no less than twice each year (April and November). The report following each formal inspection is to be submitted to NHDES. Observations of site conditions are also to be made during routine monitoring. Items not performing as intended are to be repaired in a timely manner to maintain the integrity of the closed landfill. Post-closure monitoring is to be performed in accordance with applicable law.

Post-closure monitoring will involve:

- Review of the Site perimeter to assure that access to the Site is restricted. A fence will be provided around the facility to restrict access to the Site. Access to the property will be maintained via the main gate to permit post-closure monitoring;

- Inspection of the stormwater management system, including culverts, swales, catch basins and the detention ponds. The stormwater detention ponds will be cleaned to assure

that they function as intended. Culverts will be checked to see that they are clear and sediments that have accumulated in swales will be removed. Catch basins will be cleared of sediment, debris, and any blockage;

- Inspection of landfill cap to note that vegetation is well established and has been mowed as required to prevent trees and shrubs from growing on the cap and to look for evidence of settlement or damage due to erosion. The surface of the landfill will be monitored for settlement. Benchmarks and control points have been established at the Site to provide survey control for topographic surveys of the final cap. The primary concern with respect to settlement is potential damage to the cap or ponding on the geomembrane surface;

- Differential settlement large enough to result in those conditions will be evident during routine monitoring. Settlement identified during the post-closure inspections which results in ponding or impedes drainage will be repaired. In the event there is erosion of the cover soils, the damage is to be repaired and the cause investigated and eliminated to the extent practical;

- Monitoring the perimeter berm for evidence of erosion. Any damaged noted is to be repaired and the cause determined and addressed;

- Inspection of the gas management system in accordance with the requirements outlined in the Gas System Operation and Maintenance Manual;

- Inspection of the leachate collection system appurtenances to include checking pumps and controls to determine that they are functioning properly and to collect data regarding the quantities of leachate collected from the various phases of the facility. Samples of the primary leachate are to be collected in April, July and November and analyzed for the parameters outlined in Env-Sw *806.08(d)5.* An increase in the rate of leachate removed from the facility is to be investigated to assess the cause;

- Reviewing the performance of the leak detection system by monitoring flows in the secondary leachate collection system. In the event the flow increases above historic levels, an investigation as to the cause is to be conducted;

- Groundwater and surface water quality monitoring in accordance with the Groundwater Permit for the facility. Groundwater monitoring wells will be checked during each sampling round. Damage to a well or its protective casing will be repaired to facilitate continued usage of the well; and

- Landfill gas monitoring in accordance with the Gas Monitoring Plan.

7.0 RECORD KEEPING AND REPORTING

Within 30 days following each inspection, a report is to be provided in duplicate to the Waste Management Division of NHDES signed by a person duly authorized to sign for and on behalf of NCES. Both copies of the report are to bear an original signature. In addition to the inspection reports, an annual report is to be filed for the facility containing the information outlined in Env-Sw 1105.14 including an evaluation of environmental monitoring data and other information pertaining to facility conditions. The report is to include a statement by a Professional Engineer identifying whether the facility is achieving post-closure performance expectations and whether adjustments to the post closure monitoring and maintenance provisions are recommended in light of the performance evaluation.

Following closure, facility records are to be maintained at the NCES permitting and compliance office. Records are not to be moved or destroyed unless such action is approved by NHDES pursuant to a Type V Permit Modification.

8.0 OTHER PERMITS

A Type II Permit Modification is required prior to closure construction. At this time it is not anticipated that any post-closure permits will be required. Permits such as the facility Groundwater Management Permit (GMP) are to be renewed as required.

9.0 CLOSURE COST ESTIMATE

A closure cost estimate calculated assuming a third party performs closure and post-closure activities in accordance with this Closure Plan is attached. The costs incorporated are based on bid prices for similar projects and NCES' experience at this and other facilities. Post-closure costs have been calculated for a 30-year post-closure period and presented in present 2008 dollars in Attachment C. The closure cost estimate is to be updated as appropriate to reflect modifications to the Closure Plan, or as new landfill phases are developed or portions of the facility are closed.

Attachment A

Final Grading and Closure System Details

Attachment B

Gas Extraction System Plan and Details

Attachment C

Closure and Post Closure Cost Estimates

Cost Estimate Form for Closure of a Lined Landfill

LOG# (for DES use only)

Facility Name:	North Country Environmental Services Landfill
Address of Facility:	Trudeau Road, Bethlehem, NH
C[illegible]r:	North Country Environmental Services, Inc.
Phase: Stage IV Phase II	
Acreage: 38.0	
DES Permit #: DES-SW-SP-03-002	
Site# (DES Use Only)	Facility # (DES Use Only)

State of New Hampshire
Waste Management Division
Department of Environmental Services
29 Hazen Drive, PO Box 95, Concord, NH 03302-0095
(603) 271-2925 FAX 603-271-2456
TDD Access: Relay NH 1-800-735-2964

Complete this form in accordance with the NH Solid Waste Rules Part Env-Sw 313.

	Task	DES Use Only	Unit	Unit Cost	Quantity	Total Cost
I	**Design of Final Closure Plans**	Cat 1				
	Engineering Cost	100	TS	$80,000.00	1	$80,000.00
	Plans	110	TS	$7,500.00	1	$7,500.00
	Modification/Closure Plan Review Fees	120	TS	$5,250.00	1	$5,250.00
II	**Mobilization, Demobilization & Insurance**	Cat 2				
	Total cost	200	TS	$300,000.00	1	$300,000.00
	Other (Health and Safety Plan)	210	LS	$5,000.00	1	$5,000.00
III	**Erosion Control**	Cat 3				
	Silt Fence	300	LF	$3.50	1,000	$3,500.00
	Erosion Matting/ Blanket	310	LS	$5,000.00	1	$5,000.00
	Hay Bale Sediment Barrier	320	LF	$5.50	360	$1,980.00
	Hay Mulch Cover	330				
	Check Dams	340	EA	$50.00	16	$800.00
	Other (Misc.)	350	LS	$5,000.00	1	$5,000.00
IV	**Waste Relocation**	Cat 4				
	Test Pits (to define limits of refuse and/or ground water to refuse contact)	400	DAY			
	Clearing & Grubbing	410	AC			
	Waste Regrading (Refuse Excavation/Relocation & Compaction)	420	LS			
	Other (Misc. Grading)	430	LS			
V	Capping	Cat 5				
A	Cap (Material and Installation)					
	Geomembrane (Includes testing)	510	SF	$0.45	1,655,280	$744,876.00
	Soil	520	CY			
	Testing	530				
	Anchor Trench	540	LF	$1.50	5,220	$7,830.00
	Other (Geocomposite)	550	SF	$0.55	1,655,280	$910,404.00
B	Gas Vents Devices	Cat 6				
	Vertical Gas Vents/Wells	600	VF	$105.00	520	$54,600.00
	12" Header Pipe		LF	$70.00	3,130	$219,100.00
	6" Lateral Pipe		LF	$64.00	850	$54,400.00
	4" Lateral Pipe		LF	$55.00	730	$40,150.00
	12" Control Valves		EA	$6,500.00	3	$19,500.00
	Wellheads		EA	$650.00	16	$10,400.00
	Road Crossing		LF	$40.00	75	$3,000.00
	3" Condensate Forcemain		LF	$20.00	815	$16,300.00
	Compressed Air Piping (Common Trench)		LF	$15.00	4,000	$60,000.00
	Well Drilling Access Preparation		DAY	$2,000.00	7	$14,000.00
	Capping System Repairs		EA	$1,400.00	16	$22,400.00
	Drainage Swale Crossings		LF	$50.00	160	$8,000.00
	Other	610	LS			

	Task		Unit	Unit Cost	Quantity	Total Cost
C	Layers	Cat 7				
	Drainage Layer - Free Draining Sand - 12" thick	700	CY	$18.00	61307	$1,103,520.00
	Intermediate Cover Placement	710	CY			
	Sand - Protective Gas Venting Layer - 6" thick	720	CY	$14.00	30653	$429,146.67
	Topsoil/Loam or Manufactured Soil - 4" thick	730	CY	$22.00	20436	$449,582.22
	Other (Screened Till - 6" thick bedding & 6" thick moisture retention)	740	CY	$10.00	61307	$613,066.67
VI	**Stabilization, Run-off Control**	Cat 8				
	Seed & Mulch (Include Lime, Fertilizer, Seed & Hay Mulch)	800	AC	$1,800.00	38	$68,400.00
	Stone Lined Drainage Benches	810	LF	$50.00	12,940	$647,000.00
	Stone Rip-Rap (Swales, Spillways)	820	CY	$35.00	150	$5,250.00
	Seepage Bench		LF	$20.00	5,450	$109,000.00
	Catch Basins, Manholes & Drop Inlets	830				
	Toe Drain	840	LF	$50.00	4,330	$216,500.00
	Detention Pond and Associated Outlet Devices	850				
	Other – Tri-Lock Lined Dropchutes	860	LF	$100.00	470	$47,000.00
VII	**Monitoring Devices**	Cat 9				
	Settlement Monuments/Plates	900	EA	$650.00	30	$19,500.00
	Groundwater Monitoring Wells	910	EA			
	Gas Monitoring Probes	920				
	Other	930				
VIII	**Roadway**	Cat 10				
	Access Roadway (Gravel Perimeter + Top Berm Access)	1000	LF	$75.00	800	$60,000.00
	Drainage Ditches (Grass Lined)	1010				
	Culvert Inlet & Outlet Headwalls	1020				
	Guide Rail (Single and Double)	1030	LF			
	Dust Control - Calcium Chloride	1040				
	New/Replaced Pavement	1050	SY			
	Other	1060				
IX	**Miscellaneous**	Cat 11				
	Signs	1100	LS			
	Perimeter Fence	1110	LF	$18.50	5650	$104,525.00
	Entry Gate - Double Unit	1120	EA			
	Miscellaneous Work and Cleanup	1130	LS			
	Ledge Removal	1140	CY			
	Other	1150				
X	**Surveying**	Cat 12				
	Baseline, Bench Marks, and Survey Control	1200	LS	$20,000.00	1	$20,000.00
	Other	1210				
XI	**Construction Phase Testing**	Cat 13				
	Compaction Testing	1300				
	QAQC	1310	LS	$4,000.00	35.15	$140,600.00
	Other	1320				
XII	**Engineering**	Cat 14				
	Resident Engineer, Project Manager, Project Engineer	1400	LS	$250,000.00	1	$250,000.00
	Record Drawings/ As-Built	1410	LS	$20,000.00	1	$20,000.00
	Other	1420				
XIII	**Other (list)**	Cat 15				
		1500				
		1510				
XIV	**Contingency (minimum 10%)**	Cat 16				
		1600	LS	10%	$6,902,100.00	$690,210.00
	Total Cost					**$7,592,300.00**

Signature of Preparer: (must be prepared by a Professional Engineer)

Date: 2/9/09

THE STATE OF NEW HAMPSHIRE
JEFFREY S. MURRAY
No. 10139
LICENSED
PROFESSIONAL ENGINEER

This form provides a basis for cost estimating closure costs for a lined landfill. This form is not inclusive of all costs that may be associated with the landfill closure.
The cost estimate must include all items needed to comply with all DES permits. Please use the spaces provided above noted as "Other" or attach an additional sheet if necessary.

Cost Estimate Form for Post Closure of a Landfill

(lined or unlined)

State of New Hampshire
Department of Environmental Services
Waste Management Division
29 Hazen Drive, PO Box 95, Concord, NH 03302-0095
(603) 271-2925 FAX 603-271-2456
TDD Access: Relay NH 1-800-735-2964

Facility Name: North Country Environmental Services	Date: 12/4/2008
Owner: North Country Environmental Services, Inc.	
Address of Facility: 581 Trudeau Road, Bethlehem, NH	
Acreage: 34.2 Acres	Phase: Stage I through Stage IV - Phase I
DES Permit #: DES-SW-SP-03-02	Log #: (for DES Use Only)
Facility # (for DES Use Only)	Site #: (for DES Use Only)

Complete this form in accordance with the NH Solid Waste Rules Part Env-Wm 3100.

Task	Unit	Unit Cost	Quantity	Total Cost
I Water Monitoring				
Surface Water Sampling & Analysis				
Other (Permit Requirement)				
Ground Water Sampling & Analysis	LS	$44,000.00	1	$44,000
Other (Permit Requirement)				
Other				
II Gas Monitoring				
Landfill Gas Migration Monitoring	LS	$8,000.00	1	$8,000
Operation and Maintenance of Gas Collection System	LS	$69,820.00	1	$69,820
Other - Maintenance of Wells & Probes	LS	$1,100.00	1	$1,100
III Settlement Monitoring				
Field Survey	LS	$1,650.00	1	$1,650
Data Tabulation	LS			
Other				
IV Leachate Collection/Monitoring				
Sewer Charges	LS	$87,500.00	1	$87,500
Electricity				
Maintenance of Collection System				
Sampling & Analysis	LS	$7,100.00	1	$7,100
Other - Pump System O&M	LS	$19,000.00	1	$19,000
V Air Quality Data				
Monitoring & Analysis				
Other				
VI Repair & Site Maintainance Costs				
Snow Removal	LS	$500.00	1	$500
Roadway Maintenance	LS			
Mowing	AC	$100.00	34	$3,400
Soil Cover Maintainance and Planting ($5,000/2 years)	LS	$2,500.00	1	$2,500
Maintenance of Gas Venting System				
Subsidence Repair ($10,000/5 years)	LS	$2,000.00	1	$2,000
Stormwater Maintenance	LS	$2,000.00	1	$2,000
Other				
VII Inspections				
Annual Report	LS	$6,000.00	1	$6,000
Annual Site Inspections	LS	$6,000.00	1	$6,000
Other				
VIII Other				
IX Contingency (10 % min)				
	LS	10%	$260,570.00	$26,057
Total Yearly Cost				$286,627
Total 30-Year Cost*				$7,255,703.00

Signature of Preparer: Jeffrey S. Murray 2/9/09 (Must be prepared by a Professional Engineer)

Date:

The cost estimate must include all expenses associated with compliance of all DES permits. Please use the spaces provided above noted as "Other" or attach an additional sheet if necessary.

* The 30-year total costs assumes reductions in the operation and maintenance costs, sampling costs and leachate disposal costs beginning in the 6th year following closure. (See attached Table 1)

THE STATE OF NEW HAMPSHIRE
JEFFREY S. MURRAY No. 10139
LICENSED
PROFESSIONAL ENGINEER

Table 1
Estimated Post-Closure Monitoring/Maintenance Costs
North Country Environmental Services, Inc.
December 2008

Task		Annual Cost Years 1-5	Annual Cost Years 6-10	Annual Cost Years 11-20	Annual Cost Years 21-30
I-a	Water Quality Monitoring	$ 44,000	$ 35,000	$ 35,000	$ 35,000
I-b	Repair of Monitoring Wells	$ 1,100	$ 1,100	$ 1,100	$ 1,100
II-a	Landfill Gas Migration Monitoring	$ 8,000	$ 8,000	$ 8,000	$ 8,000
II-b	Landfill Gas Collection System O&M	$ 69,820	$ 27,400	$ 52,200	$ 39,800
III	Settlement Monitoring	$ 1,650	$ 1,650	$ 1,650	$ 650
IV-a	Leachate/Condensate Disposal	$ 87,500	$ 50,430	$ 50,430	$ 38,100
IV-b	Leachate Monitoring	$ 7,100	$ 7,100	$ 4,750	$ 4,750
IV-c	Leachate Pump Station O&M	$ 19,000	$ 13,000	$ 11,700	$ 11,200
V	Air Quality Monitoring	$ -	$ -	$ -	$ -
VI	Capping System Maintenance/Repair	$ 10,400	$ 9,000	$ 6,000	$ 4,000
VII	Inspections	$ 12,000	$ 8,000	$ 8,000	$ 8,000
VIII	Other	$ -	$ -	$ -	$ -
IX	10% Contingency	$ 26,057	$ 16,068	$ 17,883	$ 15,060
	TOTAL	**$ 286,627**	**$ 176,748**	**$ 196,713**	**$ 165,660**

Notes:
A summary of the assumptions made in developing the estimate is attached
Costs presented are in 2009 dollars
Costs are based on our experience and data and information provided by NCES. Actual costs may vary.

Table 2

Present Value of Post-Closure Monitoring/Maintenance Costs

North Country Environmental Services, Inc.

December 2008

Assumptions:

Discount Rate (ir) **1.250%**

Annual Inflation (j) **2.57%**

Years After Closure	Annual Post Closure Cost	Annual Present Value Cost
1	$ 286,627	$ 290,556
2	$ 286,627	$ 294,538
3	$ 286,627	$ 298,575
4	$ 286,627	$ 302,668
5	$ 286,627	$ 306,816
6	$ 176,748	$ 191,791
7	$ 176,748	$ 194,420
8	$ 176,748	$ 197,085
9	$ 176,748	$ 199,786
10	$ 176,748	$ 202,524
11	$ 196,713	$ 228,490
12	$ 196,713	$ 231,622
13	$ 196,713	$ 234,797
14	$ 196,713	$ 238,015
15	$ 196,713	$ 241,278
16	$ 196,713	$ 244,585
17	$ 196,713	$ 247,937
18	$ 196,713	$ 251,336
19	$ 196,713	$ 254,780
20	$ 196,713	$ 258,273
21	$ 165,660	$ 220,483
22	$ 165,660	$ 223,505
23	$ 165,660	$ 226,569
24	$ 165,660	$ 229,674
25	$ 165,660	$ 232,822
26	$ 165,660	$ 236,013
27	$ 165,660	$ 239,248
28	$ 165,660	$ 242,528
29	$ 165,660	$ 245,852
30	$ 165,660	$ 249,222
Total Cost in 2008 $	**$ 5,940,605**	
Total Present Value Cost		**$ 7,255,787**

Notes:

Annual present value cost calculated by multiplying the annual post closure cost by a discount factor (DF) calculated as follows:

$$DF = (1 + ir - j - ir*j)^{-t}$$

where:

ir = discount rate for Boston listed by the Federal Reserve Bank, December 2008 (source: www.frbdiscountwindow.org)

j = average inflation rate for the previous 11 years (1997-2008) (source:www.inflationdata.com)

t = years since closure

Supporting Documentation for Post-Closure Costs

December 2008

The following assumptions were made in developing the post-closure cost estimate. The estimated initial annual cost is summarized in the NHDES Post-Closure Cost Estimate form and the estimated annual costs for the entire 30-year post-closure period are summarized in Table 1 with the present value for the annual costs presented in Table 2. The costs were developed based on information provided by North Country Environmental Services, previous cost estimates developed for the facility, and our experience.

Item Ia – Water Quality Monitoring

Years 1 – 5

- Annual Costs for sampling and reporting were estimated to be **$44,000**. These costs will remain unchanged in the first five years of the post-closure monitoring program.

Years 6 - 10

- We have assumed that after the first five years of monitoring, that a reduction from tri-annual to bi-annual sampling will be allowed by NHDES, based on our experience at many unlined landfill closure site. This will reduce the annual costs by approximately $9,000 to an annual cost of **$35,000**

Years 11 – 30

- While NHDES may permit a further reduction in sampling parameters or locations, we have assumed that the monitoring costs of **$35,000** will continue to apply to the remainder of the sampling program.

Item Ib – Repair of Monitoring Wells

Years 1 - 30

- Cost to purchase and install a new bladder pump is estimated to be about $1,300.
- Pumps are required in 14 of the monitoring wells at the Site.
- Assuming each pump is replaced once during the post-closure period would result in a cost of $18,200.
- **Carry an annual cost of $1,100, which provides additional funds for minor repairs or for replacement of additional pumps.**

Item IIa - Landfill Gas Migration Monitoring

- The annual costs of **$8,000** for the quarterly monitoring of landfill gas migration will be required to be completed throughout the post-closure monitoring period. It is possible that NHDES may permit some reductions to the frequency and locations, after several years of monitoring and data gathering, but this is not relied upon in the estimate.

Item IIb – Landfill Gas Collection System Operation and Maintenance

Maintenance Costs

Years 1 - 30

- Routine maintenance of control system and flare, monthly monitoring of collection system and balancing. Assumed 2 hours per week for weekly tasks and 16 hours per month for monthly tasks. Estimated labor costs are $1560/month, or approximately **$18,720** per year.

- Semi-annual maintenance of blower bearings, testing automated devices, gas canister maintenance/refill, and coordinating any unscheduled maintenance. Assuming 4 hours per event, $260 per event or **$520** per year.

- Annual calibration and maintenance of GEM field instrument are estimated to be **$1,350** per year.

- Replacement of condensate knockout pump every 10-years. Assuming a cost of $4,300 installed an annual cost of **$430** has been included.

- Assuming unscheduled responses to alarm conditions occurs 4 times per year. At 6 hours per event, and 24 hours per year, **$1,560** has been included in the annual cost for alarm conditions.

- Included **$2,720** per year for replacement parts for blower/flare/controls etc.

Therefore, the annual costs for years 1 through 30 shall include $25,300 per year

Operational Costs

Years 1 – 5

Landfill gas wells will tend to accumulate liquid over time. We have assumed that the purchase and installation of 4 pneumatic pumps for insertion in the landfill gas extraction wells will be required by year 5. These 4 pumps can then be rotated between remaining wells as needed to remove accumulated liquid from the wells. Assume the pumps discharge through a short hose to the LFG lateral pipe. Assume the pumps cost about $8,000 each, installed. The total pump cost will be **$32,000.**

The pumps require a compressed air delivery system, including a compressor and air drying equipment. The cost of a typical air compressor of sufficient capacity with an 80-gallon receiver tank is about $3,000, and air drying equipment, including a refrigerated dryer and a desiccant dryer, costs about $2,500. The equipment has to be sheltered from the elements. Therefore assume $4,100 for a shelter and installation of the equipment. The total assumed cost of the compressed air system is **$9,600**.

Assume that a compressed air distribution system has to be constructed to deliver air to the pneumatic pumps at the LFG wells. Assume 4,000 linear feet of pipe is required for initial construction with an average burial depth of 1-foot installed with a "Ditch Witch" type of pipe installation. Based on an assumed pipe cost of $3.00 per linear foot and an installation cost of approximately $4.50 per linear foot, plus $5,000 of fittings and detail work at the terminations, the cost is **$35,000**.

Therefore, the cost of the pumps and compressed air delivery system is about $76,600, **or $15,320 per year to be added to the routine annual costs in years 1 through 5.**

Assume that quarterly surface scans will be required for the first five years of the post-closure period, along with 20 hours per quarter of labor and equipment associated with addressing methane emission exceedances. Assume that the cost of a surface scan, excluding reporting, is about $2,100, and the labor and equipment cost associated with correcting exceedances is about $5,200 per quarter. Therefore, **the annual cost is about $29,200 in years 1 through 5.**

Years 6 - 30

Assume that annual surface scans are required for years 6 through 30, with no repair of cap associated with exceedances required through the period. Assume the same $2,100 per surface scan cost. Therefore, **the annual cost for surface scans is $2,100 for years 6 through 30.**

Electricity Costs

Based on historical information provided by CommonWealth Resource Management Corporation (CRMC), the annual electricity cost to operate the LFG system in the current configuration is estimated to be approximately $62,000. Assuming that CRMC continues to operate the facility through the first 10 years of the post-closure period, during which time the electricity costs are paid by CRMC, then there would be no electric post-closure costs for years 1 through 10.

Years 11 - 20

Assume that starting in year 11, the LFG collection system operates on one blower and one flare, and that NCES operates the system. Assume the electricity cost, in 2007 dollars, would be 40 percent of the current total electricity cost, or about **$24,800 per year for 10 years.**

Years 20 - 30

Assume that the one blower and one flare operate on a part-time basis with a 50 percent duty cycle. Therefore, the annual electricity cost would be about **$12,400 per year for the last 10 years of the period.**

Item III – Settlement Monitoring

Years 1 - 30

- **Assume settlement survey costs will average about $1,650 per year for years 1 through 20. Years 20 through 30 will not require instrument survey and only a visual inspection at an estimated cost of $650 per year.**

Item IVa – Leachate Condensate Disposal

Leachate evaporation operations at the NCES were discontinued in 2007. Leachate generated at NCES is now hauled to an off-site disposal facility. Based on information provided by NCES, the average transportation and disposal cost is $0.061 per gallon of leachate.

Years 1 - 5

- Assume 12.0 acres of Stage I cap will have been in place more than 10 years at the time of closure and that the leachate flow rate will average 50 gallons per acre per day (gpad), which would produce about 600 gallons per day (gpd).
- Assume 22.2 acres of cap are constructed in Year 1 and that leachate is produced in this area at the rate of 150 gpad or 3,330 gpd.
- **Therefore, the annual cost for years 1 through 5 is approximately $87,500.**

Years 6 - 10

- Assume flow rate of 50 gpad over 12.0 acres, or 600.
- Assume a flow rate of 75 gpad for the remaining 22.2 acres, or 1,665 gpd.
- **Therefore, the annual cost for years 6 through 10 is approximately $50,430.**

Years 11 - 20

- Assume a flow rate of 50 gpad over 12.0 acres, or 600
- Assume a flow rate of 75 gpad over 22.2 acres, or 1,665
- **Therefore, the annual cost for years 11 through 20 is approximately $50,430.**

Years 21 - 30

- Assume flow rate of 50 gpad over the entire 34.2 acres, or 1,710

Therefore, the annual cost for years 21 through 30 is approximately $38,100.

Item IVb – Leachate Monitoring

Years 1 - 10

- Assume leachate is collected for analysis for the parameters required by the Solid Waste Rules three times per year from the four phases of Stage I, Stage III, and Stage IV Phase I *(note: Stage II leachate drains into and is collected with Stage IV leachate).*
- Based on current costs for analytical testing, the annual laboratory cost is $4,700.
- Assume labor and expenses total $800 per round or $2,400 annually.
- **Therefore, the annual cost for years 1 through 10 is $7,100.**

Years 11 - 30

- Assume based on diminishing flows and stabilization of the leachate that the frequency of sampling may be cut by one-third so that the cost of monitoring is two-thirds of the initial cost. During years 11-20 following closure, sampling will be conducted twice per year. With stabilization, it is likely that the parameters for which analyses are required could also be reduced resulting in a further reduction in the monitoring cost, which is not reflected here.
    - **Therefore, the annual cost for years 11 through 30 is about 4,750.**

Item IV-c Leachate Pump Station Operation & Maintenance

Years 1 - 30

- Assume routine checks are performed with gas system maintenance under Item 2 at a cost of **$2,900** per year.
- Assume replacement parts and repairs for system components cost approximately $2,300 per year.
- Assume pipes are cleaned every two years at a cost of $3,600 (annualized cost of **$1,800).**
- **Therefore, the annual maintenance cost for years 1 through 30 is about $7,000.**

Electricity Costs

Years 1 - 5

- Assume the annual electricity cost for years 1 through 5 is about **$12,000** based on historical cost information and projected costs for Stage IV Phase I.

Years 6 -10

- Assume the leachate flow rates drop by about 50 percent on average over the 5 year period due to the cap so that the annual electricity cost for years 6 through 10 is about **$6,000.**

Years 11 - 20

- Assume the leachate flow rates drop by about 20 percent on average over the 10 year period so that the annual electricity cost for years 11 through 15 is about **$4,700.**

Years 21 - 30

- Assume the leachate flow rates drop by about 10 percent on average over the 10 year period so that the annual electricity cost for years 21 through 30 is about **$4,200.**

Item VI - Cap Maintenance/Repair

Years 1 - 5

- Assume snow removal of **$500** per year
- Assume mowing costs will be approximately $100/acre or **$3,400** per year.
- Assume costs for repair of minor erosion of the final capping system will involve a day for an excavator, truck and laborer every two years at a cost of $5,000 (annualized cost of **$2,500**).
- Assume costs for repair of capping system subsidence at a cost of $10,000 every five years (annualized cost of **$2,000**).
- Assume stormwater maintenance including removal of sediments which collect in ponds and swales will be required on a yearly basis. Costs assumed to be **$2,000** per year.
- **Therefore the annual cost for years 1 through 5 is approximately $10,400.**

Years 6 - 10

- Snow removal and mowing costs remain the same. Stabilization of the capping system and slowing of settlement results in a reduction in the repair work required.
- **An annual cost of $9,000 is estimated.**

Years 11 - 20

- Further stabilization of the capping system and the annualized cost is reduced to **$6,000** per year.

Years 21 - 30

- Further stabilization of the capping system and the annualized cost is reduced to **$4,000** per year, and primarily includes mowing costs.

Item VII - Inspections

Years 1 - 5

- Assume semi-annual site inspections and reporting for the first 5 years of the post-closure period to be **$12,000** per year. Work includes groundwater reporting, site inspection reporting, settlement reporting and reporting on the landfill gas collection system.

Years 6 - 30

- Site inspections are reduced to once per year and the reporting becomes more straightforward over time. Assume that annual inspection and reporting costs are **$8,000** per year.

Section VI
Design Report

SECTION VI: DESIGN REPORT

Introduction

On March 13, 2003, North County Environmental Services, Inc. (NCES) received Solid Waste Permit No. DES-SW-SP-03-002 from the New Hampshire Department of Environmental Services (NHDES) for Stage IV, an expansion of the NCES landfill in Bethlehem, New Hampshire with a permitted capacity of 2,050,000 cubic yards. On April 24, 2003 the Grafton County Superior Court issued an order in litigation between NCES and the Town over several aspects of the NCES development. In that order, the Superior Court upheld a Town ordinance banning the expansion of privately operated landfills. The Town had sought to impose this ordinance to prohibit the development of Stage IV of the landfill.

NCES appealed the Superior Court's order to the New Hampshire Supreme Court and on March 1, 2004, the Supreme Court issued an opinion on the appeal. With regard to development of landfill capacity on that portion of NCES' land outside of the 51 acres – within which the courts in prior decisions had ruled that landfill development could take place -- the Supreme Court found that the issue of whether the ordinance is lawful had not been fully addressed in the trial court. The matter was remanded back to the trial court for resolution. Meanwhile, the Town passed another ordinance making landfilling a permitted use within the 51 acres but prohibiting it elsewhere. Because NCES's right to expand the landfill outside the 51 acres remains unsettled, NCES has decided to seek approval to continue development of Stage IV capacity within the 51 acres.

In 2004, NCES obtained a Type II Permit Modification to the Stage IV permit for grading modifications allowing the development of 153,000 cubic yards of the Stage IV capacity above the side slopes of Stages II and III through the use of berms. In 2005, NCES obtained a Type II Permit Modification to the Stage IV permit to construct Phase I of Stage IV, which involves developing that portion of the permitted Stage IV footprint to the north of Stage II and within the 51-acre parcel. The permit for Phase I of Stage IV allows the development of 470,000 cubic yards of the permitted Stage IV capacity.

NCES is now seeking construction approval for Phase II of the Stage IV. The Stage IV Phase II application seeks to develop 1,280,000 of the 1,427,000 cubic yards of capacity that remains after approval of the two previous modifications to the Stage IV permit.

Description of Modification

This modification involves development of about 1,280,000 cubic yards of Stage IV capacity within the original 51-acre parcel. Construction design drawings for the development are referenced in Section II of the application and are enclosed, and Technical Specifications are provided in Section III. A revised Facility Operating Plan is provided in Section V, while a

anchor trench to the leachate handling and storage area located northeast of Stage IV Phase I and Stage II. The force mains will be constructed using dual-walled HDPE pipe, which includes a carrier pipe within a larger diameter containment pipe. The modified Stage I leachate system will allow for the decommissioning of the current Stage I pump stations and piping systems, leachate flow metering building and wet well pump station.

Excavation of the four Stage I sumps will require interim leachate management during construction. Sheets C-7 through C-17 depict details of the proposed leachate management system, which are consistent with the details presented in the permitted Stage IV Design drawings and construction drawings for Stage IV Phase I. The construction notes on Sheet C-10 describe the construction sequence and interim leachate management.

The calculations presented in Appendix A indicate the contingency leachate storage requirement to comply with NH Solid Waste Rules (Rules) Env-Sw *805.06(g)* is about 86,552 gallons. Leachate production from Stages I through IV were combined since the leachate is directed to one new location. With a total of 210,000 gallons of capacity, the two existing Stage III 30,000 gallon USTs and the 150,000 gallon AST has sufficient storage capacity. The calculations assume a conservative contingency event during initial filling of Stage IV Phase II.

Leak Detection System Travel Time

Based on Env-Sw 805.07(b)(1), the leak detection system is to convey liquids to an observation point for detection (sump) based on a maximum time of concentration of 24 hours under saturated hydraulic conditions. All new liners are being constructed consistent with the permitted Stage IV design, and include highly transmissive geonet (geocomposite) above the secondary liner. Calculations included in Section VI, Appendix A indicate the leak detection system of the applicable new liners in these areas meets the travel time requirement.

In Phases I, II, and III of Stage I, the flatter portions of the secondary collection system did not include geonet, as it was not required by NHDES rules at the time, and was not widely applied on landfill projects. Stage I, Phase IV was constructed with geonet in the secondary collection system in accordance with the current standards. Critical areas including side slopes, berms, sumps, and pipe trenches in Stage I do have geonet. Under the proposed construction, waste will be excavated to expose the liner system upstream of the sumps, so that the sumps and associated piping can be re-built. The reconstructed liner systems will be constructed to current standards as permitted for Stage IV. Accordingly, a significant improvement to the liner systems will be effected, including at the most sensitive locations: the low points associated with the sumps.

In order to comply with Env-Sw 805.07, an overlay liner will be constructed over the existing waste materials in Stage I, Phases I, II and III. The overlay liner will be constructed from bottom to top with: woven geotextile fabric; 12 inches of drainage sand; 60 mil secondary geomembrane; drainage geocomposite; 60 mil primary geomembrane; drainage geocomposite;

modification. The calculations indicate that the peak storm water discharge from the site will be less than the predevelopment condition.

In addition, the facility has a USEPA, NPDES multi-sector General Permit for Stormwater Management, and an associated Storm Water Pollution Prevention Plan (SWPPP) including application of Best Management Practices (BMP's) for stormwater management.

Groundwater Monitoring

The locations of groundwater monitoring wells with the planned work area are shown on Sheets C-2. A listing of monitoring wells impacted by the proposed development is provided below. These impacts include the need to extend or reduce well casings and resetting of protective casings or installation of road boxes. While the installation of road boxes and extensions of some existing wells is proposed, no additions, deletions, or replacement wells are proposed.

Well	Work Required	Road Box Required
MW-701	Protect	No
GP-1	Protect	No
GP-7	Raise	Yes
B-401	Raise	Yes
GP-2	Raise	Yes
GP-8A	Raise	Yes
B901-U	Protect	No
B901L	Protect	No
GP-15	Protect	No

Landfill Stability

A geotechnical evaluation and report on landfill stability is provided in Appendix A. The analyses completed as part of this work indicate that the proposed landfill configuration and construction materials provide adequate factors of safety against foundation failure and sliding among liner and cap system components under the expected static loading conditions. Under seismic loads, the landfill is stable and permanent deformation of the liner or other systems is not expected, and the cap system deformations are acceptable.

Appendix A
Design Calculations

1. *Leachate Calculations*
2. *Geotechnical Calculations*
3. *Stormwater Management*

Appendix A-1

Leachate Collection System Calculations

1 Primary Leachate Collection System
2 Secondary Leachate Collection System
3 Leak Detection and Location System
4 100 Year Storm Containment
5 Maximum Head on Liner
6 Pipe Selection
7 Pump Selection
8 Supporting Information / Data

Section 1

PRIMARY LEACHATE COLLECTION SYSTEM

Objective: Determine appropriate pipe size for primary leachate collection for a 25-year storm event with a duration equivalent to the time of concentration of the drainage area of the component being sized.

Design Case: Phase IV, Stage II Cell open with 6 feet of MSW in bottom of cell (0.98 acres), with run-off from the Phase II sideslope and portion of the Overlay Liner with exposed drainage sand.

Assumptions:

- Time of concentration calculated for 1.5 feet of drainage sand, 6 feet of MSW and geocomposite.
- 40% runoff from the exposed drainage sand of the Overlay Liner (0.75 acres) and Phase II Side Slopes (1.25 acres) area enters the Stage I base area as run-on. Remaining would infiltrate direct to geocomposite and collection pipe prior to precipitation infiltrating through waste.
- Temporary plastic on other portions of the Overlay Liner above the active area will direct stormwater runoff as clean stormwater to the outboard drainage swale.
- Temporary plastic will divert stormwater runoff from southern areas of Overlay Liner, reducing active areas to maximum of 2.5 acres.
- 100% of precipitation falling into an open cell area becomes leachate.
- Pipe flow calculated for gravity flow with Manning's equation.
- Base flows estimated from actual landfill data and HELP Model. (Appendix D.8)
- No change in Stage II, III & IV, Phase I where additional filling is proposed due to the permitted maximum height remaining unchanged.

Conclusions:

- A 12 inch primary leachate pipe will adequately remove the leachate discharged through the MSW or drainage sand, there is no potential for ponding during the 25-year storm.
- The phased filling sequence of Phase IV, Stage II expansion and use of temporary plastic over exposed drainage sand greatly reduces the amount of leachate generated by collecting and discharging all clean stormwater separately through the berm.

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: NCES Stage IV - Phase II Project No: 656 Date: January 2009 Calc. By: JSM Chkd. By: RJG

LEACHATE COLLECTION SYSTEM CALCULATIONS

25 Year Storm Event Time of Concentration - Base Liner Expansion

Cover Soil
6-inch thick layer

	k	3.1E-03 cm/s
	n	0.457
	i	1
V=(k*i)/n	=	0.0068 cm/s
		0.0002 ft/s
	TC =	**0.62 hr**

MSW
6 ft lift of MSW

	k	1.0E-03 cm/s
	n	0.671
	i	1
V=(k*i)/n	=	0.00149 cm/s
		0.00005 ft/s
	TC =	**34.09 hr**

1.5-inch Crushed Stone
1.5 ft thick layer

	k	1.0E-02 cm/s
	n	0.45
	i	1
V=(k*i)/n	=	0.022 cm/s
		0.001 ft/s
	TC =	**0.57 hr**

Drainage Geocomposite
7.6 mm thick $9x10^{-4}$ m^2/s transmissivity, 100 ft long

	k	4.61E+01 cm/s
	n	0.85
	i	0.02
V=(k*i)/n	=	1.084 cm/s
		0.036 ft/s
	TC =	**0.74 hr**

TOTAL TC = 36.0 hrs

25 Year Storm Event Time of Concentration - Overlay Liner

Drainage Sand
1.5 ft thick layer

	k	3.1E-03 cm/s
	n	0.457
	i	1
V=(k*i)/n	=	0.0068 cm/s
		0.0002 ft/s
	TC =	**1.87 hr**

Drainage Geocomposite
7.6 mm thick $9x10^{-4}$ m^2/s transmissivity, 300 ft long

	k	4.61E+01 cm/s
	n	0.85
	i	0.33
V=(k*i)/n	=	18.060 cm/s
		0.593 ft/s
	TC =	**0.14 hr**

TOTAL TC = 2.0 hrs

CMA ENGINEERS, Inc.	Project:	NCES Stage IV - Phase II
Civil/Environmental Engineers	Project No:	656
35 Bow Street	Date:	January 2009
Portsmouth, NH 03801	Calc. By:	JSM
	Chkd. By:	RJG

LEACHATE COLLECTION SYSTEM CALCULATIONS

Proposed 12" Primary Leachate Collection Pipe Discharge

Leachate pipe slope (So)	0.0053	ft/ft
SDR	17	
Pipe inside diameter (D)	11.25	in
Manning's n	0.012	

Assuming Gravity Flow

Hydraulic radius (Rh): Rh = D/4	2.81	in
Area (A): A = (Pi * D^2)/4	0.69	ft^2
Flow capacity (Q):		
Q = 1.486*A*Rh^(2/3)*So^(1/2)/n	2.36	cfs
	1,061	gpm
	1,528,072	GPD

CMA ENGINEERS, Inc.	Project:	NCES Stage IV - Phase II
Civil/Environmental Engineers	Project No:	656
35 Bow Street	Date:	January 2009
Portsmouth, NH 03801	Calc. By:	JSM
	Chkd. By:	RJG

LEACHATE COLLECTION SYSTEM CALCULATIONS

25 Year Storm Event, 6 feet MSW - Base

Input variables:			
Stage IV, Phase II Expansion (Ac)	0.98	acres	Base Expansion Area
Run-on area (Ar)	2.00	acres	Phase II Side Slope & Overlay Liner
Percent run-off from Ar (Pr)	40%		*
Time of concentration (Tc)	2161	min	
Rainfall Intensity (I)	0.16	in/hr	Figure 6-3 (Appendix A-1-8)
Leachate outflow rate (Lo)	2.36	cfs	Full Pipe Flow to Pump Station I Sump
Base flow total	7474	gpd	Site Data (See Base Flow Calculation)

Total Base Liner Volume (Vb)		
Vt = I * Ac * Tc	37,140	CF
	277,803	gpd

Infiltration rate	1.0098	in/d	from HELP (Appendix A-1-8)
Discharge to pipe (La)	0.0414	cfs	La << Lo; no ponding occurs on liner
	18.57	gpm	
	26,734	gpd	

Time for ponded leachate to infiltrate through MSW:		
t = Vt / La	14,963	min
	10.39	day

25 Year Storm Event, 0 feet MSW - Overlay Liner

Input variables:			
Stage IV, Phase II Overlay Liner (Ac)	2.50	acres	**Southern Overlay Exposed Select Sand
Run-on area (Ar)	0.00	acres	
Percent run-off from Ar (Pr)	0%		
Time of concentration (Tc)	121	min	Overlay Liner Time of Concentration
Rainfall Intensity (I)	1.20	in/hr	Figure 6-3 (Appendix A-1-8)
Leachate outflow rate (Lo)	2.36	cfs	Full Pipe Flow to Pump Station I Sump
Base flow total	0	gpd	No Base Flow into new Overlay Liner

Total Overlay Liner Flow			
Rainfall Intensity	8.47E-04	cm/s	
Drainage Sand Permeability	3.10E-03	cm/s	Permeability >> Intensity; all Infiltration
Total Overlay Liner Volume (Vo)	21,920	CF	through Sand and into Composite
	163,963	gpd	

Total Stage IV, Phase II 25 Year Storm Event

Total Flow	190,697	gpd	
Discharge to Pipe	0.30	cfs	<< Lo; No Ponding Occures on Liner

Section 2

SECONDARY LEACHATE COLLECTION SYSTEM

Objective: Determine appropriate pipe sizes for secondary leachate collection.

Conclusions:

The required hydraulic capacity of the secondary leachate collection system is a minor fraction of that required for the primary leachate pipe. A minimum diameter of 8 inches is specified however, to provide access with conventional camera pipeline inspection equipment.

Section 3

LEAK DETECTION AND LOCATION SYSTEM

Objective: Design leak detection system to convey liquids to an observation point, based on a maximum time of concentration equal to 24-hours under saturated hydraulic conditions.

Design: Potential for leakage through the secondary liner is reduced through the use of double-sided geocomposite which will rapidly convey liquid off the liner. Geocomposite will be placed over the entire primary and secondary liners. GCL below the primary liner in the base are further reduces the potential for leakage through the primary liner. GCL is below the primary liner and above a layer of 40-mil textured HDPE (for increased stability).

Conclusions:

The time of concentration for the secondary leak detection system is 2 hours for the base landfill area and 1.4 hours for the Overlay Liner area, both are well below the regulation of 24 hours.

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LEACHATE COLLECTION SYSTEM CALCULATIONS

Leak Detection in Secondary Liner System

Drainage Sand

1 ft thick

k	3.1E-03	cm/s
n	0.457	
i	1	

V=(k*i)/n

=	0.007	cm/s
	0.0002	ft/s
TC =	**1.25**	**hr**

Drainage Geocomposite

7.6 mm thick $9x10^{-4}$ m^2/s Transmissivity, 100 ft long

k	4.61E+01	cm/s
n	0.85	
i	0.02	

V=(k*i)/n

=	1.084	cm/s
	0.036	ft/s
TC =	**0.78**	**hr**

TOTAL TC = 2.0 HOURS

Leak Detection in Secondary Overlay Liner System

Drainage Sand

1 ft thick

k	3.1E-03	cm/s
n	0.457	
i	1	

V=(k*i)/n

=	0.007	cm/s
	0.000	ft/s
TC =	**1.25**	**hr**

Drainage Geocomposite

7.6 mm thick $9x10^{-4}$ m^2/s Transmissivity, 300 ft long

k	4.61E+01	cm/s
n	0.85	
i	0.33	

V=(k*i)/n

=	18.060	cm/s
	0.593	ft/s
TC =	**0.14**	**hr**

TOTAL TC = 1.4 HOURS

Section 4

100 YEAR STORM CONTAINMENT

Objective: Determine the on-liner storage capacity and the required storage outside the liner system to contain the leachate generated from a 24-hour/100-year storm event. The system cannot allow over 12 inches of leachate to remain on the liner for a period of more than 7 days.

Design Case: Stage IV, Phase II active with 6 feet of MSW in bottom of cell. Temporary plastic installed over areas of constructed overlay liner to reduce active leachate collection areas to the extent practical. Maximum of 2.0 acres adjacent to base area and 2.5 acres on southern overlay assumed to contribute to leachate generation.

Assumptions:

- Containment berms and grading retains run-off from MSW in operating area, with no direct discharge to pipe.
- 40% runoff from the exposed drainage sand of the Overlay Liner (0.75 acres) and Phase II Side Slopes (1.25 acres) area enters the Stage I base area as run-on. Remaining would infiltrate direct to geocomposite and collection pipe prior to precipitation infiltrating through waste.
- Temporary plastic on other portions of the Overlay Liner above the active area will direct stormwater runoff as clean stormwater to the outboard drainage swale.
- Temporary plastic will divert stormwater runoff from southern areas of Overlay Liner, reducing exposed select sand and active leachate collection area to maximum of 2.5 acres.
- 100% of precipitation falling into an open cell area becomes leachate.

Conclusions:

- Pipe can handle 100-year storm peak discharge from the infiltration rate through the 6 feet of MSW.
- Outside storage capacity exceeds the regulated 15% of the volume generated by the 100-year storm (86,522 gallons).

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LEACHATE COLLECTION SYSTEM CALCULATIONS

100 Year Storm - Base Area and Base Flow

Input Variables:			
Cell area (Ac)	0.98	acres	Base Expansion Area
Run-on area (Ar)	2.00	acres	Phase II Side Slope & Overlay Liner
Percent from run-on area Ar (Pr)	40%		*
Time of Concentration	2161	min	
Rainfall Intensity	0.2	in/hr	Figure 6-3 (Appendix A-1-8)
Base flow	7,474	gpd	Site Data (See Base Flow Calculation)

Total Inflow Stage IV, Phase I Volume (Vb)

Vb = I*Tc * Ac			
Vb =	46,424	CF	
	347,254	gal	
Total Volume (Vb + Base flow)	**354,728**	**gal**	Stage IV, Phase II, Stage I Base Flow

100 Year Storm - Overlay Liner

Input Variables:			
Overlay Liner Area (Ac)	2.50	acres	**Southern Overlay Exposed Select Sand
Time of Concentration	121	min	
Rainfall Intensity	1.5	in/hr	Figure 6-3 (Appendix A-1-8)

Total Overlay Liner Flow			
Rainfall Intensity	1.06E-03	cm/s	
Drainage Sand Permeability	3.10E-03	cm/s	Permeability >> Intensity; all Infiltration
Total Overlay Liner Volume (Vo)	27,400	CF	through Sand and into Composite
	204,953	gal	

Total Stage I, Phase II Volume			
Vt = Vb + Vo + Vbase	**559,682**	**gal**	Stage IV, Phase II, Stage I
	0.85	**cfs**	< 2.436 cfs pipe capacity

Available Storage on Liner in Stage IV, Phase I w/2ft Freeboard:

Sump and Header	33,703	gal
Drainage Sand	157,105	gal
MSW	919,674	gal
Total Available Storage on Liner, Stage IV, Phase II	**1,110,482**	**gal**

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LEACHATE COLLECTION SYSTEM CALCULATIONS

100 Year Storm - Base Area and Base Flow

Total Leachate Generation

Stage IV, Phase I, Stage I	**559,682**	**gal**
Stage IV, Phase I, Stage II	**12,586**	**gal**
Stage III	**4,543**	**gal**
Total Landfill Inflow	**576,810**	**gal**

Available Tank Storage:

Existing Stage III Tanks	60,000	gal	
150,000 gal AST	150,000	gal	
Total Tank Storage	**210,000**	**gal**	
15% of Total Leachate Volume	**86,522**	**gal**	Meets Regulation

Leachate Removal Rates:

Tanker Trucks	3		
Volume per Truck	5,000	gal/truck	
	0.29	trip/hr	1 per 3.5 hours to Concord
	102,857	gal/day	
	6	days	

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100 Year Storm Event Leachate Storage Capacity
Porosity of Class D Stone 0.45
Porosity of MSW: 0.671

Elevation (ft)	Area (ft^2)	Avg Area (ft^2)	Total Volume (ft^3)	Total Volume (gal)	Total Storage Volume (gal)
In Leachate Pipes					
Primary Risers	3.14	-	132	987	987
Primary Header	0.79	-	393	2,936	2,936
Pipe Max Storage			**524**	**3,923**	**3,923**
In D-Stone in Sump					
2' Deep Sump w/2' Risers	45.72	-	960	7,183	3,232
1'Deep Sump w/1' Header	19.72	-	7,886	58,995	26,548
Sump Max Storage			**960**	**7,183**	**29,780**
In 1.5' D-Stone Over Liner					
1322	13,935				
		31,112	46,668	349,123	157,105
1324	48,289				
Drainage Sand Max Storage			**46,668**	**349,123**	**157,105**
In 4.5' Waste					
1324	48,289				
		91,606	183,211	1,370,601	919,674
1326	134,922				
Max Storage in Waste			**183,211**	**1,370,601**	**919,674**

Total Storage **1,110,482**

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LEACHATE COLLECTION SYSTEM CALCULATIONS

Site Base Flow Data

2007		Stage I PHASE I Measured Flow				Stage I PHASE II Measured Flow				Stage I PHASE III Measured Flow				Stage I PHASE IV Measured Flow				Stage III Measured Flow				Stage IV Measured Flow							
		Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary					
Month:	Leachate Transported (GALLONS)	Total Gallons	6.5 acres G/A/D	Total Gallons	6.5 acres G/A/D	Total Gallons	3.8 acres G/A/D	Total Gallons	3.8 acres G/A/D	Total Gallons	3.8 acres G/A/D	Total Gallons	3.8 acres G/A/D	Total Gallons	3.7 acres G/A/D	Total Gallons	3.7 acres G/A/D	Total Gallons	6.5 acres G/A/D	Total Gallons	6.5 acres G/A/D	Total Gallons	10 acres G/A/D	Total Gallons	10 acres G/A/D	Combined Monthly Totals	Primary Monthly Totals	Monthly Totals	
January	475,915	71,746	356	18,340	91	21,654	184	736	6	1,891	16	2,384	20	13,350	116	8,913	78	131,210	651	1,060	5	352,210	1,136	8,030	26	631,524	592,061	39,463	January
February	302,760	37,328	205	4,298	24	25,848	243	104	1	593	6	1,682	16	7,136	69	7,570	73	105,230	578	910	5	118,210	422	2,030	7	310,939	294,345	16,594	February
March	470,378	71,611	355	18,270	91	31,436	267	4,023	34	4,575	39	3,567	30	6,242	54	9,243	81	111,680	554	940	5	300,240	969	4,230	14	566,057	525,784	40,273	March
April	574,516	69,509	356	21,232	109	26,998	237	3,649	32	3,338	29	4,119	36	6,802	61	3,484	31	123,710	634	460	2	317,480	1,058	4,920	16	585,701	547,837	37,864	April
May	354,846	47,926	238	3,572	18	27,571	234	353	3	10,589	90	2,435	21	6,194	54	537	5	98,600	489	820	4	180,320	582	2,330	8	381,247	371,200	10,047	May
June	340,462	52,727	270	2,926	15	21,743	191	184	2	2,683	24	2,278	20	1,173	11	0	0	85,800	440	930	5	144,950	483	2,120	7	317,514	309,076	8,438	June
July	329,604	52,478	260	1,540	8	24,829	211	187	2	2,015	17	2,488	21	9,796	85	264	2	76,600	380	360	2	121,740	393	1,540	5	293,837	287,458	6,379	July
August	271,139	44,410	220	1,676	8	22,556	191	682	6	4,649	39	2,012	17	5,533	48	390	3	60,640	301	1,280	6	95,680	309	1,102	4	240,610	233,468	7,142	August
September	220,426	38,223	196	1,188	6	16,775	147	101	1	9,364	82	1,791	16	7,499	68	381	3	50,960	261	80	0	88,064	294	800	3	215,226	210,885	4,341	September
October	246,287	38,775	192	1,704	8	19,965	169	406	3	4,856	41	1,991	17	4,405	38	606	5	60,780	302	480	2	109,091	352	580	2	243,639	237,872	5,767	October
November	311,978	43,578	223	898	5	22,157	194	518	5	3,058	27	3,246	28	3,431	31	562	5	56,760	291	510	3	146,017	487	3,370	11	284,105	275,001	9,104	November
December	300,178	38,821	193	732	4	20,565	175	1,373	12	8,610	73	2,754	23	3,465	30	597	5	79,980	397	840	4	143,044	461	2,200	7	302,981	294,485	8,496	December
	4,198,489	607,132		76,376		282,097		12,316		56,221		30,747		75,026		32,547		1,041,950		8,670		######		33,252		*4,373,180*	*4,179,472*	*193,908*	
ANNUAL TOTAL PER CELL:																													
AVERAGE DAILY FLOW G/A/D:			256		32		204		9		40		22		56		24		440		4		579		9				

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Base Flow Calculations

100 Yr - 24 Hour Storm (P_{100}):	6.0	inches*
Capped Area Base Flow:	300	gal/ac/day**
Intermediate Cover Base Flow:	700	gal/ac/day***
Active 30' MSW Base Flow:	1,300	gal/ac/day
Active 60' MSW Base Flow:	1,300	gal/ac/day

Capped Area Base Flow:	300	gal/ac/day**
Intermediate Cover Base Flow:	700	gal/ac/day***
Active 30' MSW Base Flow:	8,168	gal/ac/day
Active 60' MSW Base Flow:	6,092	gal/ac/day

Leachate Base Flow - Average Annual

Stage	Area (ac)	Flow (gal/day)
Flow to Pump Station I		
Stage I		
30' MSW Active Area	2.23	2,899
Capped Areas	15.25	4,575
Total		**7,474**
Flow Stage IV Phase I Side Slope Riser Building		
Stage II		
Phase I - 60' MSW	3.53	4,589
Phase II - 60' MSW	3.19	4,147
Stage IV		
Phase I - 30' MSW	2.96	3,850
Total		**12,586**
Flow to Pump Station 3		
Stage III - Int Cover	6.49	4,543
TOTAL		**24,603**

*Conservative, Tc = 36 hrs
**From Site Data, Conservative
***From Help Model

Leachate Base Flow - Peak Daily

Stage	Area (ac)	Flow (gal/day)
Flow to Pump Station I		
Stage I		
30' MSW Active Area	2.23	18,214
Capped Areas	15.25	4,575
Total		**22,789**
Flow Stage IV Phase I Side Slope Riser Building		
Stage II		
Phase I - 60' MSW	3.53	21,506
Phase II - 60' MSW	3.19	19,435
Stage IV		
Phase I - 30' MSW	2.96	24,187
Total		**65,128**
Flow to Pump Station 3		
Stage III - Int Cover	6.49	4,543
TOTAL		**92,460**

Section 5

MAXIMUM HEAD ON LINER

Objective: Determine the maximum head on liner during routine operations (not to exceed 1 foot of leachate).

Design Case: 1) Stage IV, Phase II active with 6 feet of MSW, initial operating conditions.
2) Stage IV, Phase II active with 30 feet of MSW, intermediate operating conditions.

Assumptions:

- Leachate collection system incorporates an 18-inch layer of crushed stone (min k = 0.01 cm/sec, n = 0.45) and a layer of double-sided geocomposite over the primary liner. (Appendix D.8)
- Transmissivity of geocomposite determined from published values of a geocomposite tested between liner and geotextile at 10,000 psf, and reduction factors for deformation, creep, and chemical and biological clogging. (Appendix D.8)
- Average precipitation/evapotranspiration rates and peak leachate infiltration rates for design cases determined using HELP Model, 5-year evaluation. (Appendix D.8)

Conclusions:

- Geocomposite prevents head build up in drainage sand under average precipitation/ evapotranspiration rates.
- Factor of safety of 2.28 (6ft waste) and 1.11 (30ft waste) for flow in geocomposite and crushed stone under peak leachate infiltration rates over the open cell using the HELP model peak leachate inflow rate.

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LEACHATE COLLECTION SYSTEM CALCULATIONS

Maximum Head on Liner Calculation for 25 Year 36 Hour Storm Event

6' MSW Peak Daily Leachate Impingement Rate 1.00980 in/d

30' MSW Peak Daily Leachate Impingement Rate 0.28749 in/d

Based on Peak Daily Leachate Impingement Rate (Over 5yr Period)
Stage IV Expansion - 6' of trash with no run-off

Input Variables:			
Stage IV, Phase II			
Area (A)	2.25	acre	
Liner Slope (So)	0.020	ft/ft	
Max Drainage Length (L)	100	ft	
Crushed Stone (K)	10E-3	cm/sec	
Composite Transmissivity (T)	1E-03	m^2/s	*
	1E-02	ft^2/s	
Factors of Safety for Composite			
Elastic Deformation (FSin)	1		
Creep (FScr)	1		
Chemical Clogging (FScc)	1		
Biological Clogging (FSbc)	1		

Calculation

Peak Leachate Inflow Rate (I):
from HELP MODEL I = 1.00980 in/d
1.17E-05 in/s

Leachate Flow Rate (Q):
Q = I*L*w (w = 1 ft)
Q = 1.68E-01 in^3/s

Ultimate Composite Transmissivity (Tu):
Tu = T /(FSin*FScr*FScc*FSbc)
Tu = 1.08E-02 ft^2/s

Max Flow in Composite (Qc):
Qc = Tu * So *w Qc = 3.72E-01 in^3/s

Max Flow in Stone
Qs = K * So * w Qs = 1.19E-02 in^3/s

Factor of Safety (FS):
FS = Qc/Q **FS = 2.28**

Based on Peak Daily Leachate Impingement Rate (Over 5yr Period)
Stage IV Expansion - 30' of trash with no run-off

Input Variables:			
Stage IV, Phase II			
Area (A)	2.25	acre	
Liner Slope (So)	0.02	ft/ft	
Max Drainage Length (L)	100	ft	
Crushed Stone (k)	10E-3	cm/sec	
Composite Transmissivity (T)	1E-03	m^2/s	*
	1E-02	ft^2/s	
Factors of Safety for Composite			
Elastic Deformation (FSin)	1.5		
Creep (FScr)	1.5		
Chemical Clogging (FScc)	2		
Biological Clogging (FSbc)	2		

Calculation

Peak Leachate Inflow Rate (I):
from HELP MODEL I = 0.28749 in/d
3.33E-06 in/s

Leachate Flow Rate (Q):
Q = I*L*w
Q = 4.79E-02 in^3/s

Ultimate Composite Transmissivity (Tu):
Tu = T /(FSin*FScr*FScc*FSbc)
Tu = 1.20E-03 ft^2/s

Max Flow in Composite (Qc):
Qc = Tu * So *w Qc = 4.13E-02 in^3/s

Max Flow in Stone
Qs = K * So * w Qs = 1.19E-02 in^3/s

Factor of Safety (FS):
FS = Qc/Q **FS = 1.11**

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LEACHATE COLLECTION SYSTEM CALCULATIONS

Maximum Head on Liner Calculation for 25 Year 36 Hour Storm Event

6' MSW Peak Daily Leachate Impingement Rate 1.00980 in/d

30' MSW Peak Daily Leachate Impingement Rate 0.28749 in/d

Based on Peak Daily Leachate Impingement Rate (Over 5yr Period)
Stage IV Overlay Liner - 6' of trash with no run-off

Input Variables:			
Stage IV, Phase II			
Area (A)	2.50	acre	
Liner Slope (So)	0.33	ft/ft	
Max Drainage Length (L)	300	ft	
Drainage Sand (K)	3.1E-3	cm/sec	
Composite Transmissivity (T)	1E-03	m^2/s	*
	1E-02	ft^2/s	
Factors of Safety for Composite			
Elastic Deformation (FSin)	1		
Creep (FScr)	1		
Chemical Clogging (FScc)	1		
Biological Clogging (FSbc)	1		

Calculation

Peak Leachate Inflow Rate (I):
from HELP MODEL I = 1.00980 in/d
1.17E-05 in/s

Leachate Flow Rate (Q):
Q = I*L*w (w = 1 ft)
Q = 5.05E-01 in^3/s

Ultimate Composite Transmissivity (Tu):
Tu = T /(FSin*FScr*FScc*FSbc)
Tu = 1.08E-02 ft^2/s

Max Flow in Composite (Qc):
Qc = Tu * So *w Qc = 6.20E+00 in^3/s

Max Flow in Stone
Qs = K * So * w Qs = 6.12E-02 in^3/s

Factor of Safety (FS):
FS = Qc/Q **FS = 12.40**

Based on Peak Daily Leachate Impingement Rate (Over 5yr Period)
Stage IV Overlay Liner - 30' of trash with no run-off

Input Variables:			
Stage IV, Phase II			
Area (A)	2.50	acre	
Liner Slope (So)	0.33	ft/ft	
Max Drainage Length (L)	300	ft	
Drainage Sand (k)	3.1E-3	cm/sec	
Composite Transmissivity (T)	1E-03	m^2/s	*
	1E-02	ft^2/s	
Factors of Safety for Composite			
Elastic Deformation (FSin)	1.5		
Creep (FScr)	1.5		
Chemical Clogging (FScc)	2		
Biological Clogging (FSbc)	2		

Calculation

Peak Leachate Inflow Rate (I):
from HELP MODEL I = 0.28749 in/d
3.33E-06 in/s

Leachate Flow Rate (Q):
Q = I*L*w
Q = 1.44E-01 in^3/s

Ultimate Composite Transmissivity (Tu):
Tu = T /(FSin*FScr*FScc*FSbc)
Tu = 1.20E-03 ft^2/s

Max Flow in Composite (Qc):
Qc = Tu * So *w Qc = 6.89E-01 in^3/s

Max Flow in Stone
Qs = K * So * w Qs = 6.12E-02 in^3/s

Factor of Safety (FS):
FS = Qc/Q **FS = 5.22**

* See GSE Data Sheet Supplied in Appendix A-1-8

Section 6

PIPE SELECTION

Objective: Determine appropriate pipe to withstand a static load from the refuse.

Design Cases:
1) Compression
2) Wall Buckling
3) Ring Deflection

Assumptions:

- Max height - 150 ft. Calculated Strengths demonstrated for maximum height of landfill. Actual waste height over the leachate collection pipes for Phase II expansion are approximately 60 feet. Final Closure Site Plan is attached for reference.
- MSW density - 56 pcf
- Soil density - 120 pcf
- Performance Pipe published values were used.

Conclusions:

- SDR 17 provides adequate resistance to the loads for 150 feet of waste height. Factors of safety for compression, buckling, and deflection are 1.5, 1.39, and 7.5, respectively.

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PIPE SELECTION

Loading input variables	8"	12"	
Maximum MSW Height (H) (ft)	150	150	* 8" Secondary Leachate Collection
MSW density (A) (lb/ft^3)	56	56	* 12" Primary Leachate Collection
Soil density (S) (lb/ft^3)	120	120	
Soil cover height (S_c) (ft)	5.5	4.5	inlcuding liner and capping system

Vertical load		8" PSF	8" PSI	12" PSF	12" PSI
MSW load (P_A): P_A= H * A	P_A =	8400	58.33	8400	58.33
Soil cover load (P_{sc}): P_{sc} = S* S_c	P_{sc} =	540	3.75	540	3.75
Total vertical load (P_T): P_T = P_a + P_{sc}	P_T =	8940	62.08	8940	62.08

SDR 17 pipe characteristics	8"	12"	
Outside diameter (D_o) (in)	8.625	12.75	[1]
Inside diameter (D_i) (in)	7.55	11.16	[1]
Thickness (t) (in)	0.507	0.75	[1]
Soil reaction modulus (E') (lb/in^2)	23000	23000	From Table 5-1[2]
Allowable ring (hoop) stress (lb/in^2)	800	800	From Page 103[2]
Allowable ring deflection	5%	5%	From Table 7-9[2]
Poisson' s ratio (μ)	0.45	0.45	From Page 104[2]
Elastic modulus (E) (lb/in^2)	2000	2000	From Table 7-7[2]

Compression		8"	12"
Compressive stress (S) (lb/in^2): $S=(P_T D_o)/288t$	S=	528.08	527.71
FS = allowable hoop stress/S	FS =	1.51	1.52

Wall buckling		8"	12"
P_{wc}=allowable constrained buckling pressure (lb/in^2) P_{wc}=(5.65/N)*(R*B'*E'*(E/(12*(SDR-1)^3)))^0.5 N=safety factor=2	P_{wc}=	86.41	86.41
R=1-0.33H'/H H'=groundwater height over pipe=0 H=cover above pipe=55 ft	R'=	1	1
B'=elastic support factor B'=1/(1+4e^(-0.065H)	B'=	1.00	1.00
FS=P_{wc}/P_T	FS=	1.39	1.39

Ring deflection		8"	12"
ΔX=horizontal deflection (in) ΔX/D_i=P_T/144*(KL/(((2E/3)*(1/SDR-1)^3))+0.061E') K=bedding factor=0.1 (From Page 108) L=deflection lag factor=1.5 (From Page 111)	ΔX=	0.05	0.07
% deflection=(ΔX/D_i)*100	% deflection=	0.66	0.66
FS=Allowable ring deflection/%deflection	FS=	7.53	7.53

[1] Performance Pipe Bulletin: PP 152, November 2003.
2 Performance Pipe "System Design" Bulletin: PP 900, September 2003.

Section 7

PUMP SELECTION

Objective: Determine appropriate pump to provide desired pump rate at the static and dynamic head losses of the operating system.

Design Cases: 1) Pump Station I – Primary and Secondary pumps

Conclusions:

- Primary Pumps 83 gpm, 5hp
- Secondary Pumps 30 gpm, 0.75hp

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Civil/Environmental Engineers	Project No:	656
35 Bow Street	Date:	January 2009
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	Chkd. By:	RJG

LEACHATE COLLECTION SYSTEM CALCULATIONS

Primary Leachate Sump Pump - Pump Station I
Max Flow - 25 year 36 hour Storm Event

Total Flow
Q = 190,697 gal
Sump Capacity to 1-foot above liner 190,808 gal

Number of Days Leachate can Accumulate
Before Pumping is Required 1.00 days for sump to fill, Sump capacity is sufficient to reduce well below 12" above liner
83 gal/min Pump Rate = 1.60 days to remove leachate from within sump with 1 pump
1.27 days to remove leachate from within sump with 2 pumps at total discharge of 130 gpm
From EPG Pump Catalog Series 17-3 5hp pumps will be used to pump out of the sump and discharge via the force main to the storage tanks.

Primary Leachate Sump Pump - Pump Station I
Max Flow - 100 year 36 hour Storm Event

Total Flow
Q = 559,682 gal
Sump Capacity to 1-foot above liner 190,808 gal

Amount of Leachate to be Removed Over 7 days 368,873 gal

83 gal/min Pump Rate = 3.1 days to draw down the inflow with 1 pump running
3.1 days to draw down the inflow with 2 pumps running at total of 130 gpm
From EPG Pump Catalog Series 17-3 5hp pumps will be used to pump out of the sump and discharge via the force main to the storage tanks.

Secondary Leachate Sump Pump - Pump Station I
Max Base Flow - 25 gallons per acre per day
Total Area 18.28 acres
Q = 457 gal/day

30 gal/min Pump Rate = 0.01 days to draw down the leachate volume
From EPG Pump Catalog Series 8-2, 0.75hp pump will be used to pump out of the sump and into the primary riser sump

Secondary Overlay Liner Leachate Sump Pump - Pump Station I
Max Base Flow - 25 gallons per acre per day
Total Area 11.50 acres
Q = 288 gal/day

30 gal/min Pump Rate = 0.007 days to draw down the leachate volume
From EPG Pump Catalog Series 8-2, 0.75hp pump will be used to pump out of the sump and into the primary riser sump

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PUMP STATION I PRIMARY FORCE MAIN HEAD LOSS AND PUMP CAPACITY

3" Force Main from Stage IV, Phase II Sump to Tank A

General Diameter:	3	in
Material:	SDR 11	
Inner Diameter (D):	2.825	in
Area:	0.0435	ft2
Force Main Length (L1):	1,700	ft
C Factor:	115	
Peak Flow (Q):	83	gpm
	0.185	cfs
Velocity:	4.25	ft/s

Friction Pressure Loss per 1000 ft of Pipe (DF/1000):

DF/1000 = 4520 * Q1.85 / (C1.85 * D4.86) Hazen and Williams Formula

= 36.68 ft/1000'

Force Main Friction Head (Fh):

Fh = DF/1000 * L1/1000

= **62.35** **feet**

Fitting Loss Calculations:

Type of Loss	Quantity	Total	Equivalent Length (ft)	Total Length (ft)
Pump Station I	*1*			
2" Ball Valve	2	2	2	4
2" Check Valve	2	2	13	26
2" 90 Degree Bend	8	8	5	40
2" Flow Meter	1	1	11	11
2" Tee	4	4	3	12
2" Pressure Gauge	1	1	5	5
2"x3" Enlarger	1	1	3	3
3" 90 Degree Bend	1	1	8	8
Leak Detection Manhole	*2*			
3" Wye	1	2	6	12
Air Release Chamber	*1*			
3" Tee	1	1	5	5
3"x2" Reducer	1	1	3	3
3" Ball Valve	1	1	5	5
3" Air Release Valve	1	1	10	10
Force Main	*1*			
Outlet Loss	1	1	16	16
		Fitting Equivalent Length (L2):		160 ft

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PUMP STATION I PRIMARY FORCE MAIN HEAD LOSS AND PUMP CAPACITY

3" Force Main from Stage IV, Phase II Sump to Tank A

Fitting Loss (Fl):

Fl = DF/1000 * L2/1000

= **5.87** **feet**

Static Head Calculation:

Invert at Pump Station I:	1348	
Invert at Sump:	1320	
Static Head Loss =	**28**	**ft**

Total Dynamic Head (TDH)

TDH = Fitting Losses + Friction Head + Static Head

Fitting Loss:	5.87	ft
Friction Head Loss:	62.35	ft
Static Head Loss:	28.00	ft
Total Dynamic Head:	**96.22**	**ft**
Design Condition (110%):	105.84	ft
Discharge Pressure:	45.86	psi

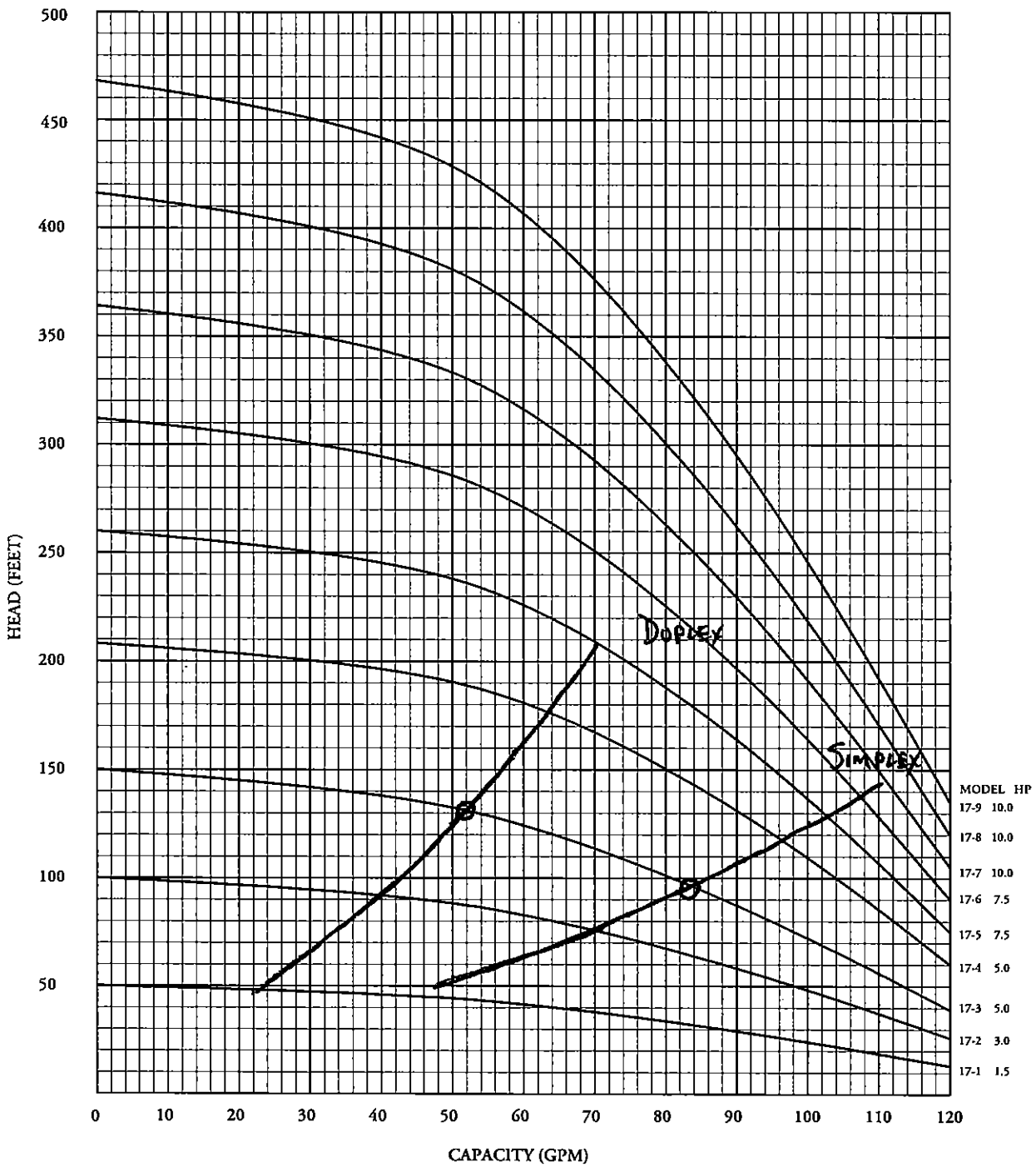
System Curve

Q (gpm)	DF/1000 FM	Head (feet)
50	14.36	54.71
55	17.13	59.86
60	20.12	65.43
65	23.33	71.40
70	26.76	77.78
75	30.40	84.55
80	34.26	91.72
85	38.33	99.29
90	42.60	107.24
95	47.08	115.57
100	51.77	124.29
105	56.66	133.39
110	61.75	142.86
115	67.05	152.70
120	72.54	162.92
125	78.23	173.50
130	84.11	184.45
135	90.20	195.77
140	96.47	207.44
145	102.95	219.48
150	109.61	231.87
155	116.46	244.62
160	123.51	257.73
165	130.74	271.18

STAGE IV PHASE II
PUMP STATION I
PRIMARY PUMPS

SERIES 17 SurePump™

Flow Range 20-120 GPM
60 Hz



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PUMP STATION I SECONDARY FORCE MAIN HEAD LOSS AND PUMP CAPACITY

1.5" Force Main from Stage IV, Phase II Secondary Sump to Primary Sump

General Diameter:	1.5	in
Material:	SDR17	
Inner Diameter (D):	1.534	in
Area:	0.0128	ft2
Force Main Length (L1):	85	ft
C Factor:	115	
Peak Flow (Q):	30	gpm
	0.067	cfs
Velocity:	5.21	ft/s

Friction Pressure Loss per 1000 ft of Pipe (DF/1000):

DF/1000 = 4520 * Q1.85 / (C1.85 * D4.86) Hazen and Williams Formula

= 108.54 ft/1000'

Force Main Friction Head (Fh):

Fh = DF/1000 * L1/1000

= **9.23** **feet**

Fitting Loss Calculations:

Type of Loss	Quantity	Total	Equivalent Length (ft)	Total Length (ft)
Pump Station I	*1*			
2" Ball Valve	2	2	2	4
2" 90 Degree Bend	4	4	5	20
2" 45 Degree Bend	1	1	3	3
2" Flow Meter	1	1	11	11
2" Pressure Gauge	1	1	5	5
Force Main	*1*			
Outlet Loss	1	1	16	16
		Fitting Equivalent Length (L2):		59 ft

Fitting Loss (Fl):

Fl = DF/1000 * L2/1000

= **6.40** **feet**

Static Head Calculation:

Invert at Pump Station I:	1348
Invert at Sump:	1319
Static Head Loss =	**29 ft**

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PUMP STATION I SECONDARY FORCE MAIN HEAD LOSS AND PUMP CAPACITY

1.5" Force Main from Stage IV, Phase II Secondary Sump to Primary Sump

Total Dynamic Head (TDH)

TDH = Fitting Losses + Friction Head + Static Head

Fitting Loss:	6.40	ft
Friction Head Loss:	9.23	ft
Static Head Loss:	29.00	ft
Total Dynamic Head:	**44.63**	**ft**
Design Condition (110%):	49.09	ft
Discharge Pressure:	21.27	psi

System Curve

Q (gpm)	DF/1000 FM	Head (feet)
0	0.00	29.00
5	3.94	29.57
10	14.22	31.05
15	30.11	33.34
20	51.26	36.38
25	77.46	40.15
30	108.54	44.63
35	144.36	49.79
40	184.81	55.61
45	229.80	62.09
50	279.26	69.21
55	333.11	76.97
60	391.29	85.35
65	453.74	94.34
70	520.41	103.94
75	591.26	114.14
80	666.24	124.94
85	745.31	136.33
90	828.44	148.30
95	915.59	160.85
100	1006.73	173.97
105	1101.83	187.66
110	1200.85	201.92

CMA ENGINEERS, INC.	Project:	NCES Stage IV Phase II
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PUMP STATION I SECONDARY OVERLAY LINER FORCE MAIN HEAD LOSS AND PUMP CAPACITY

1.5" Force Main from Stage IV, Phase II Secondary Overlay Liner Sump to Primary Sump

General Diameter:	1.5	in
Material:	SDR17	
Inner Diameter (D):	1.534	in
Area:	0.0128	ft2
Force Main Length (L1):	85	ft
C Factor:	115	
Peak Flow (Q):	30	gpm
	0.067	cfs
Velocity:	5.21	ft/s

Friction Pressure Loss per 1000 ft of Pipe (DF/1000):

DF/1000 = 4520 * Q1.85 / (C1.85 * D4.86) Hazen and Williams Formula

= 108.54 ft/1000'

Force Main Friction Head (Fh):

Fh = DF/1000 * L1/1000

= **9.23** **feet**

Fitting Loss Calculations:

Type of Loss	Quantity	Total	Equivalent Length (ft)	Total Length (ft)
Pump Station I	*1*			
2" Ball Valve	2	2	2	4
2" 90 Degree Bend	4	4	5	20
2" 45 Degree Bend	1	1	3	3
2" Flow Meter	1	1	11	11
2" Pressure Gauge	1	1	5	5
Force Main	*1*			
Outlet Loss	1	1	16	16
		Fitting Equivalent Length (L2):		59 ft

Fitting Loss (Fl):

Fl = DF/1000 * L2/1000

= **6.40** **feet**

Static Head Calculation:

Invert at Pump Station I:	1348
Invert at Sump:	1320
Static Head Loss =	**28 ft**

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Civil/Environmental Engineers	Project No:	656
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PUMP STATION I SECONDARY OVERLAY LINER FORCE MAIN HEAD LOSS AND PUMP CAPACITY

1.5" Force Main from Stage IV, Phase II Secondary Overlay Liner Sump to Primary Sump

Total Dynamic Head (TDH)

TDH = Fitting Losses + Friction Head + Static Head

Fitting Loss:	6.40	ft
Friction Head Loss:	9.23	ft
Static Head Loss:	28.00	ft
Total Dynamic Head:	**43.63**	**ft**
Design Condition (110%):	47.99	ft
Discharge Pressure:	20.80	psi

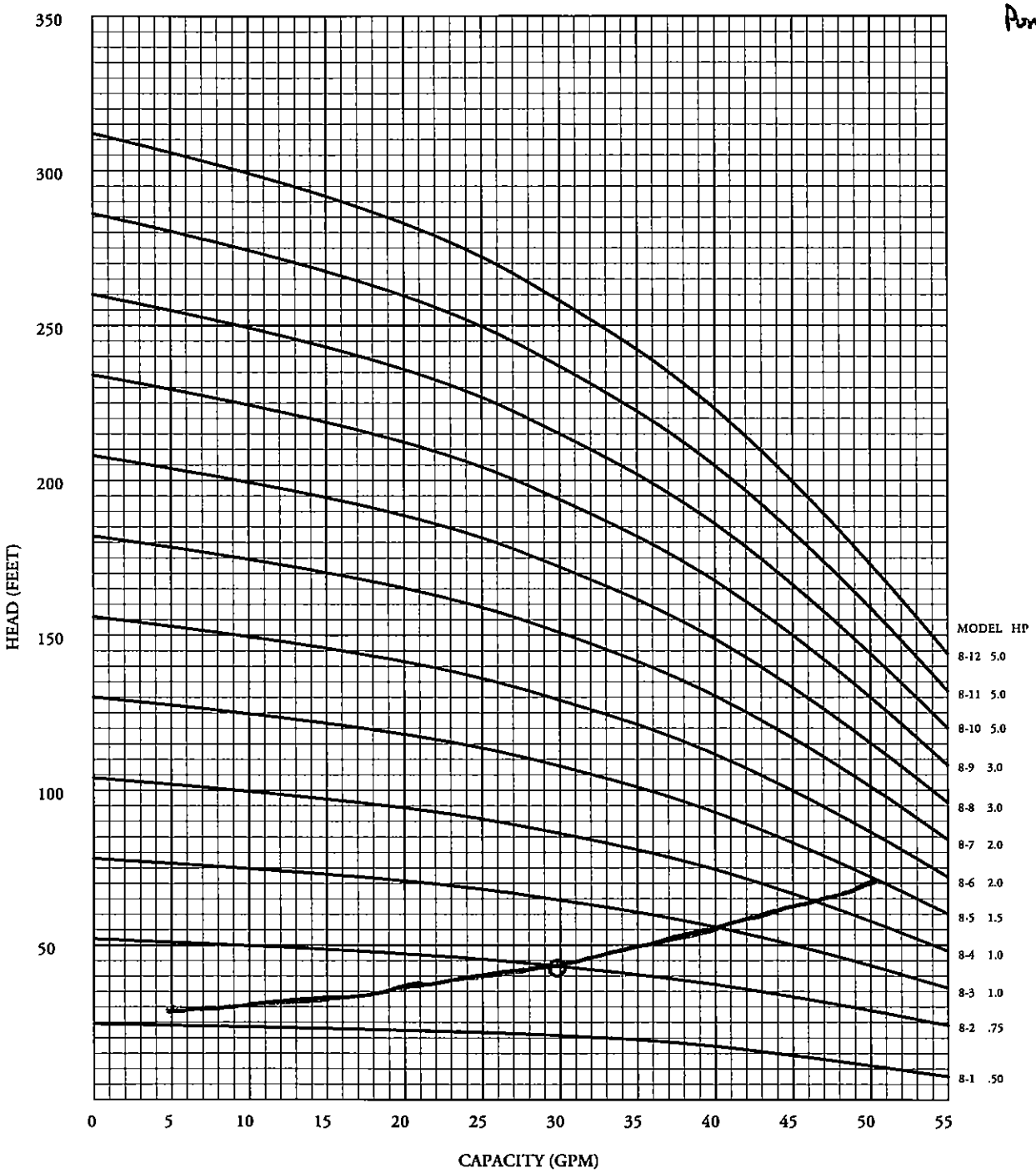
System Curve

Q (gpm)	DF/1000 FM	Head (feet)
0	0.00	28.00
5	3.94	28.57
10	14.22	30.05
15	30.11	32.34
20	51.26	35.38
25	77.46	39.15
30	108.54	43.63
35	144.36	48.79
40	184.81	54.61
45	229.80	61.09
50	279.26	68.21
55	333.11	75.97
60	391.29	84.35
65	453.74	93.34
70	520.41	102.94
75	591.26	113.14
80	666.24	123.94
85	745.31	135.33
90	828.44	147.30
95	915.59	159.85
100	1006.73	172.97
105	1101.83	186.66
110	1200.85	200.92

STAGE IV PHASE II
PUMP STATION I
SECONDARY & OVERLAY
LINER SECONDARY
PUMPS

SERIES 8 SurePump™

Flow Range 20-50 GPM
60 Hz



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CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: NCES Stage IV Phase II Project No: 656 Date: January 2009 Calc. By: JSM Chkd. By: RJG

SUMMARY OF RESULTS

Total Dynamic Head (TDH)

TDH = (Fitting $Losses_2$ + Friction $Head_2$ + Static $Head_2$)
+ (Fitting $Losses_3$ + Friction $Head_3$ + Static $Head_3$)

Pump Station I Primary - 83 gpm

Fitting Loss:	5.87
Friction Head Loss:	62.35
Static Head Loss:	28.00
Total Dynamic Head:	**96.22**

Pump Station I Secondary - 30 gpm

Fitting Loss:	6.40
Friction Head Loss:	9.23
Static Head Loss:	29.00
Total Dynamic Head:	**44.63**

Pump Station I Secondary Overlay Liner - 30 gpm

Fitting Loss:	6.40
Friction Head Loss:	9.23
Static Head Loss:	28.00
Total Dynamic Head:	**43.63**

Section 8

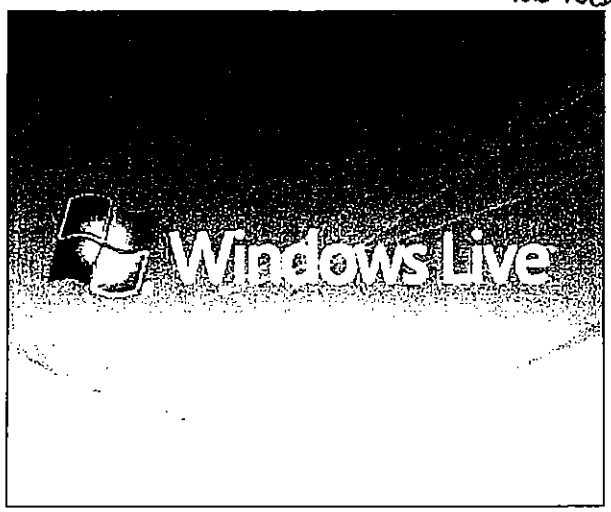
SUPPORTING INFORMATION / DATA

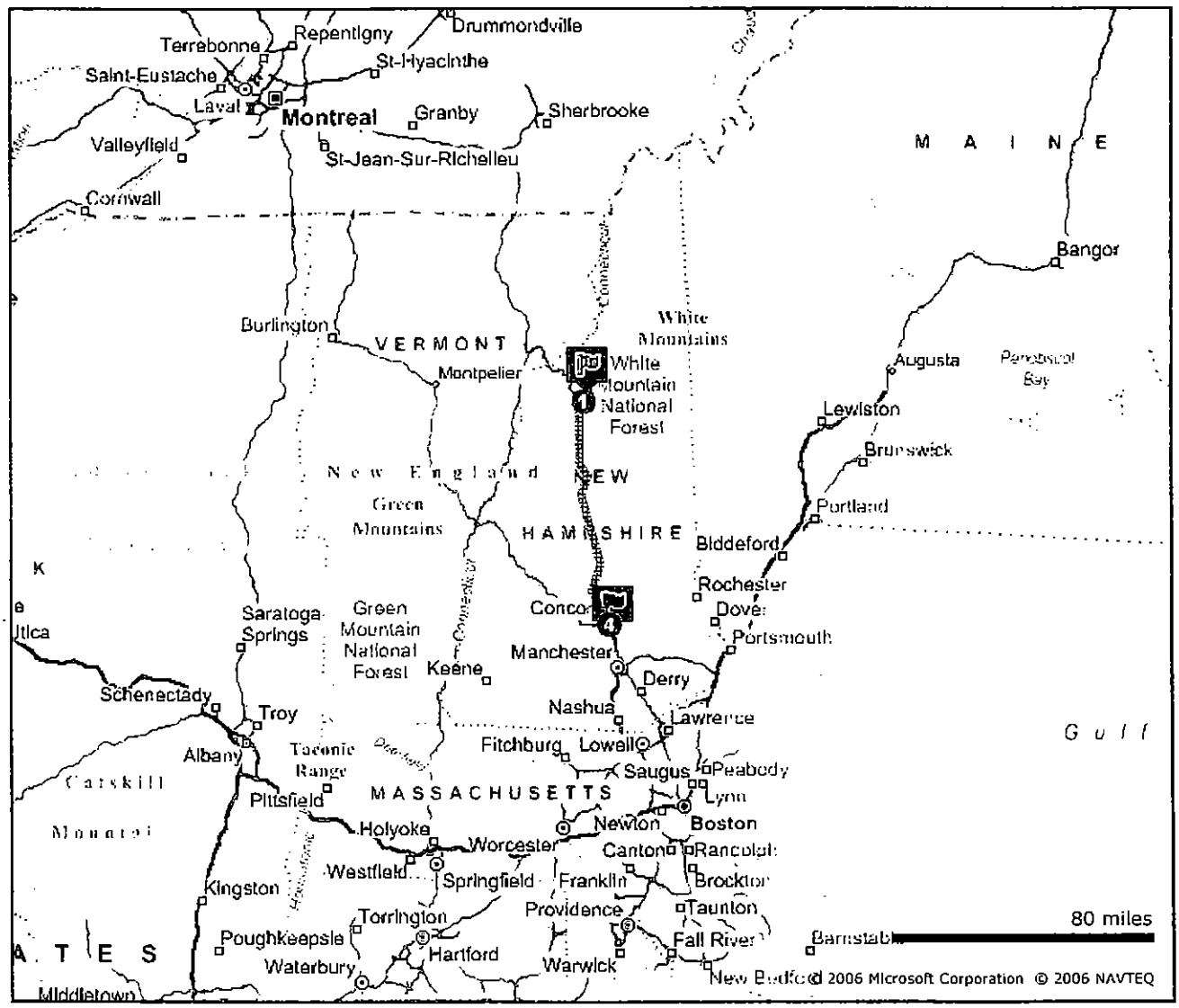
TRAVEL Times
For NCES Leach
Delivery

Live Search

Start: Trudeau Rd, Bethlehem, NH
End: Hall Street, Concord, NH

Distance: 81.7 mi
Time: 1 Hour, 16 Minutes



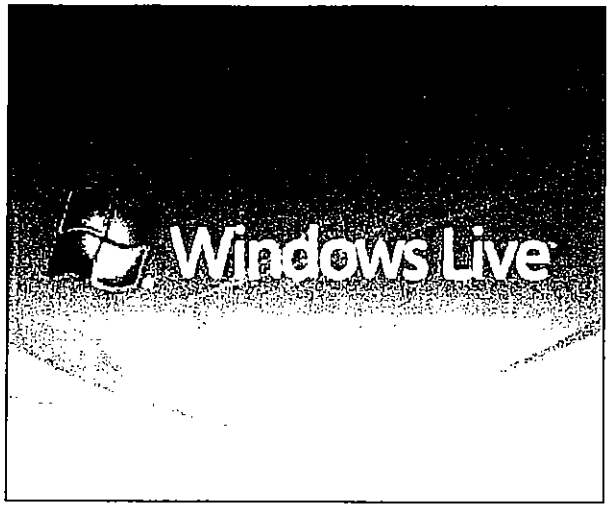


Directions		Distance	Detail Map
Start:	Depart on US-3 [Daniel Webster Hwy] (West)	4.7 mi	
1:	Take Ramp (RIGHT) onto I-93 [US-3] towards I-93 / US-3	75.5 mi	
2:	At exit 13, turn RIGHT onto Ramp towards US-3 / Manchester St. / Downtown	0.3 mi	
3:	Keep RIGHT to stay on Ramp		
4:	Bear RIGHT (West) onto Hall St	1.2 mi	
End:	Arrive at Hall Street, Concord, NH		

Live Search

Start: Trudeau Rd, Bethlehem, NH
End: Montpelier, VT

Distance: 71.8 mi
Time: 1 Hour, 21 Minutes



Directions		Distance	Detail Map
Start:	Depart US-3 / Daniel Webster Hwy (west)	4.2 mi	
1:	Turn RIGHT (south) onto SR-141 / Butterhill Rd	0.4 mi	
2:	Take ramp STRAIGHT to I-93 / Senator Styles Bridges Hwy North	18.6 mi	
3:	Entering Vermont		
4:	Stay on I-93 North (north)	7.3 mi	
5:	Take exit 1 RIGHT toward St. Johnsbury / VT-18	0.3 mi	
6:	Merge onto SR-18 (northwest)	0.4 mi	
7:	Bear LEFT (west) onto US-2 / Portland St	3 mi	
8:	Turn RIGHT (west) to stay on US-2 / Eastern Ave	0.3 mi	
9:	Turn LEFT (southeast) to stay on US-2 / Main St	37 mi	
10:	Turn RIGHT (northeast) onto SR-12 / Main St / Theodore Roosevelt Hwy	0.2 mi	
11:	Turn LEFT (west) onto US-2 Bus / State St / Theodore Roosevelt Hwy		
End:	Arrive at Montpelier, VT		

Live Search

Start: Trudeau Rd, Bethlehem, NH
End: Jay, VT

Distance: 88.6 mi
Time: 1 Hour, 38 Minutes

Directions		Distance	Detail Map
Start:	Depart on US-3 [Daniel Webster Hwy] (West)	4.2 mi	
1:	Bear RIGHT (South) onto SR-141 [Butterhill Rd]	0.4 mi	
2:	Take Ramp (RIGHT) onto I-93 [Senator Styles Bridges Hwy] towards I-93	29.7 mi	
3:	Entering Vermont		
4:	Take Ramp (RIGHT) onto I-91 towards I-91 / St. Johnsburg	33.3 mi	
5:	At exit 26, turn LEFT onto Ramp towards US-5 / VT-58 / Orleans / Irasburg	0.2 mi	
6:	Keep RIGHT to stay on Ramp	0.1 mi	
7:	Bear RIGHT (West) onto US-5 [SR-58]	0.4 mi	
8:	Keep STRAIGHT onto US-5	4.7 mi	
9:	Bear RIGHT (North-East) onto US-5 [SR-14]	0.5 mi	
10:	Turn LEFT (North-West) onto SR-14	4.9 mi	
11:	Bear LEFT (West) onto SR-100	5.8 mi	
12:	Turn RIGHT (North) onto SR-101	3.1 mi	
13:	Turn LEFT (West) onto SR-242	1.3 mi	
14:	Turn LEFT (South) onto Cross Rd		
15:	Turn LEFT (East) onto Local road(s)		
End:	Arrive at Jay, VT		

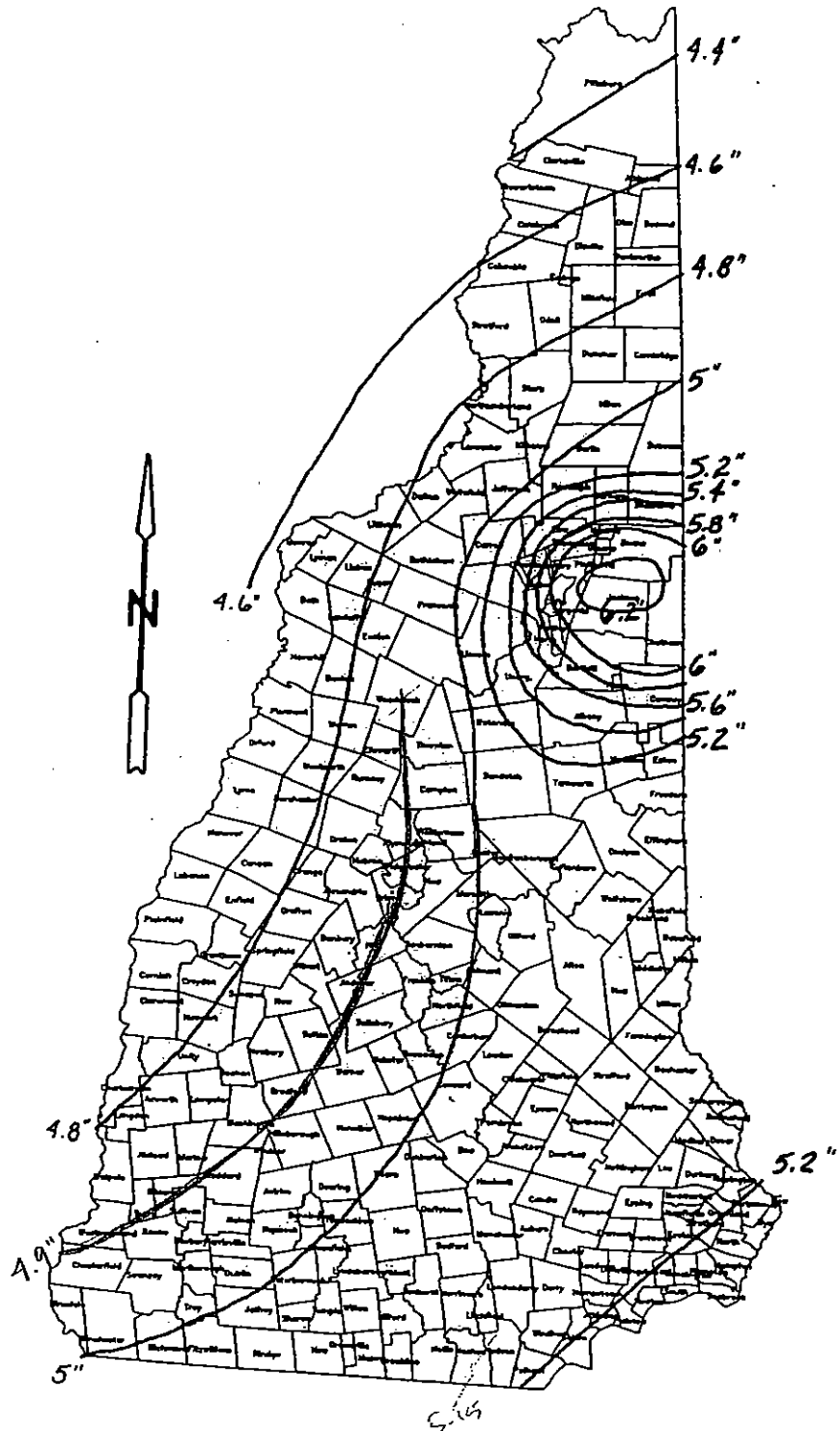


FIGURE 6-9 -- 25-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

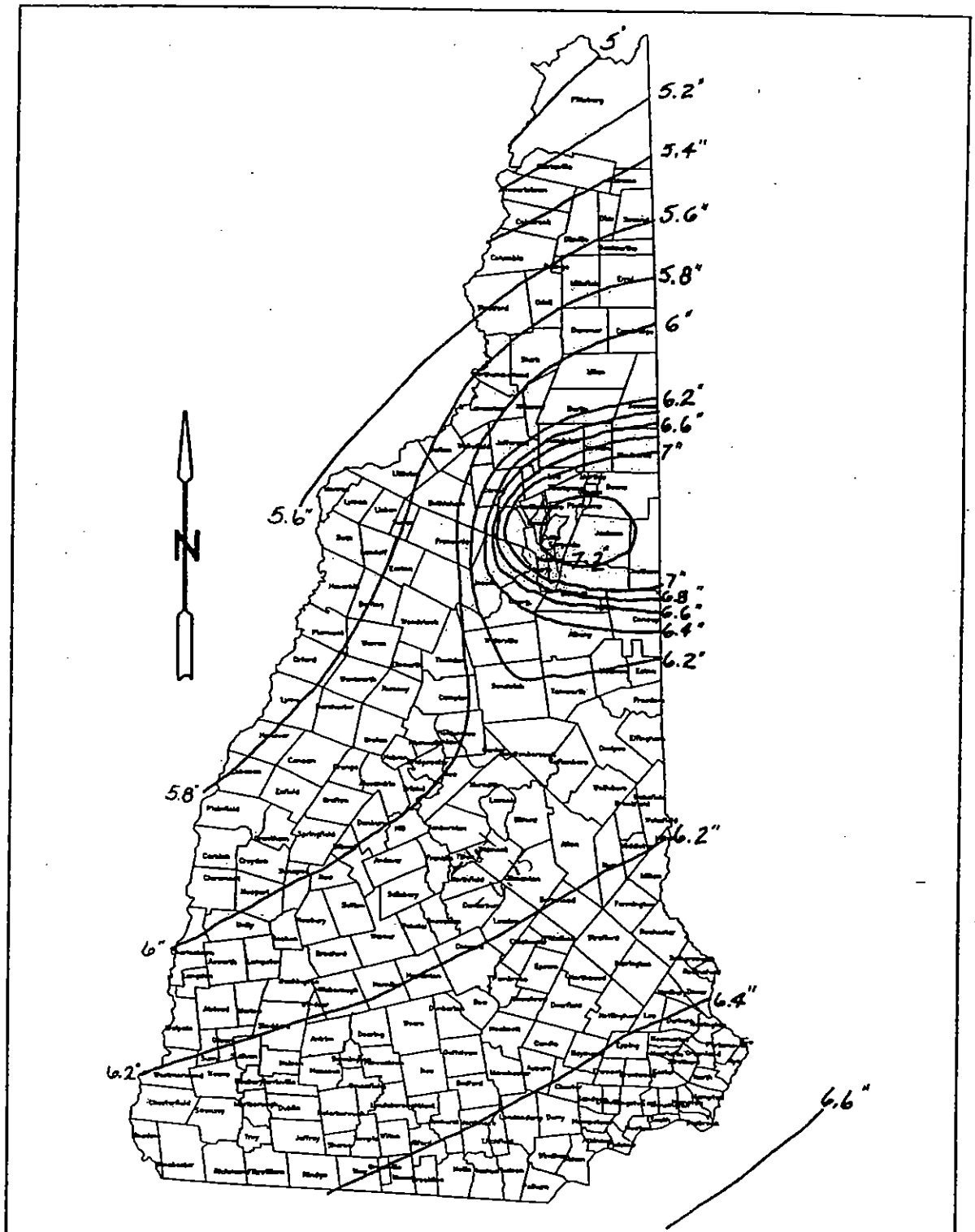


FIGURE 6-11 -- 100-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

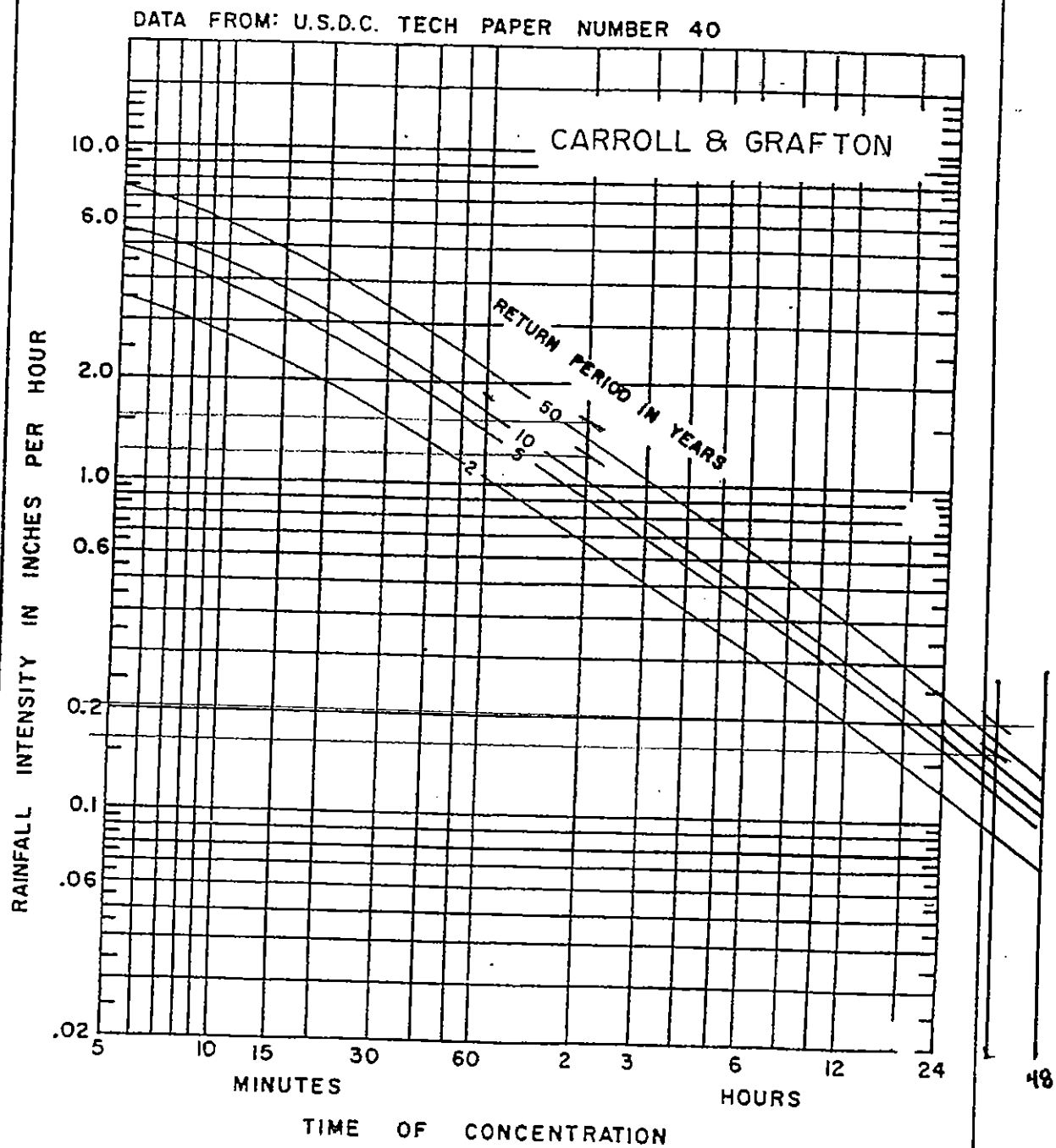


FIGURE 6-3 -- RAINFALL INTENSITIES FOR CARROLL AND GRAFTON COUNTIES

Source: NH Department of Transportation Drainage Manual

GSE®

GSE STANDARD PRODUCTS

Product Data Sheet

GSE FabriNet UF Geocomposite (Double-Sided)

GSE FabriNet UF geocomposite consists of GSE HyperNet UF geonet heat-laminated on both sides with a GSE nonwoven needlepunched geotextile. GSE HyperNet UF is a 300 mil thick geonet manufactured from a premium grade high density polyethylene resin. For the purpose of lamination to geonets, GSE nonwoven needlepunched geotextiles are available in mass per unit area range of 6 oz/yd² (200 g/m²) to 16 oz/yd² (540 g/m²). GSE FabriNet UF geocomposites are designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions. Index properties for the product are provided in the table below. Please contact GSE for further information regarding performance under site-specific conditions.

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE ROLL VALUE[a]		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Product Code			F82060060T	F82080080T	F82100100T
Transmissivity[b], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²	4.35 (9.0 x 10^{-4})	4.35 (9.0 x 10^{-4})	4.35 (9.0 x 10^{-4})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Roll Width[c], ft (m)			15.0 (4.5)	15.0 (4.5)	15.0 (4.5)
Roll Length[c], ft (m)			160 (48)	150 (45)	140 (42)
Roll Area, ft² (m²)			2,400 (223)	2,250 (209)	2,100 (195)
Geonet core[d]					
Transmissivity[b], gal/min/ft (m²/sec)	ASTM D 4716		38.64 (8 x 10^{-3})	38.64 (8 x 10^{-3})	38.64 (8 x 10^{-3})
Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	300 (7.6)	300 (7.6)	300 (7.6)
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035	1/50,000 ft²	75 (13.3)	75 (13.3)	75 (13.3)
Carbon Black Content, %	ASTM D 1603	1/50,000 ft²	2.0	2.0	2.0
Geotextile (prior to lamination)[d,e]					
Mass per Unit Area, oz/yd² (g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	170 (755)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US Sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec⁻¹)	ASTM D 4491	1/540,000 ft²	1.5	1.5	1.2
Flow Rate, gpm/ft² (l/min/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	110 (4,480)	85 (3,460)
UV Resistance, % Retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70

NOTES:

- [a]These are MARV values and are based on the cumulative results of specimens tested by GSE. AOS in mm is a maximum average roll value.
- [b]Gradient of 0.1, normal load of 10,000 psf, water at 70° F (20° C), between stainless steel plates for 15 minutes.
- [c]Roll widths and lengths have a tolerance of ±1%.
- [d]Component properties prior to lamination.
- [e]Refer to geotextile product data sheet for additional specifications.

DS066 FabriNetUF R03/07/06

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South America	GSE Lining Technology Chile S.A.	Santiago, Chile		56 2 595 4200	Fax: 56 2 595 4290
Asia Pacific	GSE Lining Technology Company Limited	Bangkok, Thailand		66 2 937 0091	Fax: 66 2 937 0097
Europe & Africa	GSE Lining Technology GmbH	Hamburg, Germany		49 40 767420	Fax: 49 40 7674234
Middle East	GSE Lining Technology-Egypt	The 6th of October City, Egypt		202 2 828 8888	Fax: 202 2 828 8889

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-6-1.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCES-61.OUT


TIME:  10:21     DATE:   1/ 2/2007

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     TITLE:  NCES Landfill - Active Cell with 6' of Waste

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   3
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.0830 VOL/VOL
          WILTING POINT                =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.310000009000E-02 CM/SEC


                                LAYER  2
                                --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =     72.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2903 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2284	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0157	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 95. FEET.

SCS RUNOFF CURVE NUMBER	=	86.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.490	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.084	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.352	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	27.045	INCHES
TOTAL INITIAL WATER	=	28.519	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	2.70	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	2.13	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	0.467	0.571	0.524	0.802	1.906	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.697	1.140
	0.441	0.540	0.443	0.224	0.106	0.083

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	0.3689	0.1778	0.3857	4.3979	5.1515	1.2188
	0.5258	0.2309	0.7122	1.4150	1.4327	0.9205
STD. DEVIATIONS	0.1147	0.0343	0.5585	3.3705	1.9752	0.9276
	0.3090	0.1117	0.7557	1.1727	0.8734	0.4500

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0010	0.0005	0.0010	0.0123	0.0139	0.0034
	0.0014	0.0006	0.0020	0.0038	0.0040	0.0025
STD. DEVIATIONS	0.0003	0.0001	0.0015	0.0094	0.0053	0.0026
	0.0008	0.0003	0.0021	0.0032	0.0024	0.0012

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	34.54	(5.138)	125380.2	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.835	(1.9438)	64742.50	51.637
LATERAL DRAINAGE COLLECTED FROM LAYER 4	16.93756	(4.48410)	61483.332	49.03751
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP	0.004	(0.001)		

OF LAYER 5

CHANGE IN WATER STORAGE -0.233 (1.0919) -845.62 -0.674

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	1.00982	3665.62915
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 5	0.085	
MAXIMUM HEAD ON TOP OF LAYER 5	0.164	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.7 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5105

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	20.9406	0.2908
3	4.0250	0.2236
4	0.0037	0.0148
5	0.0000	0.0000
SNOW WATER	1.359	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES25.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-6-1.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCES625.OUT


TIME:  12: 9     DATE:   1/ 2/2007


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     TITLE:  NCES Landfill - Active Cell 6' of Waste - 25 Yr Storm

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   3
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.0830 VOL/VOL
          WILTING POINT                =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.310000009000E-02 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =     72.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2903 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
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LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2284	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0157	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 95. FEET.

SCS RUNOFF CURVE NUMBER	=	86.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.490	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.084	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.352	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	27.045	INCHES
TOTAL INITIAL WATER	=	28.519	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

****

DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.032	0.0767	0.0257	.3071	.6803E-08
131			0.00	0.000	0.029	0.0731	0.0235	.2810	.6803E-08
132			0.00	0.000	0.027	0.0698	0.0216	.2579	.6803E-08
133			0.02	0.000	0.025	0.0692	0.0199	.2377	.6803E-08
134			0.00	0.000	0.023	0.0663	0.0184	.2201	.6803E-08
135			0.00	0.000	0.022	0.0612	0.0168	.2005	.6803E-08
136			0.00	0.000	0.021	0.0586	0.0170	.2030	.6803E-08
137			0.17	0.000	0.020	0.0773	0.0150	.1789	.6803E-08
138			0.00	0.000	0.019	0.0749	0.0138	.1642	.6803E-08

139	0.00	0.000	0.018	0.0726	0.0102	.1220	.6803E-08
140	0.00	0.000	0.018	0.0704	0.0131	.1562	.6803E-08
141	0.00	0.000	0.017	0.0682	0.0147	.1759	.6803E-08
142	3.84	0.000	0.017	0.3451	0.0186	.2213	.6803E-08
143	1.92	0.000	0.194	0.3041	0.0137	.1638	.6803E-08
144	0.85	0.000	0.195	0.2742	0.0108	.1291	.6803E-08
145	1.74	0.000	0.185	0.3091	0.0051	.6104E-01	.6803E-08
146	0.23	0.000	0.205	0.2228	0.0040	.4753E-01	.6803E-08
147	0.06	0.000	0.167	0.1981	0.0094	.1118	.6803E-08
148	0.57	0.000	0.143	0.2456	0.0017	.2084E-01	.4288E-08
149	0.12	0.000	0.211	0.2112	0.0000	.0000E+00	.0000E+00
150	0.06	0.000	0.154	0.1859	0.0137	.1636	.4252E-08
151	0.00	0.000	0.239	0.1484	0.0431	.5139	.6803E-08
152	0.00	0.000	0.234	0.1157	0.0428	.5107	.6803E-08
153	0.00	0.000	0.121	0.0993	0.0384	.4581	.6803E-08
154	0.00	0.000	0.056	0.0923	0.0347	.4139	.6803E-08
155	0.00	0.000	0.043	0.0870	0.0319	.3807	.6803E-08
156	0.23	0.000	0.037	0.1108	0.0293	.3497	.6803E-08
157	0.00	0.000	0.032	0.1068	0.0307	.3662	.6803E-08
158	0.00	0.000	0.029	0.1032	0.0299	.3567	.6803E-08
159	0.00	0.000	0.027	0.0999	0.0279	.3330	.6803E-08
160	0.00	0.000	0.025	0.0968	0.0257	.3061	.6803E-08
161	0.00	0.000	0.023	0.0939	0.0235	.2805	.6803E-08
162	1.18	0.000	0.023	0.2376	0.0218	.2599	.6803E-08
163	0.10	0.000	0.155	0.2152	0.0200	.2386	.6803E-08
164	0.00	0.000	0.188	0.1772	0.0171	.2040	.6803E-08
165	0.00	0.000	0.218	0.1428	0.0172	.2051	.6803E-08
166	0.00	0.000	0.166	0.1181	0.0186	.2215	.6803E-08
167	0.00	0.000	0.117	0.1017	0.0176	.2097	.6803E-08
168	0.00	0.000	0.056	0.0944	0.0178	.2125	.6803E-08
169	0.00	0.000	0.043	0.0890	0.0120	.1427	.6803E-08
170	0.00	0.000	0.036	0.0845	0.0081	.9628E-01	.6803E-08
171	0.00	0.000	0.032	0.0805	0.0068	.8078E-01	.6803E-08
172	0.00	0.000	0.029	0.0769	0.0068	.8118E-01	.6803E-08
173	0.00	0.000	0.027	0.0736	0.0074	.8811E-01	.6803E-08
174	0.00	0.000	0.025	0.0705	0.0048	.5776E-01	.6803E-08
175	0.00	0.000	0.023	0.0676	0.0099	.1177	.6803E-08
176	0.00	0.000	0.022	0.0649	0.0142	.1689	.6803E-08
177	0.00	0.000	0.021	0.0623	0.0154	.1833	.6803E-08
178	0.00	0.000	0.020	0.0598	0.0118	.1412	.6803E-08
179	0.06	0.000	0.020	0.0648	0.0096	.1143	.6803E-08
180	0.00	0.000	0.017	0.0626	0.0080	.9563E-01	.6803E-08
181	0.09	0.000	0.019	0.0715	0.0069	.8197E-01	.6803E-08
182	1.20	0.000	0.018	0.2192	0.0060	.7156E-01	.6803E-08
183	0.03	0.000	0.103	0.2092	0.0051	.6123E-01	.6803E-08
184	0.00	0.000	0.199	0.1718	0.0038	.4531E-01	.6803E-08
185	0.00	0.000	0.196	0.1390	0.0012	.1460E-01	.6803E-08
186	0.06	0.000	0.142	0.1265	0.0040	.4786E-01	.6803E-08
187	0.00	0.000	0.141	0.1070	0.0032	.3824E-01	.6803E-08
188	0.00	0.000	0.135	0.0872	0.0024	.2814E-01	.6803E-08
189	0.00	0.000	0.056	0.0803	0.0007	.8682E-02	.4268E-08
190	0.00	0.000	0.043	0.0749	0.0040	.4830E-01	.5528E-08
191	0.00	0.000	0.036	0.0704	0.0048	.5693E-01	.6803E-08
192	0.00	0.000	0.032	0.0664	0.0043	.5150E-01	.6803E-08
193	0.00	0.000	0.029	0.0628	0.0039	.4697E-01	.6803E-08
194	0.00	0.000	0.027	0.0595	0.0036	.4313E-01	.6803E-08
195	0.00	0.000	0.025	0.0564	0.0033	.3984E-01	.6803E-08
196	0.00	0.000	0.023	0.0535	0.0031	.3699E-01	.6803E-08
197	0.26	0.000	0.024	0.0830	0.0029	.3450E-01	.6803E-08
198	0.29	0.000	0.023	0.1165	0.0027	.3231E-01	.6803E-08
199	0.00	0.000	0.020	0.1140	0.0025	.3036E-01	.6803E-08
200	0.00	0.000	0.019	0.1116	0.0024	.2863E-01	.6803E-08

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.00	1.23	1.87	2.70	10.02	1.66
	2.68	4.05	3.24	3.50	3.09	1.72
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.405	0.572	0.683	0.827	2.969	1.882
	2.327	3.221	2.864	1.842	1.060	0.347
LATERAL DRAINAGE COLLECTED	0.2220	0.1311	0.1070	4.9126	7.6391	6.7567
FROM LAYER 4	1.0186	0.3338	0.2927	0.7178	1.1144	1.5132
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.014	0.021	0.019
TOP OF LAYER 5	0.003	0.001	0.001	0.002	0.003	0.004
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.026	0.012	0.011
HEAD ON TOP OF LAYER 5	0.001	0.000	0.001	0.002	0.002	0.004

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	41.76	151588.781	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.998	68963.703	45.49
DRAINAGE COLLECTED FROM LAYER 4	24.7592	89875.734	59.29
PERC./LEAKAGE THROUGH LAYER 5	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0057		
CHANGE IN WATER STORAGE	-1.997	-7250.646	-4.78
SOIL WATER AT START OF YEAR	25.422	92281.633	
SOIL WATER AT END OF YEAR	26.087	94697.211	

SNOW WATER AT START OF YEAR	4.022	14598.911	9.63
SNOW WATER AT END OF YEAR	1.359	4932.691	3.25
ANNUAL WATER BUDGET BALANCE	0.0000	-0.015	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	3.85	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	3.96	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.802	1.978	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.798	1.140
	0.441	0.540	0.443	0.224	0.106	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.3689	0.1778	0.3857	4.3979	5.2460	2.1486
	0.5736	0.2353	0.7142	1.4167	1.4330	0.9205
STD. DEVIATIONS	0.1147	0.0343	0.5585	3.3705	2.1029	2.6925
	0.3705	0.1161	0.7543	1.1715	0.8733	0.4500
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0010	0.0005	0.0010	0.0123	0.0142	0.0060
	0.0016	0.0006	0.0020	0.0038	0.0040	0.0025
STD. DEVIATIONS	0.0003	0.0001	0.0015	0.0094	0.0057	0.0075
	0.0010	0.0003	0.0021	0.0032	0.0024	0.0012

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	35.69	(6.102)	129562.0	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.907	(1.9869)	65001.52	50.170
LATERAL DRAINAGE COLLECTED FROM LAYER 4	18.01820	(5.69909)	65406.078	50.48248
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.004	(0.001)		
CHANGE IN WATER STORAGE	-0.233	(1.0919)	-845.62	-0.653

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	1.00982	3665.62915
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 5	0.085	
MAXIMUM HEAD ON TOP OF LAYER 5	0.164	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.7 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5105

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	20.9406	0.2908
3	4.0250	0.2236
4	0.0037	0.0148
5	0.0000	0.0000
SNOW WATER	1.359	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE:     F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D4
TEMPERATURE DATA FILE:       F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:   F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:     F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:   F:\CMAMAI~1\JSM.MB\HELP3\NCES-30.D10
OUTPUT DATA FILE:            F:\CMAMAI~1\JSM.MB\HELP3\NCES301.OUT


TIME:  11:30     DATE:   1/ 2/2007

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     TITLE:  NCES Landfill - Active Cell with 30'of Waste

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   3
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.0830 VOL/VOL
          WILTING POINT                =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.310000009000E-02 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    360.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2917 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
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LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2649	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0304	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 95. FEET.

SCS RUNOFF CURVE NUMBER	=	86.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.490	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.084	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.352	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	111.801	INCHES
TOTAL INITIAL WATER	=	113.275	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	2.70	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	2.13	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	0.467	0.571	0.524	0.802	1.906	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.697	1.140
	0.441	0.540	0.443	0.224	0.106	0.083

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	0.5870	0.2144	0.1373	0.8830	3.2023	3.7123
	2.6371	1.0459	0.8535	0.9332	1.6490	1.2115
STD. DEVIATIONS	0.3023	0.0610	0.0429	0.9791	1.4107	0.4444
	1.2657	1.1853	0.7221	0.7825	0.7434	0.8596

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0016	0.0006	0.0004	0.0025	0.0087	0.0104
	0.0071	0.0028	0.0024	0.0025	0.0046	0.0033
STD. DEVIATIONS	0.0008	0.0002	0.0001	0.0027	0.0038	0.0012
	0.0034	0.0032	0.0020	0.0021	0.0021	0.0023

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	34.54	(5.138)	125380.2	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.835	(1.9438)	64742.50	51.637
LATERAL DRAINAGE COLLECTED FROM LAYER 4	17.06647	(4.37565)	61951.289	49.41074
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP	0.004	(0.001)		

OF LAYER 5

CHANGE IN WATER STORAGE -0.362 (0.8939) -1313.59 -1.048

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.26653	967.49939
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.022	
MAXIMUM HEAD ON TOP OF LAYER 5	0.044	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	1.0 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5105

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	105.0366	0.2918
3	4.0405	0.2245
4	0.0037	0.0149
5	0.0000	0.0000
SNOW WATER	1.359	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES25.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-30.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCES3025.OUT


TIME:  12: 9     DATE:   1/ 2/2007


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     TITLE:  NCES Landfill - Active Cell 30'of Waste - 25 Yr Storm

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   3
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4570 VOL/VOL
          FIELD CAPACITY             =      0.0830 VOL/VOL
          WILTING POINT              =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.310000009000E-02 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                  =    360.00   INCHES
          POROSITY                   =      0.6710 VOL/VOL
          FIELD CAPACITY             =      0.2920 VOL/VOL
          WILTING POINT              =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2917 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
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LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2649	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0304	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 95. FEET.

SCS RUNOFF CURVE NUMBER	=	86.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.490	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.084	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.352	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	111.801	INCHES
TOTAL INITIAL WATER	=	113.275	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

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DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.032	0.0767	0.0000	.0000E+00	.0000E+00
131			0.00	0.000	0.029	0.0731	0.0000	.0000E+00	.0000E+00
132			0.00	0.000	0.027	0.0698	0.0000	.0000E+00	.0000E+00
133			0.02	0.000	0.025	0.0692	0.0022	.2665E-01	.5528E-08

134	0.00	0.000	0.023	0.0663	0.0082	.9748E-01	.6803E-08
135	0.00	0.000	0.022	0.0612	0.0123	.1468	.6803E-08
136	0.00	0.000	0.021	0.0586	0.0161	.1920	.6803E-08
137	0.17	0.000	0.020	0.0773	0.0163	.1943	.6803E-08
138	0.00	0.000	0.019	0.0749	0.0167	.1994	.6803E-08
139	0.00	0.000	0.018	0.0726	0.0171	.2035	.6803E-08
140	0.00	0.000	0.018	0.0704	0.0172	.2057	.6803E-08
141	0.00	0.000	0.017	0.0682	0.0173	.2059	.6803E-08
142	3.84	0.000	0.017	0.3451	0.0172	.2049	.6803E-08
143	1.92	0.000	0.194	0.3041	0.0138	.1644	.6803E-08
144	0.85	0.000	0.195	0.2742	0.0223	.2661	.6803E-08
145	1.74	0.000	0.185	0.3091	0.0220	.2624	.6803E-08
146	0.23	0.000	0.205	0.2228	0.0168	.2009	.6803E-08
147	0.06	0.000	0.167	0.1981	0.0194	.2316	.6803E-08
148	0.57	0.000	0.143	0.2456	0.0145	.1734	.6803E-08
149	0.12	0.000	0.211	0.2112	0.0122	.1454	.6803E-08
150	0.06	0.000	0.154	0.1859	0.0072	.8590E-01	.6803E-08
151	0.00	0.000	0.239	0.1484	0.0061	.7236E-01	.6803E-08
152	0.00	0.000	0.234	0.1157	0.0055	.6531E-01	.6803E-08
153	0.00	0.000	0.121	0.0993	0.0043	.5166E-01	.6803E-08
154	0.00	0.000	0.056	0.0923	0.0027	.3223E-01	.6803E-08
155	0.00	0.000	0.043	0.0870	0.0041	.4932E-01	.6803E-08
156	0.23	0.000	0.037	0.1108	0.0000	.4057E-05	.1825E-08
157	0.00	0.000	0.032	0.1068	0.0022	.2614E-01	.5953E-08
158	0.00	0.000	0.029	0.1032	0.0092	.1092	.6803E-08
159	0.00	0.000	0.027	0.0999	0.0154	.1841	.6803E-08
160	0.00	0.000	0.025	0.0968	0.0194	.2314	.6803E-08
161	0.00	0.000	0.023	0.0939	0.0214	.2552	.6803E-08
162	1.18	0.000	0.023	0.2376	0.0224	.2678	.6803E-08
163	0.10	0.000	0.155	0.2152	0.0224	.2667	.6803E-08
164	0.00	0.000	0.188	0.1772	0.0211	.2520	.6803E-08
165	0.00	0.000	0.218	0.1428	0.0231	.2756	.6803E-08
166	0.00	0.000	0.166	0.1181	0.0241	.2875	.6803E-08
167	0.00	0.000	0.117	0.1017	0.0221	.2631	.6803E-08
168	0.00	0.000	0.056	0.0944	0.0204	.2435	.6803E-08
169	0.00	0.000	0.043	0.0890	0.0137	.1639	.6803E-08
170	0.00	0.000	0.036	0.0845	0.0123	.1469	.6803E-08
171	0.00	0.000	0.032	0.0805	0.0139	.1661	.6803E-08
172	0.00	0.000	0.029	0.0769	0.0159	.1901	.6803E-08
173	0.00	0.000	0.027	0.0736	0.0174	.2079	.6803E-08
174	0.00	0.000	0.025	0.0705	0.0183	.2182	.6803E-08
175	0.00	0.000	0.023	0.0676	0.0187	.2229	.6803E-08
176	0.00	0.000	0.022	0.0649	0.0188	.2240	.6803E-08
177	0.00	0.000	0.021	0.0623	0.0187	.2231	.6803E-08
178	0.00	0.000	0.020	0.0598	0.0185	.2211	.6803E-08
179	0.06	0.000	0.020	0.0648	0.0183	.2185	.6803E-08
180	0.00	0.000	0.017	0.0626	0.0181	.2156	.6803E-08
181	0.09	0.000	0.019	0.0715	0.0178	.2126	.6803E-08
182	1.20	0.000	0.018	0.2192	0.0176	.2096	.6803E-08
183	0.03	0.000	0.103	0.2092	0.0172	.2047	.6803E-08
184	0.00	0.000	0.199	0.1718	0.0168	.2001	.6803E-08
185	0.00	0.000	0.196	0.1390	0.0171	.2042	.6803E-08
186	0.06	0.000	0.142	0.1265	0.0174	.2071	.6803E-08
187	0.00	0.000	0.141	0.1070	0.0207	.2469	.6803E-08
188	0.00	0.000	0.135	0.0872	0.0157	.1872	.6803E-08
189	0.00	0.000	0.056	0.0803	0.0132	.1574	.6803E-08
190	0.00	0.000	0.043	0.0749	0.0110	.1313	.6803E-08
191	0.00	0.000	0.036	0.0704	0.0110	.1317	.6803E-08
192	0.00	0.000	0.032	0.0664	0.0118	.1414	.6803E-08
193	0.00	0.000	0.029	0.0628	0.0127	.1521	.6803E-08
194	0.00	0.000	0.027	0.0595	0.0135	.1605	.6803E-08
195	0.00	0.000	0.025	0.0564	0.0139	.1662	.6803E-08
196	0.00	0.000	0.023	0.0535	0.0142	.1693	.6803E-08

197	0.26	0.000	0.024	0.0830	0.0143	.1707	.6803E-08
198	0.29	0.000	0.023	0.1165	0.0143	.1708	.6803E-08
199	0.00	0.000	0.020	0.1140	0.0143	.1701	.6803E-08
200	0.00	0.000	0.019	0.1116	0.0142	.1689	.6803E-08

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.00	1.23	1.87	2.70	10.02	1.66
	2.68	4.05	3.24	3.50	3.09	1.72
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.405	0.572	0.683	0.827	2.969	1.882
	2.327	3.221	2.864	1.842	1.060	0.347
LATERAL DRAINAGE COLLECTED	0.2351	0.1363	0.1102	0.0691	3.2910	5.4918
FROM LAYER 4	5.2434	3.9097	2.2227	1.3471	1.1560	1.3939
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.000	0.009	0.015
TOP OF LAYER 5	0.014	0.011	0.006	0.004	0.003	0.004
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.008	0.007
HEAD ON TOP OF LAYER 5	0.002	0.001	0.004	0.003	0.002	0.004

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	41.76	151588.781	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.998	68963.703	45.49
DRAINAGE COLLECTED FROM LAYER 4	24.6064	89321.250	58.92
PERC./LEAKAGE THROUGH LAYER 5	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0056		

CHANGE IN WATER STORAGE	-1.845	-6696.185	-4.42
SOIL WATER AT START OF YEAR	109.549	397663.625	
SOIL WATER AT END OF YEAR	110.367	400633.656	
SNOW WATER AT START OF YEAR	4.022	14598.911	9.63
SNOW WATER AT END OF YEAR	1.359	4932.691	3.25
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	3.85	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	3.96	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.802	1.978	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.798	1.140
	0.441	0.540	0.443	0.224	0.106	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.5870	0.2144	0.1373	0.8830	3.1611	4.0596
	2.8703	1.2008	1.1596	1.0073	1.6549	1.2117
STD. DEVIATIONS	0.3023	0.0610	0.0429	0.9791	1.4029	0.9154
	1.6472	1.5277	0.9309	0.8049	0.7382	0.8597
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0016	0.0006	0.0004	0.0025	0.0085	0.0113
	0.0078	0.0032	0.0032	0.0027	0.0046	0.0033
STD. DEVIATIONS	0.0008	0.0002	0.0001	0.0027	0.0038	0.0026
	0.0045	0.0041	0.0026	0.0022	0.0021	0.0023

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	35.69	(6.102)	129562.0	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.907	(1.9869)	65001.52	50.170
LATERAL DRAINAGE COLLECTED FROM LAYER 4	18.14712	(5.54596)	65874.031	50.84365
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.004	(0.001)		
CHANGE IN WATER STORAGE	-0.362	(0.8939)	-1313.59	-1.014

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.28749	1043.58362
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.024	
MAXIMUM HEAD ON TOP OF LAYER 5	0.048	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.8 FEET	

SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5105

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	105.0366	0.2918
3	4.0405	0.2245
4	0.0037	0.0149
5	0.0000	0.0000
SNOW WATER	1.359	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES100.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-30.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCES3010.OUT

TIME:  12:11     DATE:   1/ 2/2007


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     TITLE:  NCES Landfill - Active Cell 30' of Waste - 100 Yr Storm

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   3
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.0830 VOL/VOL
          WILTING POINT                =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.310000009000E-02 CM/SEC

                                LAYER  2
                                --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    360.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2917 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                                LAYER  3
                                --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER   0
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THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.4570 VOL/VOL
FIELD CAPACITY               =      0.0830 VOL/VOL
WILTING POINT                =      0.0330 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2649 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-04 CM/SEC

                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0304 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =     95.0    FEET

                        LAYER  5
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            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.08   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD

         GENERAL DESIGN AND EVAPORATIVE ZONE DATA

         ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE
          OF  2.% AND A SLOPE LENGTH OF   95. FEET.

SCS RUNOFF CURVE NUMBER              =     86.00
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =      8.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      2.490  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.084  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.352  INCHES
INITIAL SNOW WATER                   =      1.474  INCHES
INITIAL WATER IN LAYER MATERIALS     =    111.801  INCHES
TOTAL INITIAL WATER                  =    113.275  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
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EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

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DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.032	0.0767	0.0000	.0000E+00	.0000E+00
131			0.00	0.000	0.029	0.0731	0.0000	.0000E+00	.0000E+00
132			0.00	0.000	0.027	0.0698	0.0000	.0000E+00	.0000E+00
133			0.02	0.000	0.025	0.0692	0.0022	.2665E-01	.5528E-08
134			0.00	0.000	0.023	0.0663	0.0082	.9748E-01	.6803E-08

135	0.00	0.000	0.022	0.0612	0.0123	.1468	.6803E-08
136	0.00	0.000	0.021	0.0586	0.0161	.1920	.6803E-08
137	0.17	0.000	0.020	0.0773	0.0163	.1943	.6803E-08
138	0.00	0.000	0.019	0.0749	0.0167	.1994	.6803E-08
139	0.00	0.000	0.018	0.0726	0.0171	.2035	.6803E-08
140	0.00	0.000	0.018	0.0704	0.0172	.2057	.6803E-08
141	0.00	0.000	0.017	0.0682	0.0173	.2059	.6803E-08
142	4.56	0.000	0.017	0.3708	0.0172	.2049	.6803E-08
143	2.28	0.000	0.194	0.3215	0.0140	.1672	.6803E-08
144	0.85	0.000	0.195	0.2743	0.0224	.2677	.6803E-08
145	1.74	0.000	0.185	0.3090	0.0219	.2607	.6803E-08
146	0.23	0.000	0.205	0.2228	0.0166	.1985	.6803E-08
147	0.06	0.000	0.167	0.1981	0.0193	.2308	.6803E-08
148	0.57	0.000	0.143	0.2456	0.0142	.1699	.6803E-08
149	0.12	0.000	0.211	0.2112	0.0125	.1488	.6803E-08
150	0.06	0.000	0.154	0.1859	0.0071	.8513E-01	.6803E-08
151	0.00	0.000	0.239	0.1484	0.0053	.6336E-01	.6803E-08
152	0.00	0.000	0.234	0.1157	0.0044	.5265E-01	.6803E-08
153	0.00	0.000	0.121	0.0993	0.0033	.3985E-01	.6803E-08
154	0.00	0.000	0.056	0.0923	0.0022	.2670E-01	.6803E-08
155	0.00	0.000	0.043	0.0870	0.0042	.5059E-01	.6803E-08
156	0.23	0.000	0.037	0.1108	0.0009	.1067E-01	.6803E-08
157	0.00	0.000	0.032	0.1068	0.0062	.7346E-01	.6803E-08
158	0.00	0.000	0.029	0.1032	0.0137	.1637	.6803E-08
159	0.00	0.000	0.027	0.0999	0.0194	.2310	.6803E-08
160	0.00	0.000	0.025	0.0968	0.0224	.2673	.6803E-08
161	0.00	0.000	0.023	0.0939	0.0237	.2826	.6803E-08
162	1.18	0.000	0.023	0.2376	0.0243	.2901	.6803E-08
163	0.10	0.000	0.155	0.2152	0.0239	.2853	.6803E-08
164	0.00	0.000	0.188	0.1772	0.0226	.2695	.6803E-08
165	0.00	0.000	0.218	0.1428	0.0245	.2928	.6803E-08
166	0.00	0.000	0.166	0.1181	0.0252	.3008	.6803E-08
167	0.00	0.000	0.117	0.1017	0.0229	.2731	.6803E-08
168	0.00	0.000	0.056	0.0944	0.0210	.2500	.6803E-08
169	0.00	0.000	0.043	0.0890	0.0143	.1710	.6803E-08
170	0.00	0.000	0.036	0.0845	0.0134	.1598	.6803E-08
171	0.00	0.000	0.032	0.0805	0.0153	.1828	.6803E-08
172	0.00	0.000	0.029	0.0769	0.0174	.2076	.6803E-08
173	0.00	0.000	0.027	0.0736	0.0188	.2243	.6803E-08
174	0.00	0.000	0.025	0.0705	0.0195	.2331	.6803E-08
175	0.00	0.000	0.023	0.0676	0.0198	.2364	.6803E-08
176	0.00	0.000	0.022	0.0649	0.0198	.2364	.6803E-08
177	0.00	0.000	0.021	0.0623	0.0197	.2346	.6803E-08
178	0.00	0.000	0.020	0.0598	0.0194	.2320	.6803E-08
179	0.06	0.000	0.020	0.0648	0.0192	.2289	.6803E-08
180	0.00	0.000	0.017	0.0626	0.0189	.2256	.6803E-08
181	0.09	0.000	0.019	0.0715	0.0186	.2223	.6803E-08
182	1.20	0.000	0.018	0.2192	0.0184	.2190	.6803E-08
183	0.03	0.000	0.103	0.2092	0.0179	.2138	.6803E-08
184	0.00	0.000	0.199	0.1718	0.0175	.2091	.6803E-08
185	0.00	0.000	0.196	0.1390	0.0179	.2137	.6803E-08
186	0.06	0.000	0.142	0.1265	0.0181	.2159	.6803E-08
187	0.00	0.000	0.141	0.1070	0.0212	.2531	.6803E-08
188	0.00	0.000	0.135	0.0872	0.0160	.1914	.6803E-08
189	0.00	0.000	0.056	0.0803	0.0135	.1614	.6803E-08
190	0.00	0.000	0.043	0.0749	0.0115	.1371	.6803E-08
191	0.00	0.000	0.036	0.0704	0.0117	.1393	.6803E-08
192	0.00	0.000	0.032	0.0664	0.0126	.1502	.6803E-08
193	0.00	0.000	0.029	0.0628	0.0135	.1611	.6803E-08
194	0.00	0.000	0.027	0.0595	0.0142	.1694	.6803E-08
195	0.00	0.000	0.025	0.0564	0.0146	.1745	.6803E-08
196	0.00	0.000	0.023	0.0535	0.0149	.1772	.6803E-08
197	0.26	0.000	0.024	0.0830	0.0149	.1780	.6803E-08

198	0.29	0.000	0.023	0.1165	0.0149	.1777	.6803E-08
199	0.00	0.000	0.020	0.1140	0.0148	.1767	.6803E-08
200	0.00	0.000	0.019	0.1116	0.0147	.1752	.6803E-08

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.00	1.23	1.87	2.70	11.10	1.66
	2.68	4.05	3.24	3.50	3.09	1.72
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.405	0.572	0.683	0.827	2.969	1.882
	2.327	3.221	2.864	1.842	1.060	0.347
LATERAL DRAINAGE COLLECTED	0.2351	0.1363	0.1102	0.0691	3.2805	5.9549
FROM LAYER 4	5.4508	4.0180	2.2892	1.5654	1.1817	1.3950
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.000	0.009	0.017
TOP OF LAYER 5	0.015	0.011	0.006	0.004	0.003	0.004
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.008	0.007
HEAD ON TOP OF LAYER 5	0.002	0.001	0.004	0.003	0.002	0.004

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	42.84	155509.187	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.998	68963.703	44.35
DRAINAGE COLLECTED FROM LAYER 4	25.6864	93241.555	59.96
PERC./LEAKAGE THROUGH LAYER 5	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0059		

CHANGE IN WATER STORAGE	-1.845	-6696.102	-4.31
SOIL WATER AT START OF YEAR	109.549	397663.625	
SOIL WATER AT END OF YEAR	110.367	400633.750	
SNOW WATER AT START OF YEAR	4.022	14598.911	9.39
SNOW WATER AT END OF YEAR	1.359	4932.691	3.17
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	4.07	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	4.39	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.802	1.978	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.798	1.140
	0.441	0.540	0.443	0.224	0.106	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.5870	0.2144	0.1373	0.8830	3.1590	4.1523
	2.9118	1.2225	1.1729	1.0510	1.6601	1.2119
STD. DEVIATIONS	0.3023	0.0610	0.0429	0.9791	1.4027	1.1011
	1.7228	1.5757	0.9501	0.8333	0.7340	0.8598
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0016	0.0006	0.0004	0.0025	0.0085	0.0116
	0.0079	0.0033	0.0033	0.0028	0.0046	0.0033
STD. DEVIATIONS	0.0008	0.0002	0.0001	0.0027	0.0038	0.0031
	0.0047	0.0043	0.0027	0.0023	0.0021	0.0023

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	35.91	(6.383)	130346.0	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.907	(1.9869)	65001.52	49.868
LATERAL DRAINAGE COLLECTED FROM LAYER 4	18.36312	(5.87187)	66658.109	51.13935
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.004	(0.001)		
CHANGE IN WATER STORAGE	-0.362	(0.8939)	-1313.59	-1.008

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	4.56	16552.799
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.30081	1091.93665
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.025	
MAXIMUM HEAD ON TOP OF LAYER 5	0.050	

LOCATION OF MAXIMUM HEAD IN LAYER 4
(DISTANCE FROM DRAIN) 1.1 FEET

SNOW WATER 11.61 42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5105

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	105.0366	0.2918
3	4.0405	0.2245
4	0.0037	0.0149
5	0.0000	0.0000
SNOW WATER	1.359	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-60.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCES601.OUT


TIME:  11:30     DATE:   1/ 2/2007


******************************************************************************

     TITLE:  NCES Landfill - Active Cell with 60' of Waste

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   3
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.0830 VOL/VOL
          WILTING POINT                =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.310000009000E-02 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    720.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2923 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                                  LAYER  3
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
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THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.4570 VOL/VOL
FIELD CAPACITY               =      0.0830 VOL/VOL
WILTING POINT                =      0.0330 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2983 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-04 CM/SEC

                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0381 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =     95.0    FEET

                        LAYER  5
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            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.08   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD

         GENERAL DESIGN AND EVAPORATIVE ZONE DATA

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 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE
          OF  2.% AND A SLOPE LENGTH OF   95. FEET.

SCS RUNOFF CURVE NUMBER              =     86.00
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =      8.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      2.490  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.084  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.352  INCHES
INITIAL SNOW WATER                   =      1.474  INCHES
INITIAL WATER IN LAYER MATERIALS     =    217.840  INCHES
TOTAL INITIAL WATER                  =    219.314  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR

          EVAPOTRANSPIRATION AND WEATHER DATA
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NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	2.70	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	2.13	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						

TOTALS	0.467	0.571	0.524	0.802	1.906	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.697	1.140
	0.441	0.540	0.443	0.224	0.106	0.083

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	0.9103	0.2379	0.1489	0.6173	2.1976	3.3052
	2.7633	1.8897	1.2576	1.1219	1.6330	1.1672
STD. DEVIATIONS	0.7098	0.0867	0.0546	0.8455	1.0727	0.3603
	1.1484	1.2186	0.9112	0.9189	0.5031	0.7611

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0025	0.0007	0.0004	0.0017	0.0059	0.0092
	0.0075	0.0051	0.0035	0.0030	0.0046	0.0032
STD. DEVIATIONS	0.0019	0.0003	0.0001	0.0024	0.0029	0.0010
	0.0031	0.0033	0.0025	0.0025	0.0014	0.0021

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	34.54	(5.138)	125380.2	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.835	(1.9438)	64742.50	51.637
LATERAL DRAINAGE COLLECTED FROM LAYER 4	17.24999	(4.37290)	62617.480	49.94208
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.004	(0.001)		
CHANGE IN WATER STORAGE	-0.545	(0.8076)	-1979.77	-1.579

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.22242	807.38153
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.019	
MAXIMUM HEAD ON TOP OF LAYER 5	0.037	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.6 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5105
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	210.1566	0.2919
3	4.0420	0.2246
4	0.0037	0.0149
5	0.0000	0.0000
SNOW WATER	1.359	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES25.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-60.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCES6025.OUT


TIME:  12: 9     DATE:   1/ 2/2007


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     TITLE:  NCES Landfill - Active Cell 60' of Waste -  25 Yr Storm

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   3
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.0830 VOL/VOL
          WILTING POINT                =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.310000009000E-02 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    720.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2923 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
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LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2983	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0381	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 95. FEET.

SCS RUNOFF CURVE NUMBER	=	86.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.490	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.084	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.352	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	217.840	INCHES
TOTAL INITIAL WATER	=	219.314	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

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DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.032	0.0767	0.0000	.0000E+00	.0000E+00
131			0.00	0.000	0.029	0.0731	0.0000	.0000E+00	.0000E+00
132			0.00	0.000	0.027	0.0698	0.0000	.0000E+00	.0000E+00
133			0.02	0.000	0.025	0.0692	0.0000	.0000E+00	.0000E+00
134			0.00	0.000	0.023	0.0663	0.0000	.0000E+00	.0000E+00
135			0.00	0.000	0.022	0.0612	0.0000	.0000E+00	.0000E+00
136			0.00	0.000	0.021	0.0586	0.0000	.0000E+00	.0000E+00
137			0.17	0.000	0.020	0.0773	0.0000	.0000E+00	.0000E+00

138	0.00	0.000	0.019	0.0749	0.0001	.1745E-02	.2126E-08
139	0.00	0.000	0.018	0.0726	0.0023	.2728E-01	.6803E-08
140	0.00	0.000	0.018	0.0704	0.0049	.5828E-01	.6803E-08
141	0.00	0.000	0.017	0.0682	0.0070	.8399E-01	.6803E-08
142	3.84	0.000	0.017	0.3451	0.0087	.1038	.6803E-08
143	1.92	0.000	0.194	0.3041	0.0061	.7276E-01	.6803E-08
144	0.85	0.000	0.195	0.2742	0.0139	.1662	.6803E-08
145	1.74	0.000	0.185	0.3091	0.0165	.1972	.6803E-08
146	0.23	0.000	0.205	0.2228	0.0148	.1762	.6803E-08
147	0.06	0.000	0.167	0.1981	0.0170	.2031	.6803E-08
148	0.57	0.000	0.143	0.2456	0.0128	.1522	.6803E-08
149	0.12	0.000	0.211	0.2112	0.0097	.1156	.6803E-08
150	0.06	0.000	0.154	0.1859	0.0022	.2661E-01	.6803E-08
151	0.00	0.000	0.239	0.1484	0.0087	.1034	.6803E-08
152	0.00	0.000	0.234	0.1157	0.0069	.8198E-01	.6803E-08
153	0.00	0.000	0.121	0.0993	0.0048	.5674E-01	.6803E-08
154	0.00	0.000	0.056	0.0923	0.0053	.6353E-01	.6803E-08
155	0.00	0.000	0.043	0.0870	0.0070	.8377E-01	.6803E-08
156	0.23	0.000	0.037	0.1108	0.0043	.5132E-01	.6803E-08
157	0.00	0.000	0.032	0.1068	0.0003	.3778E-02	.4632E-08
158	0.00	0.000	0.029	0.1032	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.027	0.0999	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.025	0.0968	0.0001	.1040E-02	.1701E-08
161	0.00	0.000	0.023	0.0939	0.0025	.2975E-01	.6803E-08
162	1.18	0.000	0.023	0.2376	0.0060	.7135E-01	.6803E-08
163	0.10	0.000	0.155	0.2152	0.0090	.1072	.6803E-08
164	0.00	0.000	0.188	0.1772	0.0097	.1151	.6803E-08
165	0.00	0.000	0.218	0.1428	0.0125	.1496	.6803E-08
166	0.00	0.000	0.166	0.1181	0.0162	.1931	.6803E-08
167	0.00	0.000	0.117	0.1017	0.0166	.1976	.6803E-08
168	0.00	0.000	0.056	0.0944	0.0174	.2072	.6803E-08
169	0.00	0.000	0.043	0.0890	0.0116	.1383	.6803E-08
170	0.00	0.000	0.036	0.0845	0.0081	.9720E-01	.6803E-08
171	0.00	0.000	0.032	0.0805	0.0076	.9032E-01	.6803E-08
172	0.00	0.000	0.029	0.0769	0.0084	.1005	.6803E-08
173	0.00	0.000	0.027	0.0736	0.0098	.1165	.6803E-08
174	0.00	0.000	0.025	0.0705	0.0111	.1320	.6803E-08
175	0.00	0.000	0.023	0.0676	0.0121	.1444	.6803E-08
176	0.00	0.000	0.022	0.0649	0.0128	.1532	.6803E-08
177	0.00	0.000	0.021	0.0623	0.0133	.1590	.6803E-08
178	0.00	0.000	0.020	0.0598	0.0136	.1626	.6803E-08
179	0.06	0.000	0.020	0.0648	0.0138	.1645	.6803E-08
180	0.00	0.000	0.017	0.0626	0.0139	.1654	.6803E-08
181	0.09	0.000	0.019	0.0715	0.0139	.1655	.6803E-08
182	1.20	0.000	0.018	0.2192	0.0139	.1653	.6803E-08
183	0.03	0.000	0.103	0.2092	0.0136	.1627	.6803E-08
184	0.00	0.000	0.199	0.1718	0.0134	.1596	.6803E-08
185	0.00	0.000	0.196	0.1390	0.0136	.1626	.6803E-08
186	0.06	0.000	0.142	0.1265	0.0141	.1686	.6803E-08
187	0.00	0.000	0.141	0.1070	0.0184	.2200	.6803E-08
188	0.00	0.000	0.135	0.0872	0.0143	.1700	.6803E-08
189	0.00	0.000	0.056	0.0803	0.0120	.1431	.6803E-08
190	0.00	0.000	0.043	0.0749	0.0094	.1120	.6803E-08
191	0.00	0.000	0.036	0.0704	0.0088	.1051	.6803E-08
192	0.00	0.000	0.032	0.0664	0.0092	.1099	.6803E-08
193	0.00	0.000	0.029	0.0628	0.0100	.1187	.6803E-08
194	0.00	0.000	0.027	0.0595	0.0107	.1278	.6803E-08
195	0.00	0.000	0.025	0.0564	0.0114	.1355	.6803E-08
196	0.00	0.000	0.023	0.0535	0.0118	.1411	.6803E-08
197	0.26	0.000	0.024	0.0830	0.0122	.1450	.6803E-08
198	0.29	0.000	0.023	0.1165	0.0124	.1475	.6803E-08
199	0.00	0.000	0.020	0.1140	0.0125	.1489	.6803E-08
200	0.00	0.000	0.019	0.1116	0.0125	.1496	.6803E-08

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	3.85	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	3.96	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.802	1.978	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.798	1.140
	0.441	0.540	0.443	0.224	0.106	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.0781	0.2507	0.1539	0.6188	2.1729	3.4001
	2.9179	2.0048	1.3327	1.2376	1.8272	1.3359
STD. DEVIATIONS	0.7389	0.0930	0.0572	0.8443	1.0914	0.1945
	1.3536	1.4182	1.0208	1.0945	0.4942	0.9010
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5						
AVERAGES	0.0029	0.0007	0.0004	0.0017	0.0059	0.0095
	0.0079	0.0054	0.0037	0.0033	0.0051	0.0036
STD. DEVIATIONS	0.0020	0.0003	0.0002	0.0024	0.0030	0.0005
	0.0037	0.0038	0.0029	0.0030	0.0014	0.0024

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	35.69	(6.102)	129562.0	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.907	(1.9869)	65001.52	50.170
LATERAL DRAINAGE COLLECTED FROM LAYER 4	18.33064	(4.84564)	66540.227	51.35785
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.004	(0.001)		
CHANGE IN WATER STORAGE	-0.545	(0.7129)	-1979.77	-1.528

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.21999	798.56946
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.018	
MAXIMUM HEAD ON TOP OF LAYER 5	0.037	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.6 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5105
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	210.1566	0.2919
3	4.0420	0.2246
4	0.0037	0.0149
5	0.0000	0.0000
SNOW WATER	1.359	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES100.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-60.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCES6010.OUT


TIME:  12:11     DATE:   1/ 2/2007


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     TITLE:  NCES Landfill - Active Cell 60' of Waste - 100 Yr Storm

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   3
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4570 VOL/VOL
          FIELD CAPACITY             =      0.0830 VOL/VOL
          WILTING POINT              =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.310000009000E-02 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                  =    720.00   INCHES
          POROSITY                   =      0.6710 VOL/VOL
          FIELD CAPACITY             =      0.2920 VOL/VOL
          WILTING POINT              =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2923 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2983	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0381	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 85.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 95. FEET.

SCS RUNOFF CURVE NUMBER	=	86.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.490	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.084	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.352	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	217.840	INCHES
TOTAL INITIAL WATER	=	219.314	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

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DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.032	0.0767	0.0000	.0000E+00	.0000E+00
131			0.00	0.000	0.029	0.0731	0.0000	.0000E+00	.0000E+00
132			0.00	0.000	0.027	0.0698	0.0000	.0000E+00	.0000E+00
133			0.02	0.000	0.025	0.0692	0.0000	.0000E+00	.0000E+00
134			0.00	0.000	0.023	0.0663	0.0000	.0000E+00	.0000E+00
135			0.00	0.000	0.022	0.0612	0.0000	.0000E+00	.0000E+00
136			0.00	0.000	0.021	0.0586	0.0000	.0000E+00	.0000E+00
137			0.17	0.000	0.020	0.0773	0.0000	.0000E+00	.0000E+00

138	0.00	0.000	0.019	0.0749	0.0001	.1745E-02	.2126E-08
139	0.00	0.000	0.018	0.0726	0.0023	.2728E-01	.6803E-08
140	0.00	0.000	0.018	0.0704	0.0049	.5828E-01	.6803E-08
141	0.00	0.000	0.017	0.0682	0.0070	.8399E-01	.6803E-08
142	4.56	0.000	0.017	0.3708	0.0087	.1038	.6803E-08
143	2.28	0.000	0.194	0.3215	0.0062	.7352E-01	.6803E-08
144	0.85	0.000	0.195	0.2743	0.0141	.1688	.6803E-08
145	1.74	0.000	0.185	0.3090	0.0165	.1966	.6803E-08
146	0.23	0.000	0.205	0.2228	0.0151	.1796	.6803E-08
147	0.06	0.000	0.167	0.1981	0.0167	.1992	.6803E-08
148	0.57	0.000	0.143	0.2456	0.0125	.1495	.6803E-08
149	0.12	0.000	0.211	0.2112	0.0096	.1146	.6803E-08
150	0.06	0.000	0.154	0.1859	0.0018	.2198E-01	.6803E-08
151	0.00	0.000	0.239	0.1484	0.0080	.9553E-01	.6803E-08
152	0.00	0.000	0.234	0.1157	0.0071	.8419E-01	.6803E-08
153	0.00	0.000	0.121	0.0993	0.0053	.6317E-01	.6803E-08
154	0.00	0.000	0.056	0.0923	0.0056	.6631E-01	.6803E-08
155	0.00	0.000	0.043	0.0870	0.0071	.8431E-01	.6803E-08
156	0.23	0.000	0.037	0.1108	0.0038	.4540E-01	.6803E-08
157	0.00	0.000	0.032	0.1068	0.0001	.1425E-02	.3536E-08
158	0.00	0.000	0.029	0.1032	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.027	0.0999	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.025	0.0968	0.0003	.3482E-02	.2976E-08
161	0.00	0.000	0.023	0.0939	0.0034	.4013E-01	.6803E-08
162	1.18	0.000	0.023	0.2376	0.0071	.8419E-01	.6803E-08
163	0.10	0.000	0.155	0.2152	0.0101	.1200	.6803E-08
164	0.00	0.000	0.188	0.1772	0.0107	.1273	.6803E-08
165	0.00	0.000	0.218	0.1428	0.0136	.1618	.6803E-08
166	0.00	0.000	0.166	0.1181	0.0170	.2028	.6803E-08
167	0.00	0.000	0.117	0.1017	0.0171	.2044	.6803E-08
168	0.00	0.000	0.056	0.0944	0.0177	.2107	.6803E-08
169	0.00	0.000	0.043	0.0890	0.0117	.1399	.6803E-08
170	0.00	0.000	0.036	0.0845	0.0084	.1002	.6803E-08
171	0.00	0.000	0.032	0.0805	0.0080	.9587E-01	.6803E-08
172	0.00	0.000	0.029	0.0769	0.0091	.1082	.6803E-08
173	0.00	0.000	0.027	0.0736	0.0105	.1252	.6803E-08
174	0.00	0.000	0.025	0.0705	0.0118	.1409	.6803E-08
175	0.00	0.000	0.023	0.0676	0.0128	.1530	.6803E-08
176	0.00	0.000	0.022	0.0649	0.0135	.1613	.6803E-08
177	0.00	0.000	0.021	0.0623	0.0140	.1665	.6803E-08
178	0.00	0.000	0.020	0.0598	0.0142	.1696	.6803E-08
179	0.06	0.000	0.020	0.0648	0.0143	.1711	.6803E-08
180	0.00	0.000	0.017	0.0626	0.0144	.1716	.6803E-08
181	0.09	0.000	0.019	0.0715	0.0144	.1716	.6803E-08
182	1.20	0.000	0.018	0.2192	0.0143	.1711	.6803E-08
183	0.03	0.000	0.103	0.2092	0.0141	.1684	.6803E-08
184	0.00	0.000	0.199	0.1718	0.0139	.1653	.6803E-08
185	0.00	0.000	0.196	0.1390	0.0142	.1689	.6803E-08
186	0.06	0.000	0.142	0.1265	0.0146	.1747	.6803E-08
187	0.00	0.000	0.141	0.1070	0.0188	.2244	.6803E-08
188	0.00	0.000	0.135	0.0872	0.0145	.1727	.6803E-08
189	0.00	0.000	0.056	0.0803	0.0122	.1452	.6803E-08
190	0.00	0.000	0.043	0.0749	0.0096	.1149	.6803E-08
191	0.00	0.000	0.036	0.0704	0.0092	.1094	.6803E-08
192	0.00	0.000	0.032	0.0664	0.0097	.1153	.6803E-08
193	0.00	0.000	0.029	0.0628	0.0105	.1248	.6803E-08
194	0.00	0.000	0.027	0.0595	0.0112	.1342	.6803E-08
195	0.00	0.000	0.025	0.0564	0.0119	.1417	.6803E-08
196	0.00	0.000	0.023	0.0535	0.0123	.1472	.6803E-08
197	0.26	0.000	0.024	0.0830	0.0126	.1508	.6803E-08
198	0.29	0.000	0.023	0.1165	0.0128	.1530	.6803E-08
199	0.00	0.000	0.020	0.1140	0.0129	.1542	.6803E-08
200	0.00	0.000	0.019	0.1116	0.0130	.1547	.6803E-08

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.00	1.23	1.87	2.70	11.10'	1.66
	2.68	4.05	3.24	3.50	3.09	1.72
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.405	0.572	0.683	0.827	2.969	1.882
	2.327	3.221	2.864	1.842	1.060	0.347
LATERAL DRAINAGE COLLECTED	0.2374	0.1372	0.1108	0.0819	1.4869	3.3745
FROM LAYER 4	4.7063	4.1740	2.6855	2.7629	2.2603	2.2940
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.000	0.004	0.009
TOP OF LAYER 5	0.013	0.011	0.008	0.007	0.006	0.006
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.006	0.005
HEAD ON TOP OF LAYER 5	0.002	0.001	0.004	0.003	0.003	0.003

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	42.84	155509.187	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.998	68963.703	44.35
DRAINAGE COLLECTED FROM LAYER 4	24.3116	88251.258	56.75
PERC./LEAKAGE THROUGH LAYER 5	0.000002	0.009	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0055		
CHANGE IN WATER STORAGE	-0.470	-1705.710	-1.10
SOIL WATER AT START OF YEAR	214.674	779268.437	
SOIL WATER AT END OF YEAR	216.867	787228.937	

SNOW WATER AT START OF YEAR	4.022	14598.911	9.39
SNOW WATER AT END OF YEAR	1.359	4932.691	3.17
ANNUAL WATER BUDGET BALANCE	0.0000	-0.070	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	4.07	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	4.39	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.802	1.978	2.786
	2.285	2.584	2.366	1.936	1.178	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.335	0.798	1.140
	0.441	0.540	0.443	0.224	0.106	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.1410	0.2578	0.1563	0.6195	2.1734	3.4345
	2.9481	2.0269	1.3475	1.2519	1.8398	1.3498
STD. DEVIATIONS	0.7964	0.0999	0.0593	0.8438	1.0920	0.1635
	1.4001	1.4585	1.0444	1.1185	0.5066	0.9185
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0031	0.0008	0.0004	0.0017	0.0059	0.0096
	0.0080	0.0055	0.0038	0.0034	0.0051	0.0036
STD. DEVIATIONS	0.0022	0.0003	0.0002	0.0024	0.0030	0.0005
	0.0038	0.0039	0.0029	0.0030	0.0014	0.0025

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	35.91	(6.383)	130346.0	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.907	(1.9869)	65001.52	49.868
LATERAL DRAINAGE COLLECTED FROM LAYER 4	18.54664	(4.89766)	67324.312	51.65045
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.004	(0.001)		
CHANGE IN WATER STORAGE	-0.545	(0.8432)	-1979.77	-1.519

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	4.56	16552.799
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.22438	814.50293
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.019	
MAXIMUM HEAD ON TOP OF LAYER 5	0.037	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.9 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5105

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0440

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	1.0260	0.1710
2	210.1566	0.2919
3	4.0420	0.2246
4	0.0037	0.0149
5	0.0000	0.0000
SNOW WATER	1.359	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCESINT.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCESINT.OUT


TIME:  12:50     DATE:   1/ 2/2007

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 TITLE:  NCES Landfill - Intermediate Cover on 60' MSW - Average Precipitation

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    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   3
        THICKNESS                   =     18.00   INCHES
        POROSITY                    =      0.4570 VOL/VOL
        FIELD CAPACITY              =      0.0830 VOL/VOL
        WILTING POINT               =      0.0330 VOL/VOL
        INITIAL SOIL WATER CONTENT  =      0.1980 VOL/VOL
        EFFECTIVE SAT. HYD. COND.   =  0.310000009000E-02 CM/SEC


                                LAYER  2
                                --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  18
        THICKNESS                   =    720.00   INCHES
        POROSITY                    =      0.6710 VOL/VOL
        FIELD CAPACITY              =      0.2920 VOL/VOL
        WILTING POINT               =      0.0770 VOL/VOL
        INITIAL SOIL WATER CONTENT  =      0.2940 VOL/VOL
        EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
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LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2962	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0358	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 3 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 33.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	75.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.209	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.656	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.264	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	220.558	INCHES
TOTAL INITIAL WATER	=	222.031	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

****

DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.031	0.0399	0.0000	.0000E+00	.0000E+00
131			0.00	0.000	0.028	0.0364	0.0000	.0000E+00	.0000E+00
132			0.00	0.000	0.025	0.0332	0.0000	.0000E+00	.0000E+00
133			0.02	0.000	0.004	0.0352	0.0000	.0000E+00	.0000E+00

134	0.00	0.000	0.002	0.0347	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.002	0.0342	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.002	0.0338	0.0000	.0000E+00	.0000E+00
137	0.17	0.000	0.008	0.0540	0.0000	.0000E+00	.0000E+00
138	0.00	0.000	0.008	0.0510	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.007	0.0486	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.007	0.0468	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.007	0.0451	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.007	0.0435	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.006	0.0421	0.0000	.0000E+00	.0000E+00
144	0.85	0.000	0.011	0.1470	0.0000	.0000E+00	.0000E+00
145	1.74	0.077	0.179	0.2517	0.0000	.0000E+00	.0000E+00
146	0.23	0.000	0.205	0.1942	0.0000	.0000E+00	.0000E+00
147	0.06	0.000	0.167	0.1717	0.0000	.0000E+00	.0000E+00
148	0.57	0.000	0.144	0.2182	0.0001	.6796E-03	.1276E-08
149	0.12	0.000	0.211	0.1810	0.0052	.6238E-01	.6803E-08
150	0.06	0.000	0.154	0.1588	0.0082	.9780E-01	.6803E-08
151	0.00	0.000	0.239	0.1228	0.0080	.9527E-01	.6803E-08
152	0.00	0.000	0.234	0.0909	0.0068	.8170E-01	.6803E-08
153	0.00	0.000	0.119	0.0751	0.0060	.7136E-01	.6803E-08
154	0.00	0.000	0.054	0.0640	0.0053	.6322E-01	.6803E-08
155	0.00	0.000	0.041	0.0550	0.0044	.5290E-01	.6803E-08
156	0.23	0.000	0.035	0.0778	0.0030	.3617E-01	.6803E-08
157	0.00	0.000	0.029	0.0717	0.0031	.3661E-01	.6803E-08
158	0.00	0.000	0.028	0.0670	0.0018	.2154E-01	.6803E-08
159	0.00	0.000	0.025	0.0627	0.0016	.1876E-01	.6803E-08
160	0.00	0.000	0.024	0.0592	0.0017	.2049E-01	.6803E-08
161	0.00	0.000	0.022	0.0565	0.0015	.1835E-01	.6803E-08
162	1.18	0.000	0.022	0.2012	0.0014	.1635E-01	.6803E-08
163	0.10	0.000	0.155	0.1847	0.0018	.2149E-01	.6803E-08
164	0.00	0.000	0.188	0.1498	0.0015	.1815E-01	.6803E-08
165	0.00	0.000	0.218	0.1172	0.0001	.1432E-02	.3381E-08
166	0.00	0.000	0.168	0.0921	0.0000	.5312E-03	.2897E-08
167	0.00	0.000	0.117	0.0761	0.0003	.3246E-02	.4252E-08
168	0.00	0.000	0.054	0.0645	0.0033	.3921E-01	.6803E-08
169	0.00	0.000	0.041	0.0552	0.0025	.3009E-01	.6803E-08
170	0.00	0.000	0.035	0.0483	0.0028	.3394E-01	.6803E-08
171	0.00	0.000	0.031	0.0410	0.0043	.5179E-01	.6803E-08
172	0.00	0.000	0.028	0.0375	0.0034	.4062E-01	.6803E-08
173	0.00	0.000	0.025	0.0344	0.0051	.6116E-01	.6803E-08
174	0.00	0.000	0.011	0.0330	0.0058	.6955E-01	.6803E-08
175	0.00	0.000	0.000	0.0330	0.0058	.6912E-01	.6803E-08
176	0.00	0.000	0.000	0.0330	0.0056	.6639E-01	.6803E-08
177	0.00	0.000	0.000	0.0330	0.0053	.6326E-01	.6803E-08
178	0.00	0.000	0.000	0.0330	0.0051	.6066E-01	.6803E-08
179	0.06	0.000	0.003	0.0402	0.0049	.5899E-01	.6803E-08
180	0.00	0.000	0.009	0.0389	0.0049	.5848E-01	.6803E-08
181	0.09	0.000	0.009	0.0490	0.0049	.5826E-01	.6803E-08
182	1.20	0.000	0.018	0.1968	0.0050	.5956E-01	.6803E-08
183	0.03	0.000	0.103	0.1810	0.0054	.6441E-01	.6803E-08
184	0.00	0.000	0.199	0.1445	0.0056	.6635E-01	.6803E-08
185	0.00	0.000	0.195	0.1132	0.0052	.6259E-01	.6803E-08
186	0.06	0.000	0.142	0.0995	0.0047	.5601E-01	.6803E-08
187	0.00	0.000	0.129	0.0825	0.0040	.4811E-01	.6803E-08
188	0.00	0.000	0.052	0.0691	0.0048	.5761E-01	.6803E-08
189	0.00	0.000	0.041	0.0583	0.0090	.1077	.6803E-08
190	0.00	0.000	0.035	0.0520	0.0116	.1379	.6803E-08
191	0.00	0.000	0.031	0.0446	0.0105	.1253	.6803E-08
192	0.00	0.000	0.028	0.0396	0.0079	.9445E-01	.6803E-08
193	0.00	0.000	0.025	0.0364	0.0066	.7867E-01	.6803E-08
194	0.00	0.000	0.024	0.0334	0.0067	.7940E-01	.6803E-08
195	0.00	0.000	0.004	0.0330	0.0064	.7607E-01	.6803E-08

196	0.00	0.000	0.000	0.0330	0.0060	.7182E-01	.6803E-08
197	0.26	0.000	0.010	0.0643	0.0056	.6736E-01	.6803E-08
198	0.29	0.000	0.014	0.0982	0.0053	.6304E-01	.6803E-08
199	0.00	0.000	0.186	0.0749	0.0050	.5942E-01	.6803E-08
200	0.00	0.000	0.015	0.0731	0.0046	.5475E-01	.6803E-08

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.00	1.23	1.87	2.70	4.26	1.66
	2.68	4.05	3.24	3.50	3.09	1.72
RUNOFF	0.000	0.000	0.007	11.399	0.077	0.000
	0.000	0.000	0.000	0.000	0.022	0.000
EVAPOTRANSPIRATION	0.405	0.572	0.683	0.827	2.426	1.726
	2.084	3.225	2.822	1.836	1.062	0.347
LATERAL DRAINAGE COLLECTED	0.3035	0.1834	0.1504	0.1162	0.2754	1.2438
FROM LAYER 4	1.8837	0.5532	0.2854	0.7578	1.1030	1.0957
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.001	0.000	0.000	0.001	0.003
TOP OF LAYER 5	0.005	0.001	0.001	0.002	0.003	0.003
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.002	0.002
HEAD ON TOP OF LAYER 5	0.002	0.000	0.001	0.001	0.002	0.003

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	36.00	130680.016	100.00
RUNOFF	11.506	41765.437	31.96
EVAPOTRANSPIRATION	18.016	65397.980	50.04
DRAINAGE COLLECTED FROM LAYER 4	7.9513	28863.248	22.09
PERC./LEAKAGE THROUGH LAYER 5	0.000002	0.008	0.00

AVG. HEAD ON TOP OF LAYER 5	0.0018		
CHANGE IN WATER STORAGE	-1.473	-5346.677	-4.09
SOIL WATER AT START OF YEAR	216.559	786109.375	
SOIL WATER AT END OF YEAR	217.749	790428.875	
SNOW WATER AT START OF YEAR	4.022	14598.911	11.17
SNOW WATER AT END OF YEAR	1.359	4932.691	3.77
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	2.70	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	2.13	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.045	0.144	3.845	4.451	0.171	0.001
	0.000	0.002	0.008	0.014	0.004	0.022
STD. DEVIATIONS	0.102	0.321	3.827	4.111	0.340	0.002
	0.000	0.004	0.018	0.030	0.010	0.050
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.791	1.638	2.747
	2.031	2.524	2.246	1.881	1.155	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.312	0.742	1.132
	0.371	0.605	0.497	0.265	0.112	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.3497	0.3413	0.2127	0.1345	0.3746	1.2120
	1.2110	0.4604	0.6399	0.7807	1.6084	1.1809
STD. DEVIATIONS	1.0523	0.1392	0.0495	0.0232	0.5723	0.3491
	0.9270	0.2009	0.5405	0.5138	0.4129	0.6916
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0036	0.0010	0.0006	0.0004	0.0010	0.0034
	0.0033	0.0012	0.0018	0.0021	0.0045	0.0032
STD. DEVIATIONS	0.0028	0.0004	0.0001	0.0001	0.0015	0.0010
	0.0025	0.0005	0.0015	0.0014	0.0012	0.0019

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	34.54	(5.138)	125380.2	100.00
RUNOFF	8.707	(2.7550)	31605.78	25.208
EVAPOTRANSPIRATION	17.004	(1.7820)	61726.04	49.231
LATERAL DRAINAGE COLLECTED FROM LAYER 4	9.50599	(2.37672)	34506.762	27.52170
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.002	(0.001)		
CHANGE IN WATER STORAGE	-0.677	(0.7376)	-2458.39	-1.961

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	3.098	11244.1992
DRAINAGE COLLECTED FROM LAYER 4	0.18315	664.83252
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.015	
MAXIMUM HEAD ON TOP OF LAYER 5	0.030	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.8 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4352
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	2.7584	0.1532
2	210.2400	0.2920
3	4.2843	0.2380
4	0.0039	0.0154
5	0.0000	0.0000
SNOW WATER	1.359	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES25.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCESINT.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCESI25.OUT


TIME:  12:10     DATE:   1/ 2/2007


 ******************************************************************************

     TITLE:  NCES Landfill - Intermediate Cover on 60' MSW - 25 Yr Storm

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   3
          THICKNESS                   =     18.00   INCHES
          POROSITY                    =      0.4570 VOL/VOL
          FIELD CAPACITY              =      0.0830 VOL/VOL
          WILTING POINT               =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.1980 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.310000009000E-02 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                   =    720.00   INCHES
          POROSITY                    =      0.6710 VOL/VOL
          FIELD CAPACITY              =      0.2920 VOL/VOL
          WILTING POINT               =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2940 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
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LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2962	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0358	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 3 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 33.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	75.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.209	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.656	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.264	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	220.558	INCHES
TOTAL INITIAL WATER	=	222.031	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
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66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

****

DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.031	0.0399	0.0000	.0000E+00	.0000E+00
131			0.00	0.000	0.028	0.0364	0.0000	.0000E+00	.0000E+00
132			0.00	0.000	0.025	0.0332	0.0000	.0000E+00	.0000E+00
133			0.02	0.000	0.004	0.0352	0.0000	.0000E+00	.0000E+00
134			0.00	0.000	0.002	0.0347	0.0000	.0000E+00	.0000E+00
135			0.00	0.000	0.002	0.0342	0.0000	.0000E+00	.0000E+00
136			0.00	0.000	0.002	0.0338	0.0000	.0000E+00	.0000E+00
137			0.17	0.000	0.008	0.0540	0.0000	.0000E+00	.0000E+00
138			0.00	0.000	0.008	0.0510	0.0000	.0000E+00	.0000E+00

139	0.00	0.000	0.007	0.0486	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.007	0.0468	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.007	0.0451	0.0000	.0000E+00	.0000E+00
142	3.84	0.488	0.016	0.2903	0.0000	.0000E+00	.0000E+00
143	1.92	0.313	0.194	0.2719	0.0000	.0000E+00	.0000E+00
144	0.85	0.001	0.195	0.2367	0.0000	.0000E+00	.0000E+00
145	1.74	0.116	0.185	0.2653	0.0003	.4004E-02	.3201E-08
146	0.23	0.000	0.205	0.1941	0.0055	.6554E-01	.6378E-08
147	0.06	0.000	0.167	0.1716	0.0054	.6499E-01	.6803E-08
148	0.57	0.000	0.143	0.2182	0.0049	.5811E-01	.6803E-08
149	0.12	0.000	0.211	0.1810	0.0044	.5247E-01	.6803E-08
150	0.06	0.000	0.154	0.1588	0.0039	.4646E-01	.6803E-08
151	0.00	0.000	0.239	0.1228	0.0037	.4405E-01	.6803E-08
152	0.00	0.000	0.234	0.0910	0.0034	.4063E-01	.6803E-08
153	0.00	0.000	0.119	0.0751	0.0032	.3768E-01	.6803E-08
154	0.00	0.000	0.054	0.0640	0.0029	.3511E-01	.6803E-08
155	0.00	0.000	0.041	0.0550	0.0014	.1716E-01	.6803E-08
156	0.23	0.000	0.035	0.0778	0.0000	.3169E-04	.2200E-08
157	0.00	0.000	0.029	0.0717	0.0003	.3476E-02	.5953E-08
158	0.00	0.000	0.028	0.0670	0.0000	.1399E-10	.7516E-10
159	0.00	0.000	0.025	0.0627	0.0000	.5179E-03	.3402E-08
160	0.00	0.000	0.024	0.0592	0.0018	.2149E-01	.6803E-08
161	0.00	0.000	0.022	0.0565	0.0014	.1661E-01	.6803E-08
162	1.18	0.000	0.022	0.2012	0.0005	.6539E-02	.6803E-08
163	0.10	0.000	0.155	0.1847	0.0005	.6448E-02	.6095E-08
164	0.00	0.000	0.188	0.1498	0.0001	.1737E-02	.4580E-08
165	0.00	0.000	0.218	0.1172	0.0000	.0000E+00	.0000E+00
166	0.00	0.000	0.166	0.0923	0.0000	.0000E+00	.0000E+00
167	0.00	0.000	0.118	0.0762	0.0000	.0000E+00	.0000E+00
168	0.00	0.000	0.054	0.0645	0.0027	.3258E-01	.6378E-08
169	0.00	0.000	0.041	0.0553	0.0021	.2463E-01	.6803E-08
170	0.00	0.000	0.035	0.0483	0.0030	.3557E-01	.6803E-08
171	0.00	0.000	0.031	0.0410	0.0049	.5795E-01	.6803E-08
172	0.00	0.000	0.028	0.0376	0.0043	.5122E-01	.6803E-08
173	0.00	0.000	0.025	0.0344	0.0063	.7524E-01	.6803E-08
174	0.00	0.000	0.011	0.0330	0.0070	.8372E-01	.6803E-08
175	0.00	0.000	0.000	0.0330	0.0069	.8286E-01	.6803E-08
176	0.00	0.000	0.000	0.0330	0.0067	.8020E-01	.6803E-08
177	0.00	0.000	0.000	0.0330	0.0065	.7776E-01	.6803E-08
178	0.00	0.000	0.000	0.0330	0.0064	.7637E-01	.6803E-08
179	0.06	0.000	0.003	0.0389	0.0065	.7801E-01	.6803E-08
180	0.00	0.000	0.007	0.0379	0.0063	.7485E-01	.6803E-08
181	0.09	0.000	0.008	0.0480	0.0065	.7796E-01	.6803E-08
182	1.20	0.000	0.015	0.1962	0.0068	.8129E-01	.6803E-08
183	0.03	0.000	0.100	0.1810	0.0074	.8777E-01	.6803E-08
184	0.00	0.000	0.199	0.1445	0.0075	.8916E-01	.6803E-08
185	0.00	0.000	0.195	0.1132	0.0072	.8541E-01	.6803E-08
186	0.06	0.000	0.142	0.0995	0.0067	.7973E-01	.6803E-08
187	0.00	0.000	0.128	0.0827	0.0071	.8520E-01	.6803E-08
188	0.00	0.000	0.051	0.0696	0.0101	.1208	.6803E-08
189	0.00	0.000	0.041	0.0587	0.0085	.1010	.6803E-08
190	0.00	0.000	0.035	0.0523	0.0076	.9094E-01	.6803E-08
191	0.00	0.000	0.031	0.0450	0.0096	.1141	.6803E-08
192	0.00	0.000	0.028	0.0398	0.0088	.1049	.6803E-08
193	0.00	0.000	0.025	0.0366	0.0091	.1085	.6803E-08
194	0.00	0.000	0.024	0.0337	0.0096	.1148	.6803E-08
195	0.00	0.000	0.005	0.0330	0.0092	.1099	.6803E-08
196	0.00	0.000	0.000	0.0330	0.0086	.1024	.6803E-08
197	0.26	0.000	0.010	0.0643	0.0080	.9523E-01	.6803E-08
198	0.29	0.000	0.014	0.0987	0.0075	.8943E-01	.6803E-08
199	0.00	0.000	0.190	0.0750	0.0071	.8529E-01	.6803E-08
200	0.00	0.000	0.015	0.0731	0.0069	.8273E-01	.6803E-08

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.00	1.23	1.87	2.70	10.02	1.66
	2.68	4.05	3.24	3.50	3.09	1.72
RUNOFF	0.000	0.000	0.007	11.399	0.917	0.000
	0.000	0.000	0.000	0.000	0.022	0.000
EVAPOTRANSPIRATION	0.405	0.572	0.683	0.827	2.813	1.723
	2.073	3.207	2.819	1.832	1.062	0.347
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.3035	0.1834	0.1504	0.1162	0.3549	1.0964
	2.8854	3.0732	1.2565	0.8917	1.1174	1.0974
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 5	0.001	0.001	0.000	0.000	0.001	0.003
	0.008	0.008	0.004	0.002	0.003	0.003
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 5	0.000	0.000	0.000	0.000	0.002	0.003
	0.001	0.001	0.002	0.001	0.002	0.003

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	41.76	151588.781	100.00
RUNOFF	12.345	44814.035	29.56
EVAPOTRANSPIRATION	18.362	66653.414	43.97
DRAINAGE COLLECTED FROM LAYER 4	12.5263	45470.437	30.00
PERC./LEAKAGE THROUGH LAYER 5	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0029		
CHANGE IN WATER STORAGE	-1.474	-5349.059	-3.53
SOIL WATER AT START OF YEAR	216.559	786109.375	
SOIL WATER AT END OF YEAR	217.748	790426.500	

SNOW WATER AT START OF YEAR	4.022	14598.911	9.63
SNOW WATER AT END OF YEAR	1.359	4932.691	3.25
ANNUAL WATER BUDGET BALANCE	0.0000	-0.056	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	3.85	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	3.96	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.045	0.144	3.845	4.451	0.339	0.001
	0.000	0.002	0.008	0.014	0.004	0.022
STD. DEVIATIONS	0.102	0.321	3.827	4.111	0.466	0.002
	0.000	0.004	0.018	0.030	0.010	0.050
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.791	1.718	2.723
	2.026	2.522	2.249	1.881	1.155	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.312	0.856	1.144
	0.373	0.600	0.495	0.263	0.112	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.3496	0.3413	0.2127	0.1345	0.3903	1.1732
	1.4293	0.9700	0.8369	0.8109	1.6106	1.1788
STD. DEVIATIONS	1.0524	0.1392	0.0495	0.0232	0.5701	0.3423
	1.1954	1.1914	0.5500	0.5087	0.4079	0.6919
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0036	0.0010	0.0006	0.0004	0.0011	0.0033
	0.0039	0.0026	0.0023	0.0022	0.0045	0.0032
STD. DEVIATIONS	0.0028	0.0004	0.0001	0.0001	0.0015	0.0010
	0.0032	0.0032	0.0015	0.0014	0.0011	0.0019

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	35.69	(6.102)	129562.0	100.00
RUNOFF	8.875	(2.9843)	32215.80	24.865
EVAPOTRANSPIRATION	17.056	(1.8544)	61914.76	47.788
LATERAL DRAINAGE COLLECTED FROM LAYER 4	10.43808	(2.47843)	37890.246	29.24489
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.002	(0.001)		
CHANGE IN WATER STORAGE	-0.677	(0.7376)	-2458.84	-1.898

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	3.90	14157.000
RUNOFF	3.098	11244.1992
DRAINAGE COLLECTED FROM LAYER 4	0.18315	664.83252
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.015	
MAXIMUM HEAD ON TOP OF LAYER 5	0.030	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.8 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4352

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	2.7584	0.1532
2	210.2400	0.2920
3	4.2837	0.2380
4	0.0039	0.0154
5	0.0000	0.0000
SNOW WATER	1.359	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      F:\CMAMAI~1\JSM.MB\HELP3\NCES100.D4
TEMPERATURE DATA FILE:        F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D7
SOLAR RADIATION DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D13
EVAPOTRANSPIRATION DATA:      F:\CMAMAI~1\JSM.MB\HELP3\NCES-1.D11
SOIL AND DESIGN DATA FILE:    F:\CMAMAI~1\JSM.MB\HELP3\NCESINT.D10
OUTPUT DATA FILE:             F:\CMAMAI~1\JSM.MB\HELP3\NCESI100.OUT


TIME:  12:10     DATE:   1/ 2/2007


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     TITLE:  NCES Landfill - Intermediate Cover on 60' MSW - 100 Yr Storm

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   3
          THICKNESS                    =     18.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.0830 VOL/VOL
          WILTING POINT                =      0.0330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1980 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.310000009000E-02 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    720.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2940 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
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LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.0830	VOL/VOL
WILTING POINT	=	0.0330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2962	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0358	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	95.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 3 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 33.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	75.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.209	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.656	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.264	INCHES
INITIAL SNOW WATER	=	1.474	INCHES
INITIAL WATER IN LAYER MATERIALS	=	220.558	INCHES
TOTAL INITIAL WATER	=	222.031	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
MONTPELIER VERMONT

STATION LATITUDE	=	44.30	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	268	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA FOR MONTPELIER VERMONT
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	17.40	27.80	40.80	53.10	62.10
66.60	64.20	56.40	46.20	34.60	20.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR MONTPELIER VERMONT
AND STATION LATITUDE = 44.30 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 5
DRAIN #1: LATERAL DRAINAGE FROM LAYER 4 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

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DAILY OUTPUT FOR YEAR 1979

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
130			0.00	0.000	0.031	0.0399	0.0000	.0000E+00	.0000E+00
131			0.00	0.000	0.028	0.0364	0.0000	.0000E+00	.0000E+00
132			0.00	0.000	0.025	0.0332	0.0000	.0000E+00	.0000E+00
133			0.02	0.000	0.004	0.0352	0.0000	.0000E+00	.0000E+00
134			0.00	0.000	0.002	0.0347	0.0000	.0000E+00	.0000E+00
135			0.00	0.000	0.002	0.0342	0.0000	.0000E+00	.0000E+00
136			0.00	0.000	0.002	0.0338	0.0000	.0000E+00	.0000E+00
137			0.17	0.000	0.008	0.0540	0.0000	.0000E+00	.0000E+00

138	0.00	0.000	0.008	0.0510	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.007	0.0486	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.007	0.0468	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.007	0.0451	0.0000	.0000E+00	.0000E+00
142	4.56	0.796	0.016	0.2964	0.0000	.0000E+00	.0000E+00
143	2.28	0.522	0.194	0.2769	0.0000	.0000E+00	.0000E+00
144	0.85	0.002	0.195	0.2363	0.0000	.0000E+00	.0000E+00
145	1.74	0.116	0.185	0.2652	0.0013	.1538E-01	.3827E-08
146	0.23	0.000	0.205	0.1941	0.0057	.6850E-01	.6803E-08
147	0.06	0.000	0.167	0.1716	0.0051	.6094E-01	.6803E-08
148	0.57	0.000	0.143	0.2182	0.0046	.5480E-01	.6803E-08
149	0.12	0.000	0.211	0.1810	0.0042	.4973E-01	.6803E-08
150	0.06	0.000	0.154	0.1588	0.0036	.4336E-01	.6803E-08
151	0.00	0.000	0.239	0.1228	0.0035	.4220E-01	.6803E-08
152	0.00	0.000	0.234	0.0910	0.0033	.3904E-01	.6803E-08
153	0.00	0.000	0.119	0.0751	0.0030	.3629E-01	.6803E-08
154	0.00	0.000	0.054	0.0640	0.0028	.3389E-01	.6803E-08
155	0.00	0.000	0.041	0.0550	0.0012	.1435E-01	.6803E-08
156	0.23	0.000	0.035	0.0778	0.0000	.9429E-08	.7118E-09
157	0.00	0.000	0.029	0.0717	0.0001	.1437E-02	.4596E-08
158	0.00	0.000	0.028	0.0670	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.025	0.0627	0.0001	.6958E-03	.4252E-08
160	0.00	0.000	0.024	0.0592	0.0018	.2100E-01	.6803E-08
161	0.00	0.000	0.022	0.0565	0.0013	.1520E-01	.6803E-08
162	1.18	0.000	0.022	0.2012	0.0004	.4496E-02	.6803E-08
163	0.10	0.000	0.155	0.1847	0.0004	.5156E-02	.4233E-08
164	0.00	0.000	0.188	0.1498	0.0001	.8451E-03	.3728E-08
165	0.00	0.000	0.218	0.1172	0.0000	.0000E+00	.0000E+00
166	0.00	0.000	0.166	0.0923	0.0000	.0000E+00	.0000E+00
167	0.00	0.000	0.118	0.0762	0.0000	.0000E+00	.0000E+00
168	0.00	0.000	0.054	0.0645	0.0028	.3302E-01	.6378E-08
169	0.00	0.000	0.041	0.0553	0.0021	.2548E-01	.6803E-08
170	0.00	0.000	0.035	0.0483	0.0031	.3733E-01	.6803E-08
171	0.00	0.000	0.031	0.0410	0.0050	.6014E-01	.6803E-08
172	0.00	0.000	0.028	0.0376	0.0045	.5383E-01	.6803E-08
173	0.00	0.000	0.025	0.0344	0.0065	.7814E-01	.6803E-08
174	0.00	0.000	0.011	0.0330	0.0072	.8640E-01	.6803E-08
175	0.00	0.000	0.000	0.0330	0.0072	.8535E-01	.6803E-08
176	0.00	0.000	0.000	0.0330	0.0069	.8259E-01	.6803E-08
177	0.00	0.000	0.000	0.0330	0.0067	.8018E-01	.6803E-08
178	0.00	0.000	0.000	0.0330	0.0066	.7888E-01	.6803E-08
179	0.06	0.000	0.003	0.0389	0.0068	.8064E-01	.6803E-08
180	0.00	0.000	0.007	0.0379	0.0065	.7763E-01	.6803E-08
181	0.09	0.000	0.008	0.0480	0.0068	.8088E-01	.6803E-08
182	1.20	0.000	0.015	0.1962	0.0071	.8432E-01	.6803E-08
183	0.03	0.000	0.100	0.1810	0.0076	.9082E-01	.6803E-08
184	0.00	0.000	0.199	0.1445	0.0077	.9206E-01	.6803E-08
185	0.00	0.000	0.195	0.1132	0.0074	.8833E-01	.6803E-08
186	0.06	0.000	0.142	0.0995	0.0069	.8284E-01	.6803E-08
187	0.00	0.000	0.128	0.0827	0.0074	.8862E-01	.6803E-08
188	0.00	0.000	0.051	0.0696	0.0104	.1239	.6803E-08
189	0.00	0.000	0.041	0.0587	0.0087	.1037	.6803E-08
190	0.00	0.000	0.035	0.0523	0.0079	.9376E-01	.6803E-08
191	0.00	0.000	0.031	0.0450	0.0098	.1168	.6803E-08
192	0.00	0.000	0.028	0.0398	0.0090	.1073	.6803E-08
193	0.00	0.000	0.025	0.0366	0.0093	.1109	.6803E-08
194	0.00	0.000	0.024	0.0337	0.0098	.1169	.6803E-08
195	0.00	0.000	0.005	0.0330	0.0094	.1117	.6803E-08
196	0.00	0.000	0.000	0.0330	0.0087	.1040	.6803E-08
197	0.26	0.000	0.010	0.0643	0.0081	.9681E-01	.6803E-08
198	0.29	0.000	0.014	0.0987	0.0076	.9105E-01	.6803E-08
199	0.00	0.000	0.190	0.0750	0.0073	.8701E-01	.6803E-08
200	0.00	0.000	0.015	0.0731	0.0071	.8458E-01	.6803E-08

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.00	1.23	1.87	2.70	11.10	1.66
	2.68	4.05	3.24	3.50	3.09	1.72
RUNOFF	0.000	0.000	0.007	11.399	1.436	0.000
	0.000	0.000	0.000	0.000	0.022	0.000
EVAPOTRANSPIRATION	0.405	0.572	0.683	0.827	2.813	1.723
	2.073	3.207	2.819	1.832	1.062	0.347
LATERAL DRAINAGE COLLECTED	0.3035	0.1834	0.1504	0.1162	0.3542	1.1129
FROM LAYER 4	2.9601	3.0461	1.7320	0.9124	1.1188	1.0975
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.001	0.000	0.000	0.001	0.003
TOP OF LAYER 5	0.008	0.008	0.005	0.002	0.003	0.003
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.002	0.003
HEAD ON TOP OF LAYER 5	0.001	0.000	0.003	0.001	0.002	0.003

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	42.84	155509.187	100.00
RUNOFF	12.864	46697.984	30.03
EVAPOTRANSPIRATION	18.362	66653.414	42.86
DRAINAGE COLLECTED FROM LAYER 4	13.0873	47506.867	30.55
PERC./LEAKAGE THROUGH LAYER 5	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0030		
CHANGE IN WATER STORAGE	-1.474	-5349.059	-3.44
SOIL WATER AT START OF YEAR	216.559	786109.375	

SOIL WATER AT END OF YEAR	217.748	790426.500	
SNOW WATER AT START OF YEAR	4.022	14598.911	9.39
SNOW WATER AT END OF YEAR	1.359	4932.691	3.17
ANNUAL WATER BUDGET BALANCE	0.0000	-0.029	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.39	2.18	1.96	2.84	4.07	2.92
	2.58	3.43	3.88	3.86	2.24	2.56
STD. DEVIATIONS	2.86	2.35	0.79	0.80	4.39	1.66
	0.74	1.16	1.33	1.06	0.79	1.18
RUNOFF						
TOTALS	0.045	0.144	3.845	4.451	0.442	0.001
	0.000	0.002	0.008	0.014	0.004	0.022
STD. DEVIATIONS	0.102	0.321	3.827	4.111	0.649	0.002
	0.000	0.004	0.018	0.030	0.010	0.050
EVAPOTRANSPIRATION						
TOTALS	0.467	0.571	0.524	0.791	1.718	2.723
	2.026	2.522	2.249	1.881	1.155	0.429
STD. DEVIATIONS	0.094	0.093	0.120	0.312	0.856	1.144
	0.373	0.600	0.495	0.263	0.112	0.083
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.3496	0.3413	0.2127	0.1345	0.3902	1.1765
	1.4442	0.9646	0.9320	0.8150	1.6109	1.1788
STD. DEVIATIONS	1.0524	0.1392	0.0495	0.0232	0.5701	0.3414
	1.2184	1.1795	0.6689	0.5096	0.4074	0.6919
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0036	0.0010	0.0006	0.0004	0.0011	0.0033
	0.0039	0.0026	0.0026	0.0022	0.0045	0.0032
STD. DEVIATIONS	0.0028	0.0004	0.0001	0.0001	0.0015	0.0010
	0.0033	0.0032	0.0019	0.0014	0.0011	0.0019

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	35.91	(6.383)	130346.0	100.00
RUNOFF	8.979	(3.1402)	32592.59	25.005
EVAPOTRANSPIRATION	17.056	(1.8544)	61914.76	47.500
LATERAL DRAINAGE COLLECTED FROM LAYER 4	10.55028	(2.60601)	38297.531	29.38143
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.002	(0.001)		
CHANGE IN WATER STORAGE	-0.677	(0.7376)	-2458.84	-1.886

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	4.56	16552.799
RUNOFF	3.098	11244.1992
DRAINAGE COLLECTED FROM LAYER 4	0.18315	664.83252
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 5	0.015	
MAXIMUM HEAD ON TOP OF LAYER 5	0.030	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.8 FEET	
SNOW WATER	11.61	42142.8164

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4352

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	2.7584	0.1532
2	210.2400	0.2920
3	4.2837	0.2380
4	0.0039	0.0154
5	0.0000	0.0000
SNOW WATER	1.359	

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APPENDIX A.2

Geotechnical Calculations

LANDFILL STABILITY ANALYSES
NCES STAGE IV PHASE II
BETHLEHEM, NEW HAMPSHIRE

This report presents the results of stability analyses of the North Country Environmental Services Stage IV Phase II Landfill in Bethlehem, New Hampshire. The objective of this work is to assess the stability of the landfill waste, lining system, and capping system under static and seismic loads, in support of the design of the Stage IV Phase II Landfill. The proposed landfill development will be double-lined and have primary and secondary leachate collection systems.

Reference the construction design drawings and technical specifications included in this permit application for landfill base and final grades as well as proposed soil and geosynthetic materials to be used in the landfill construction. Attached is a groundwater table contour plan, boring logs and a boring location plan relevant to the design and stability of the modified portion of the landfill. Also reference the report entitled "Hydrogeologic Study, Proposed Stage IV Expansion, North Country Environmental Services, Inc., Bethlehem, New Hampshire," dated January 25, 2002 and prepared by Sanborn, Head & Associates (SHA) of Concord, New Hampshire for the subsurface information used in these analyses including boring logs and laboratory test results. The SHA report includes logs of borings drilled for the referenced study, as well as logs of all borings drilled previously at the site. Plans showing proposed landfill final grades, Overlay liner grades, and base grades are included in Figures 1 through 3 attached to this report. Base grades were determined from the design or record drawings for the eight separate landfill phases at the site.

Attached calculations to this report include the stability methods of analysis, references, and calculations. A summary of the strength values used in the stability analyses, and the basis for selecting these values, are also included in the calculations. In general, the shear strengths of the glacial till soils at the site were determined using correlations to Standard Penetration Test blow counts. Waste strength data was obtained from the literature. The interface shear strength properties of geosynthetic materials were based on the following information:

- Available soil and direct shear interface laboratory results on soils from deposits located in similar geologic settings to the Bethlehem site;
- Geosynthetic materials laboratory testing results available in our files from recent testing on similar projects; and
- Our experience with similar materials used on comparable landfill design and construction projects.

We selected a critical failure location through Stage I Phase II as modified by this application, as shown on Figure 4. This location incorporates the maximum waste height and slope lengths, and the minimum height of the containment berm. Factors of safety in

excess of 1.5 are generally considered to be acceptable for long term conditions at landfill sites.

STATIC STABILITY

Deep Rotational Failure

Subsurface conditions consist of glacial till deposits and structural fill materials consisting of compacted glacial till. The glacial till consists mostly of a non-stratified, heterogeneous mixture of fine to medium sand and silt with moderate amounts of coarser material and lesser amounts of clay. The glacial till is underlain by bedrock at depths ranging from about 100 feet to 250 feet below ground surface. The glacial till is very dense as a result of the weight and movement of the ice sheet that deposited the soil directly over bedrock. The Standard Penetration Test (SPT) values for the till are generally well in excess of 50 blows per foot, and are typically over 100 blows per foot. The depth to groundwater below the natural ground surface along the limits of the landfill ranges from about 15 feet near the northwestern limits of the Stage IV Phase II development, to about 65 feet near the southeastern limits of the landfill.

The landfill base is excavated below natural grade into the glacial till deposits. Given the very dense nature of the glacial till, by inspection the potential for a deep rotational failure through the foundation soils does not reasonably exist. Attached calculations indicate a factor of safety of 4.0 against a deep rotational failure through the landfill foundation soils.

Liner Stability

A potentially critical stability failure surface extends along the base lining system. We assigned a minimum interface friction value of 28 degrees to the lining system to Stage IV liner which incorporates textured geomembrane and drainage geocomposites, and 16 degrees with a cohesion of 40 psf for the Phase I liner which incorporate smooth geomembrane and drainage net. The attached calculations indicate a minimum factor of safety of 2.0 for these conditions.

Overlay Liner Stability

We evaluated two potentially critical stability failure surfaces along the overlay liner system interfaces. The first is a local failure in the sump area where the overlay liner slope is greatest. The second is a more shallow failure surface along the long side slope portion of the overlay liner. The attached calculations indicate minimum factors of safety of 2.6 and 2.1 for these surfaces, respectively.

Cap Stability

A preliminary cap design is provided in the drawings and the closure plan included in this permit application. The design consists of two feet of cover soil overlying a drainage

geocomposite (bonded geotextile and drainage net) and texture geomembrane. The geomembrane is underlain by screened glacial till, a gas transmission layer of granular soil and intermediate cover soil. The final capping system is proposed to be installed after the landfill is filled to capacity in about 8 years. The final design is likely to vary from this preliminary design to account for regulatory requirements and available materials at that time.

We assumed a minimum interface friction value of 28 degrees for the capping system components. The calculations indicate a minimum factor of safety of 1.6 for the preliminary design.

SEISMIC STABILITY

CMA Engineers completed seismic stability analyses of the secure landfill in accordance with Env-Wm 2503.04 and 40 CFR 258.14. Seismic stability was evaluated considering a design earthquake with a 10 percent probability of excedance in 250 years. A U. S. Geologic Survey (USGS) Hazard Map dated October 2002 and data available from USGS for the site indicate the design earthquake has a probable ground acceleration (pga) of 0.1785 of gravity. Copies of the USGS Hazard Map and site specific data are attached.

For foundation soils failure, two types of analyses are typically considered to demonstrate conformance with the above-referenced regulations. One analysis addresses the stability of the foundations soils relative to a deep rotational failure. The second analysis includes an evaluation of the liquefaction potential of the granular foundation soils. The glacial till soils are not subject to liquefaction because of their very dense nature.

Each critical section from the static analysis, including deep rotational failure and all of the critical liner interfaces, were evaluated for seismic stability. This analysis involves computing earthquake-induced displacements, using the following procedures:

- Determine the seismic coefficient, i.e., the average maximum earthquake-induced acceleration in the refuse mass immediately above the sliding surface. This involves assessment of any attenuation or amplification of the earthquake accelerations within the waste. In this instance, the analysis conservatively neglects any attenuation of earthquake acceleration in the very dense soil between bedrock and the lining system. For these analyses, calculations indicate a seismic coefficient of 0.081g.
- Determine the yield acceleration for potential sliding surfaces. The yield acceleration is the earthquake acceleration that corresponds to a factor of safety of 1.0, or an earthquake sufficiently large enough to cause movement or displacement. Each critical failure surface was evaluated by varying the earthquake acceleration until a factor of safety of 1.0 was achieved. The calculations indicate a factors of safety of 1.00, along with calculated minimum yield accelerations of 0.24g for the critical interface located within the Stage I lining system.

- Compare the yield and induced accelerations. If the induced accelerations exceed the yield accelerations, assess the magnitude of permanent displacement. In this instance, the results of pseudo-static stability analyses indicate a minimum yield acceleration of 0.24g, which is larger than seismic coefficient (induced acceleration) of 0.081g.
- Assess the effects on containment systems from the estimated permanent displacements. Since the induced acceleration is less than the yield acceleration, the analyses indicate that the design earthquake would not be expected to cause permanent deformations in the lining system.

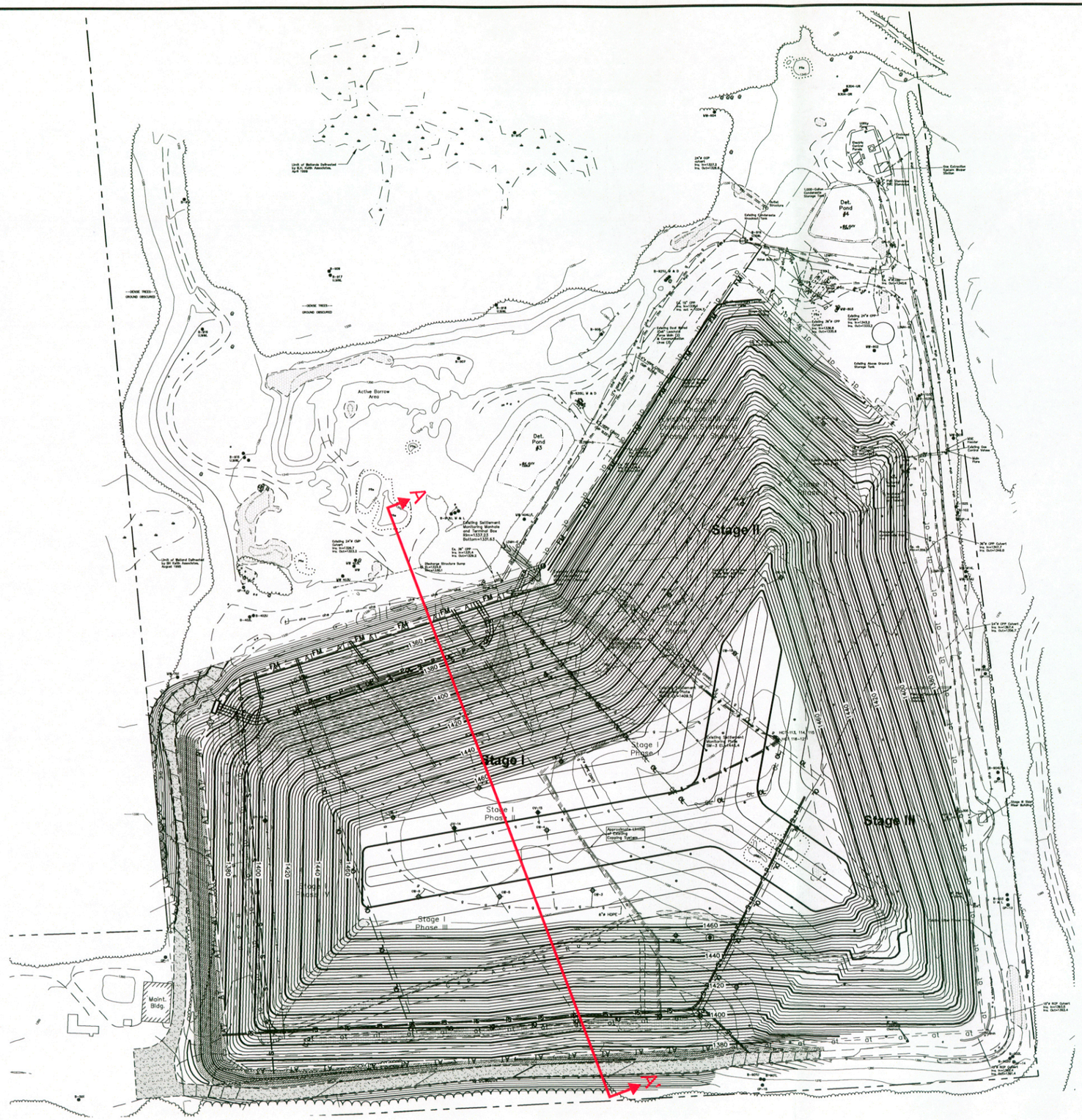
Cap Stability

Similar analyses were performed for cap stability as described above for liner stability. For the cap analyses, calculations indicate a seismic coefficient (induced acceleration) of 0.27g. Calculations indicate a yield acceleration of 0.172g, and a permanent displacement of about one inch. Permanent displacements on the order of 6 inches to a foot are typically considered acceptable for lining systems. For capping systems, larger deformations may be acceptable because the cap system components can be readily repaired.

CONCLUSIONS

The analyses completed as part of this work indicate that the proposed landfill configuration and construction materials provide adequate factors of safety against foundation failure and sliding among liner and cap system components under the expected static loading conditions. Under seismic loads, the landfill is stable relative to a deep rotational failure, permanent deformation of the liner is not expected, and the cap system deformations are small and acceptable.

Robert J. Grillo, P.E.
Project Manager



A A' *Stability Analysis Location and Designation*

CMA ENGINEERS
CIVIL/ENVIRONMENTAL ENGINEERS

35 Bow Street
Portsmouth, New Hampshire
03801-3819
Phone: 603/431-6196
Fax: 603/431-5376

Lafayette Center
Storer Street Building, Suite 208
Kennebunk, Maine 04043
Phone: 207/985-8717
Fax: 207/985-5520

E-mail: info@cmaengineers.com

North Country Environmental Services, Inc.
Bethlehem, NH

project:
Stage IV Phase II
Type IB & II Permit Application

title:
Stability Analysis
Site Plan

100 0 50 100 200
(in feet)
1 inch = 100 ft.

no.	revision	date	by

designed by: JSM/RJG/WAS	date: February 2009
drawn by: DAA/DMO/MAM	project no: 656.05
approved by: RJG/WAS	sheet no: Figure 1

F:\CADD\PROJECTS\656\656.05\dwg\Preliminary Jan09\65605pClosure.dwg 2/4/2009 2:46:05 PM EST

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: Project No: Date: Calc. By: Chkd. By:	NCES Stage IV Phase II Bethlehem, New Hampshire 656.03 January 29, 2009 RJG

OBJECTIVE: To evaluate the factor of safety against failure through the refuse and the lining system

GIVEN: Final and base grading plans, and liner system schematics, prepared by CMA Engineers. Design/Record Drawings of previous phases

METHOD: SLOPE/W slope stability program

Critical Section: A-A' Northerly through Stage I and Stage IV Phase II

Assumed Strength Properties

Interface/Material	ó degrees, c psf	Basis
STAGE IV		
drainage sand/drainage geocomposite	28 degrees, 0 psf	test data on file
drainage geocomposite/textured geomembrane	34 degrees, 200 psf	test data on file
drainage geocomposite/1-1/2" Crushed Stone	32 degrees, 0 psf	experience
textured geomembrane/screened till	30 degrees, 0 psf	test data on file
textured geomembrane/drainage sand	30 degrees, 0 psf	test data on file
REFUSE	33 degrees, 0 psf	literature
STAGES I		
drainage sand/geotextile fabric	28 degrees, 0 psf	test data on file
geotextile fabric/drainage net	30 degrees, 0 psf	experience
drainage net/smooth geomembrane	16 degrees, 40 psf	test data on file
smooth geomembrane/drainage sand or till	24 degrees, 0 psf	experience

Critical Interface Value - 28 degrees in Stage IV, and 16 degrees with 40 psf in Stages I

RESULTS:

Section	Min Factor Safety	Acceptable Factor of Safety
A-A'	2	1.5

All Soils

Soil 1
MSW
Soil Model Mohr-Coulomb
Unit Weight 75
Cohesion 0
Phi 33
Piezometric Line # 1
Ru 0
Pore-Air Pressure 0

Soil 2
Overlay Liner
Soil Model Mohr-Coulomb
Unit Weight 120
Cohesion 0
Phi 28
Piezometric Line # 1
Ru 0
Pore-Air Pressure 0

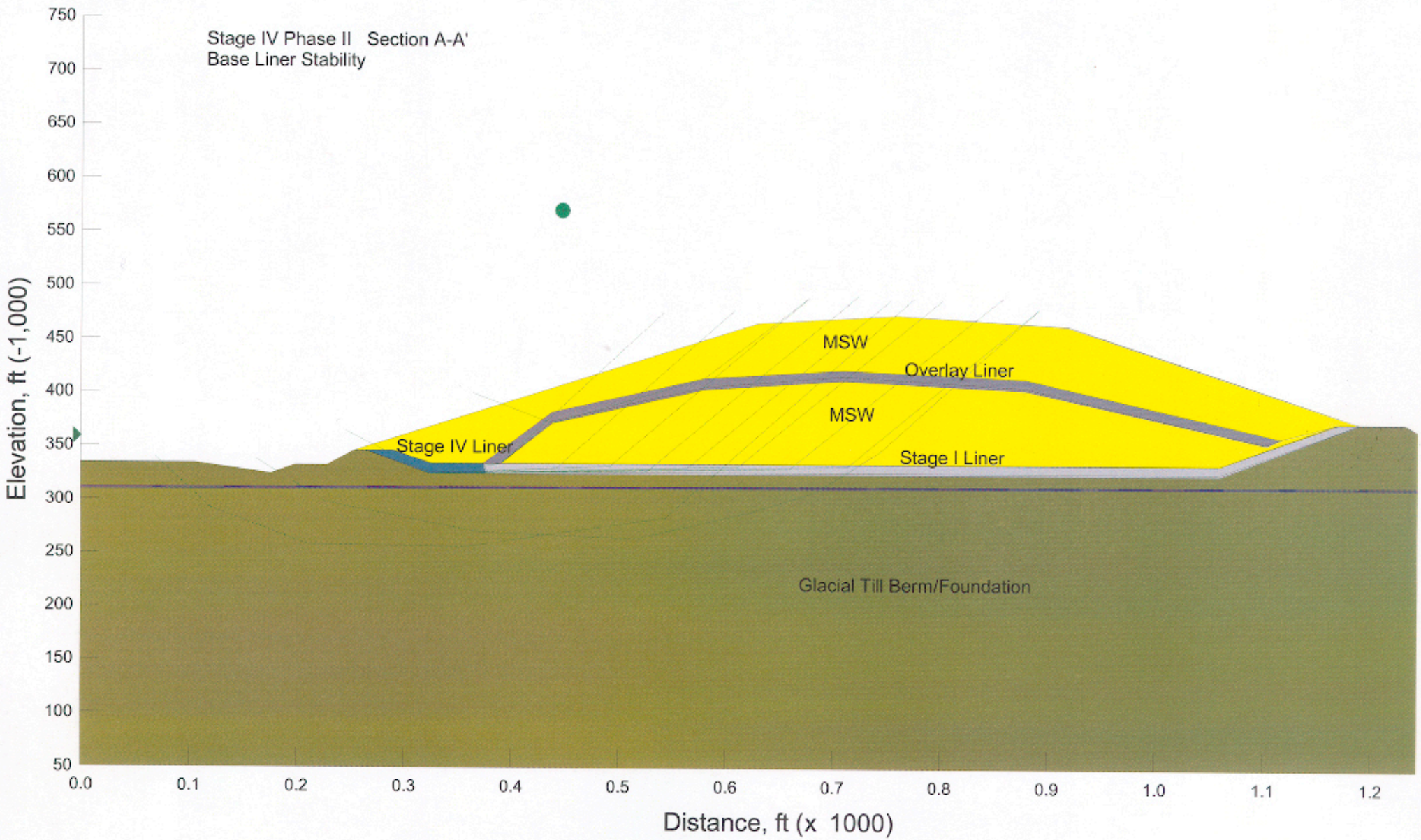
Soil 3
MSW
Soil Model Mohr-Coulomb
Unit Weight 75
Cohesion 0
Phi 33
Piezometric Line # 1
Ru 0
Pore-Air Pressure 0

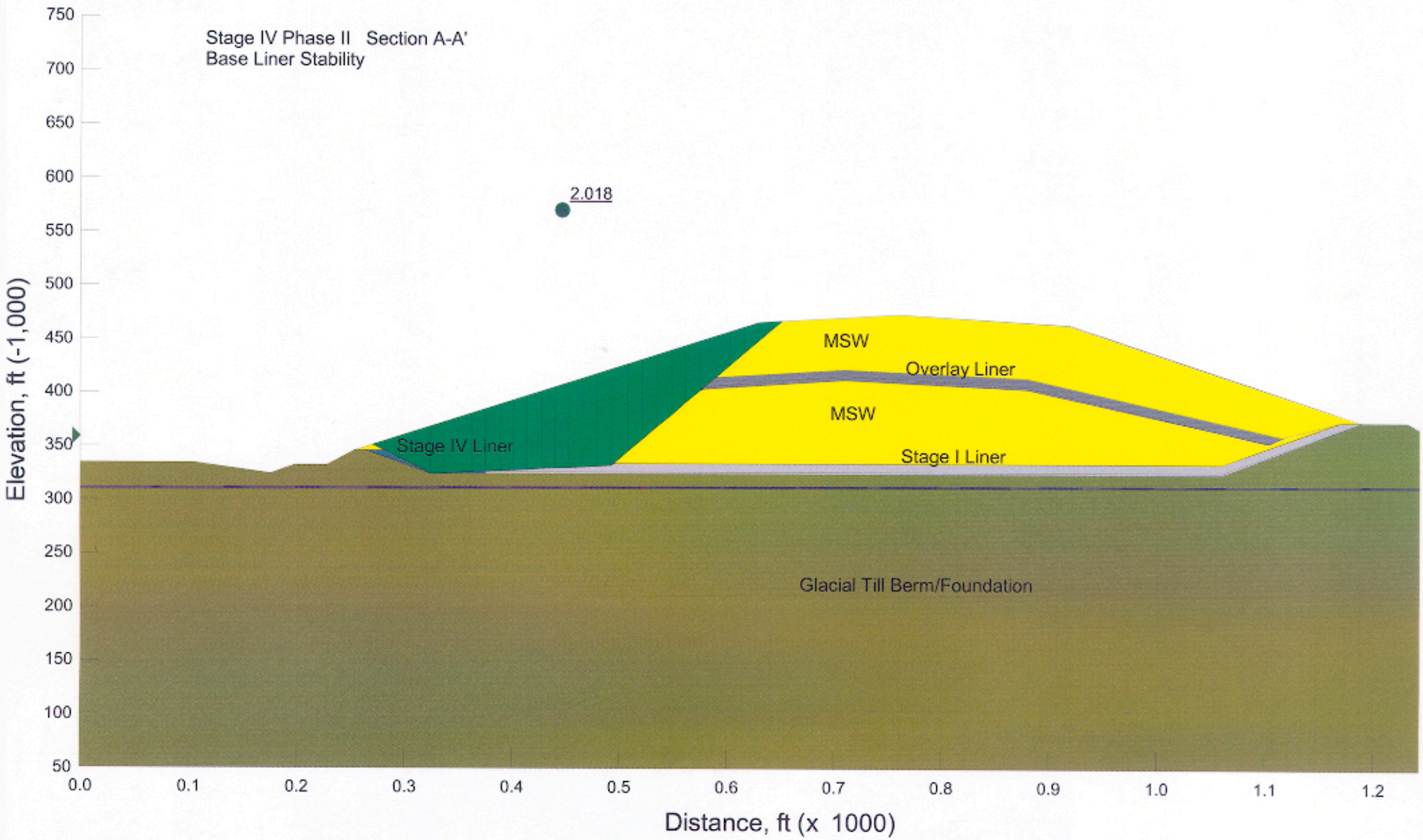
Soil 4
Stage I Liner
Soil Model Mohr-Coulomb
Unit Weight 120
Cohesion 40
Phi 16
Piezometric Line # 1
Ru 0
Pore-Air Pressure 0

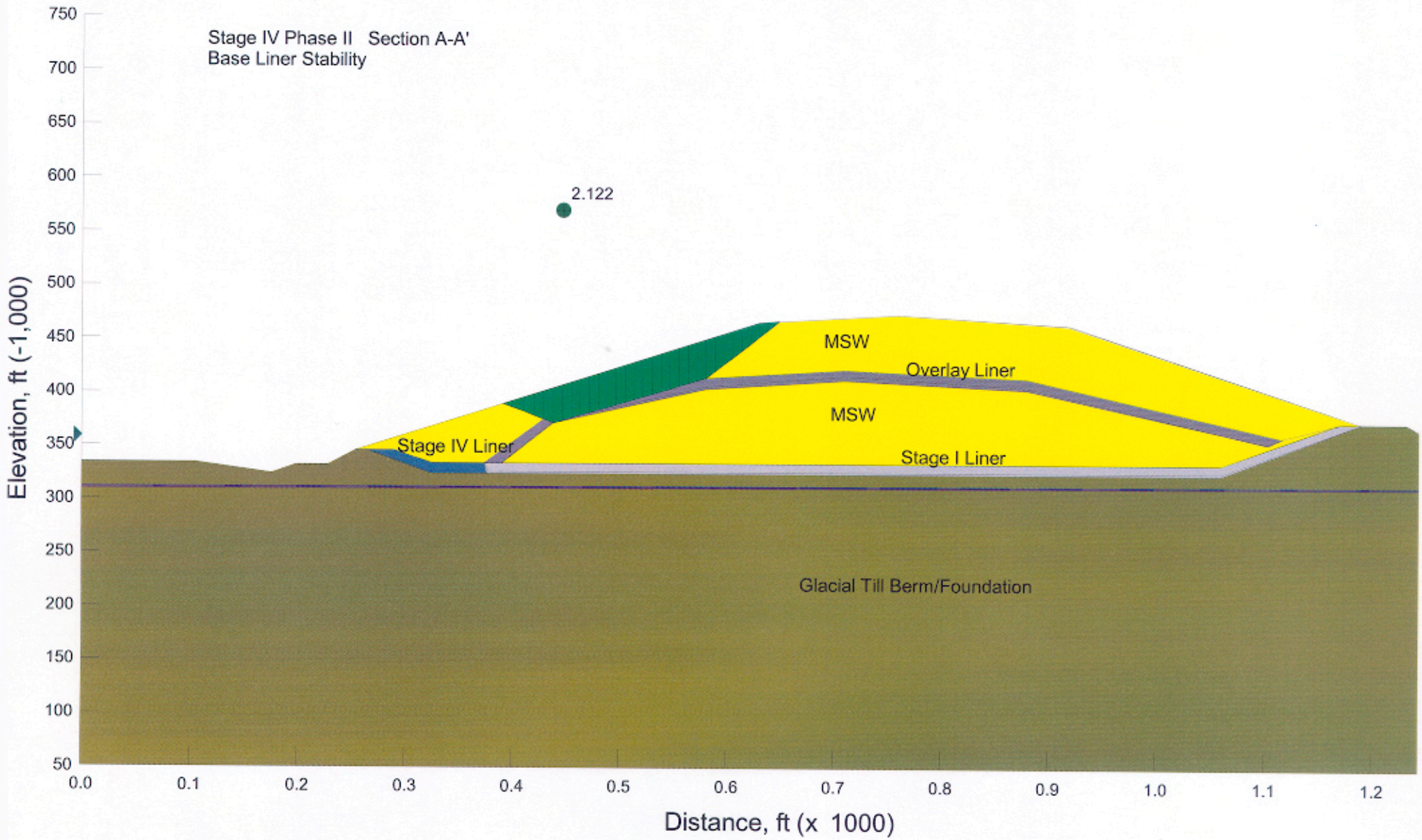
Soil 5
Stage IV Liner
Soil Model Mohr-Coulomb
Unit Weight 120
Cohesion 0
Phi 28
Piezometric Line # 1
Ru 0
Pore-Air Pressure 0

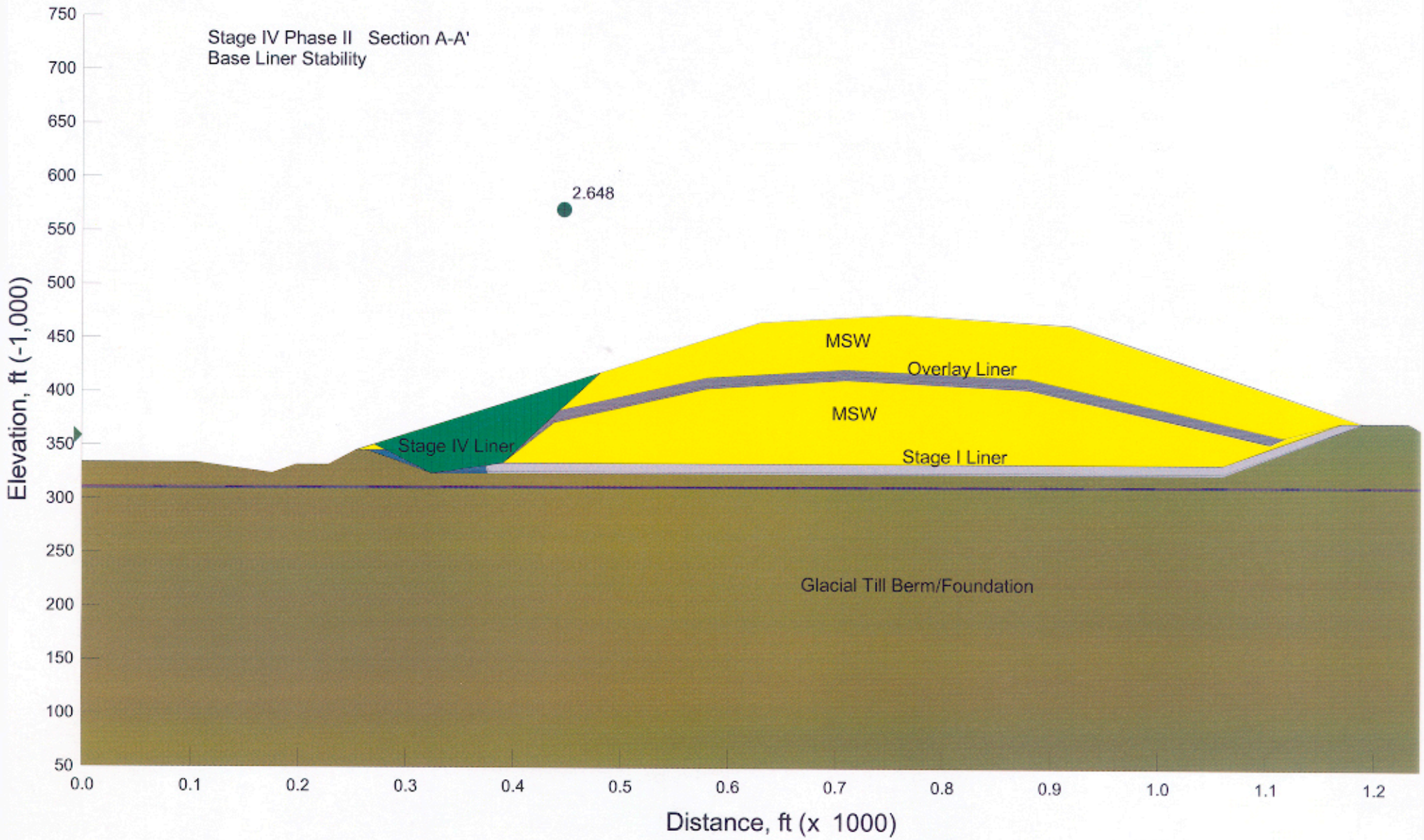
Soil 6
Glacial Till Berm/Foundation
Soil Model Mohr-Coulomb
Unit Weight 138
Cohesion 0
Phi 36
Piezometric Line # 1
Ru 0
Pore-Air Pressure 0

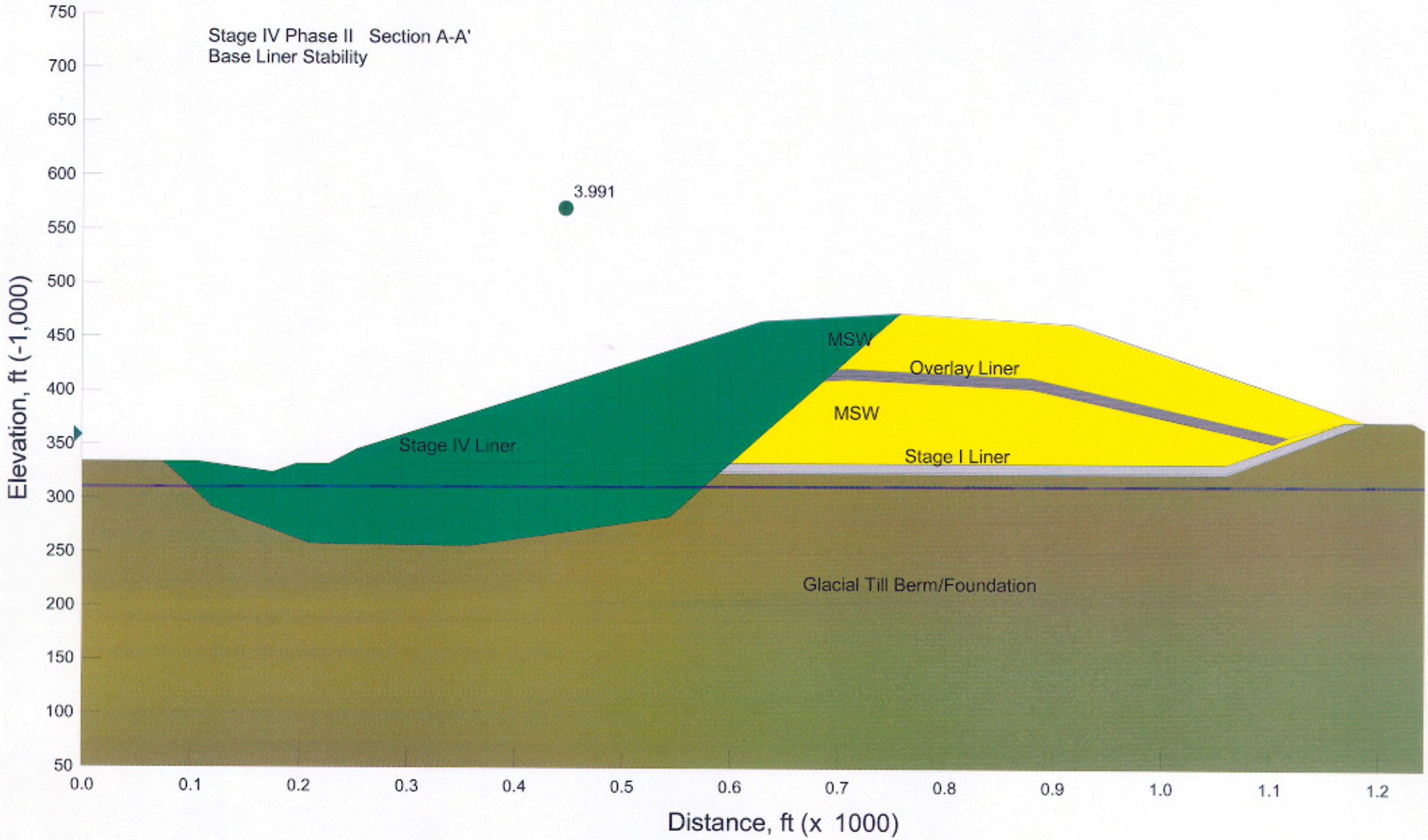
Soil 7
Bedrock
Soil Model Bedrock
P ometric Line # 1
Ru 0
Pore-Air Pressure 0


Stage IV Phase II Section A-A'
Base Liner Stability
MSW
Overlay Liner
MSW
Stage IV Liner
Stage I Liner
Glacial Till Berm/Foundation
Elevation, ft (-1,000)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Distance, ft (x 1000)


Stage IV Phase II Section A-A'
Base Liner Stability
2.018
MSW
Overlay Liner
MSW
Stage IV Liner
Stage I Liner
Glacial Till Berm/Foundation
Elevation, ft (-1,000)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Distance, ft (x 1000)


Stage IV Phase II Section A-A'
Base Liner Stability
2.122
MSW
Overlay Liner
MSW
Stage IV Liner
Stage I Liner
Glacial Till Berm/Foundation
Elevation, ft (-1,000)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Distance, ft (x 1000)


Stage IV Phase II Section A-A'
Base Liner Stability
2.648
MSW
Overlay Liner
MSW
Stage IV Liner
Stage I Liner
Glacial Till Berm/Foundation
Elevation, ft (-1,000)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Distance, ft (x 1000)


Stage IV Phase II Section A-A'
Base Liner Stability
3.991
MSW
Overlay Liner
MSW
Stage IV Liner
Stage I Liner
Glacial Till Berm/Foundation
Elevation, ft (-1,000)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Distance, ft (x 1000)

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: Project No: Date: Calc. By: Chkd. By:	NCES Stage IV Phase II Bethlehem, New Hampshire 656.03 January 29, 2009 RJG

OBJECTIVE: To evaluate the expected displacement in the liner from a design earthquake with a 10% probability of exceedance in 250 years.

GIVEN: Critical sections and waste/liner properties from previous static loading calculation

REFERENCES: RCRA Subtitle D Seismic Design Guidance for Municipal Solid Waste Le Landfill Facilities, EPA, April 1995.

Makdisi and Seed, "Simplified Procedures for Estimating Dam and Embankment Earthquake Induced Displacements," Journal of Geotechnical Engineering, July 1978

Idriss, "Response of Soft Soil Sites During Earthquakes," Proc. Symposium to Professor H. B. Seed, Berkeley, CA, 1990.

ASSUMPTIONS: Apply psuedo-static stability analysis to critical static sections w/same interface strengths.

PROCEDURE:

1. Determine seismic coefficient (average maximum earthquake induced acceleration in the refuse mass above the sliding surface).
2. Determine the yield acceleration using psuedo-static stability analyses (SLOPE/W)
3. Compare yield and seismic coefficient accelerations. If the seismic coefficient acceleration exceeds the yield acceleration, estimate the magnitude of displacement, and assess the effects on the landfill from estimated permanent displacements.

Determine Seismic Coefficient

From USGS Hazard Map in previous calculation, design earthquake equals 0.1785g at the top of bedrock. Conservatively assume no attenuation of earthquake accelerations in the medium to dense layers of till and silt between bedrock and the lining system.

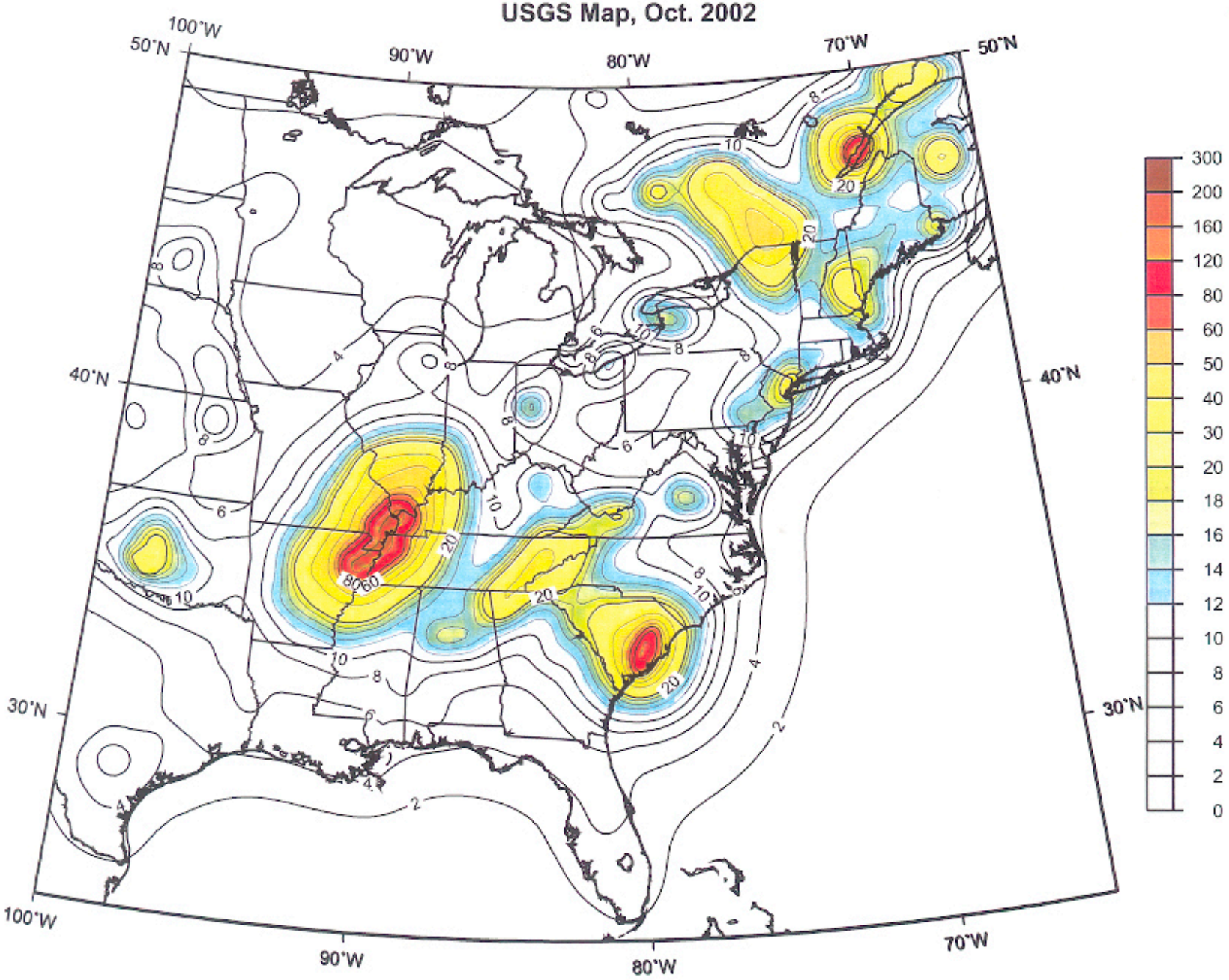
Seismic coefficient at the top of the waste equals 0.27g per Singh and Sun, attached. Seismic coeffient at the base of the landfill equals 0.081g per Makdisi and Seed (0.27 x 0.3 = 0.081).

Determine Yield Acceleration

Psuedo-static analyses indicate a minimum yield acceleration of 0.24g.

CONCLUSION: The yield acceleration (0.24g) is greater than the seismic coefficient (0.081g), therefore the design earthquake would not cause permanent deformations in the lining system.

Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
USGS Map, Oct. 2002



```
LOCATION                 44.27 Lat.  -71.60 Long.
The interpolated Probabilistic ground motion values, in %g,
at the requested point are:
            10%PE in 50 yr   2%PE in 50 yr
   PGA          5.49            17.85
0.2 sec SA     11.89            33.46
1.0 sec SA      3.25             8.65
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

SEISMIC HAZARD: Hazard by Lat/Lon, 2002

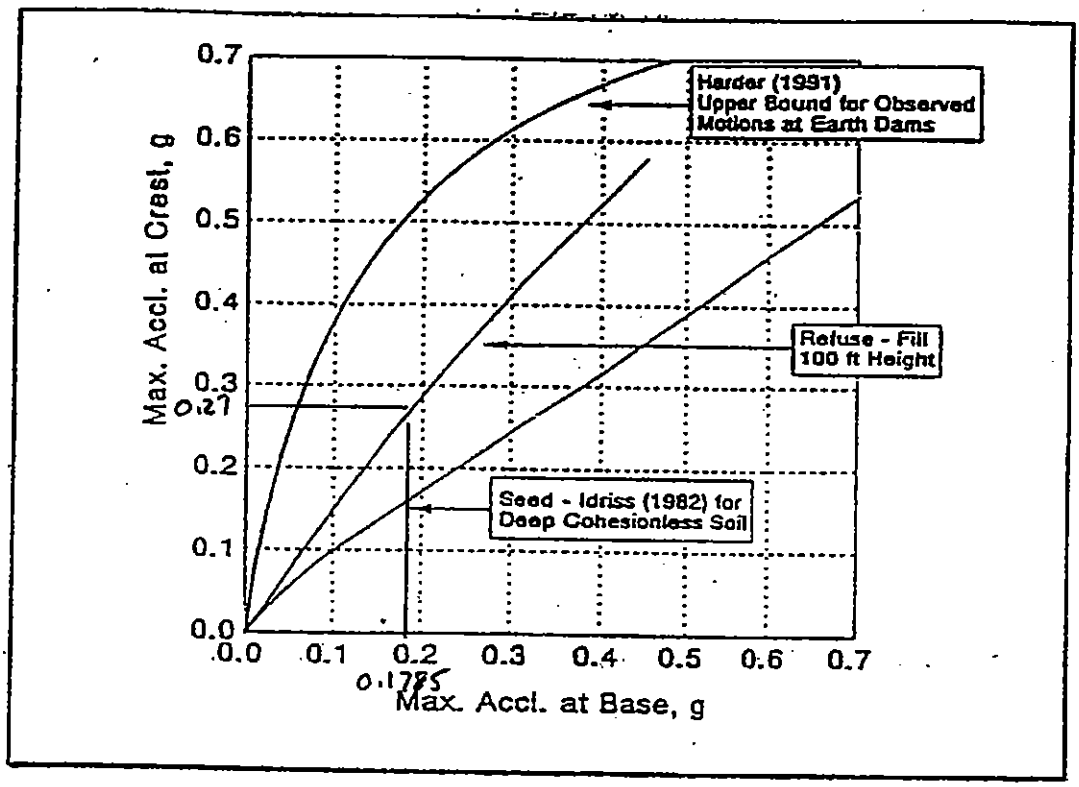
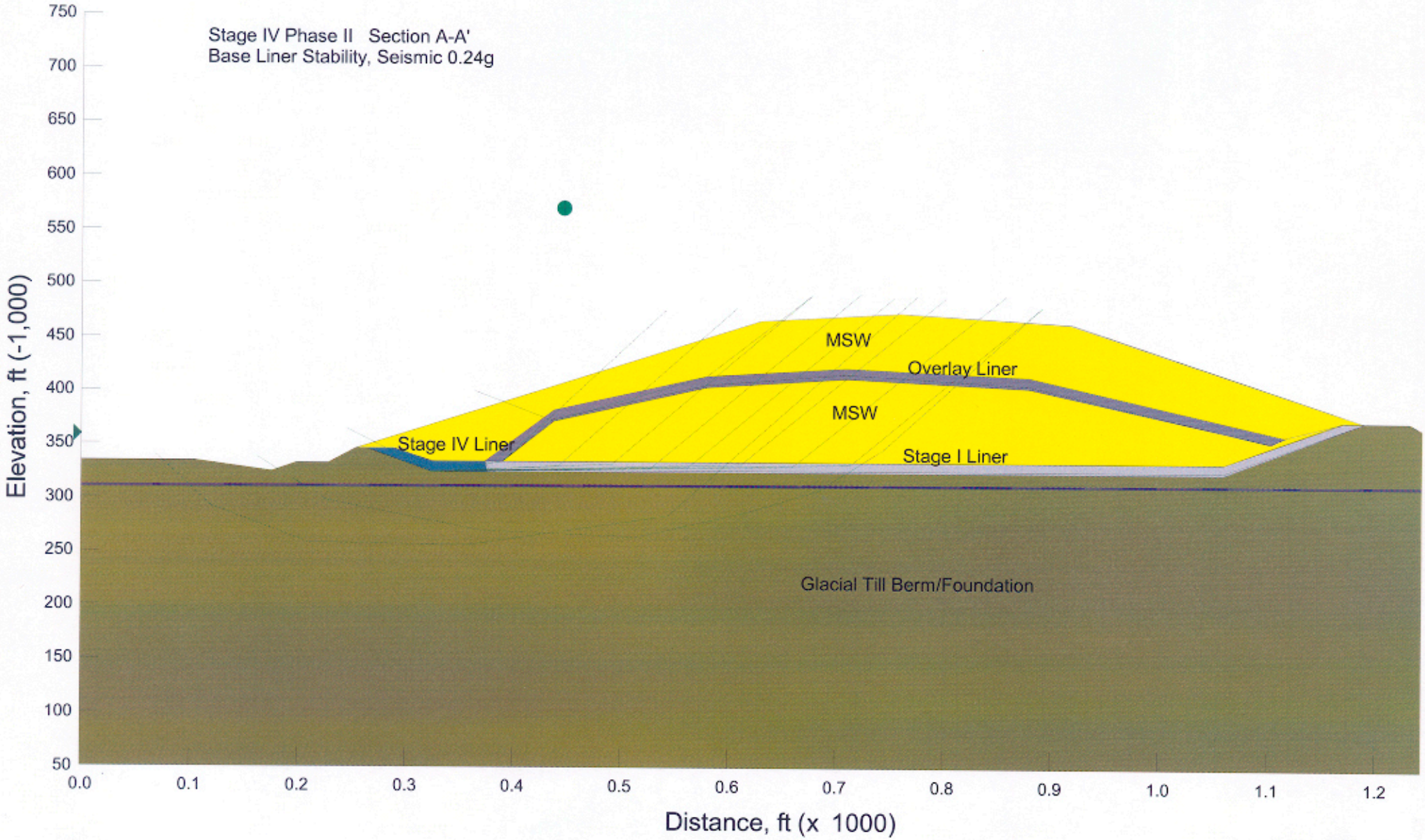
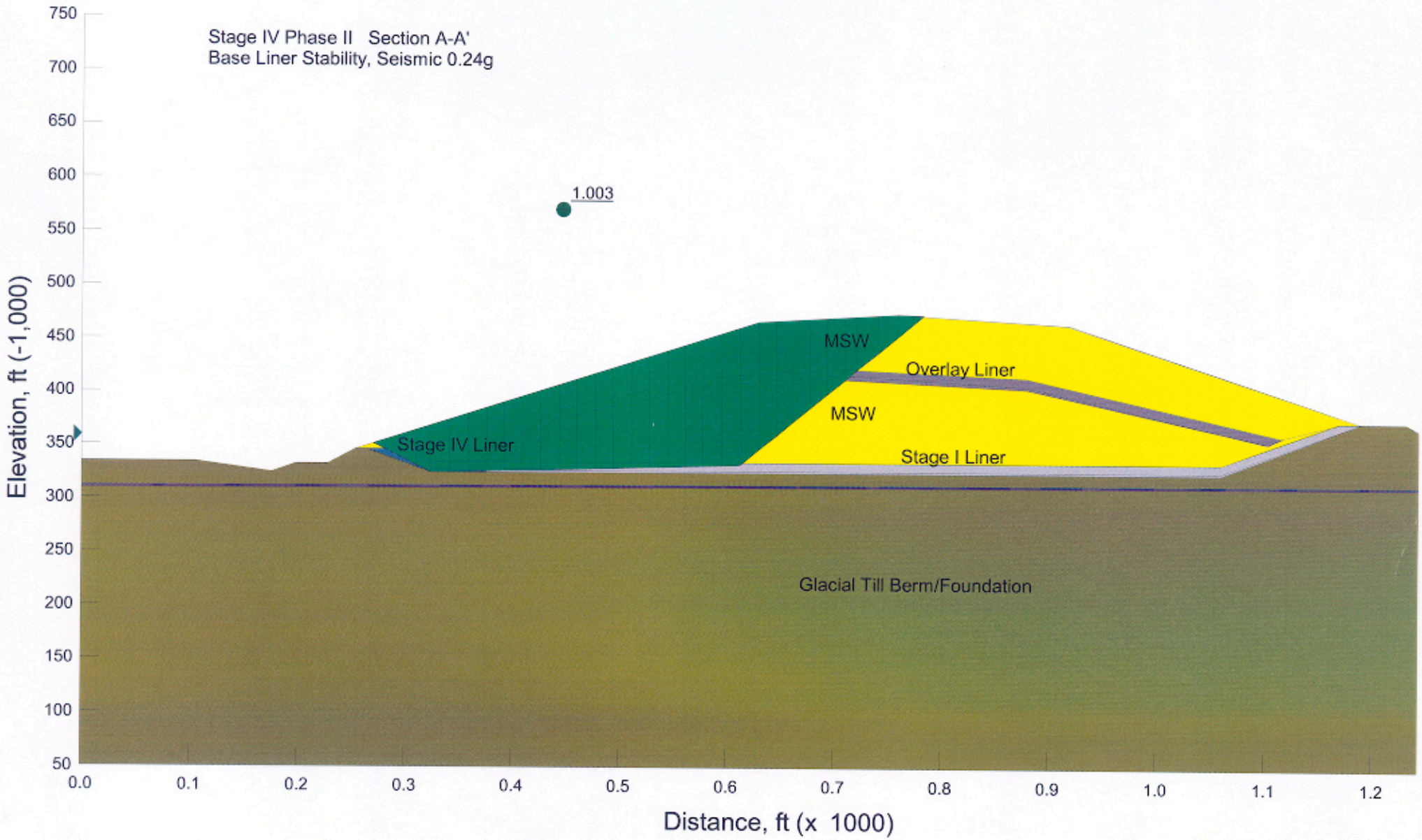


Figure 4.6 Approximate Relationship Between Maximum Accelerations at the Base and Crest for Various Ground Conditions (Singh and Sun, 1995)


Stage IV Phase II Section A-A'
Base Liner Stability, Seismic 0.24g
MSW
Overlay Liner
MSW
Stage IV Liner
Stage I Liner
Glacial Till Berm/Foundation
Elevation, ft (-1,000)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Distance, ft (x 1000)


Stage IV Phase II Section A-A'
Base Liner Stability, Seismic 0.24g
1.003
MSW
Overlay Liner
MSW
Stage IV Liner
Stage I Liner
Glacial Till Berm/Foundation
Elevation, ft (-1,000)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Distance, ft (x 1000)

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: Project No: Date: Calc. By: Chkd. By:	NCES Stage IV Phase II Bethlehem, New Hampshire 656.03 November 19, 2007 RJG

OBJECTIVE: To evaluate the factor of safety against failure through components of the cap section under static and seismic loading conditions.

GIVEN: Final Grading Plan prepared by CMA Engineers: maximum slope angle of 3H:1V
Cover Section per Preliminary Design/Closure Plan Drawings.

ASSUMPTION: Closure construction to occur in about 9 years. Available materials and methods will likely vary from those available at this time. Assume min friction angle of 28 degrees.

METHOD - STATIC: Conservatively use simplified infinite slope procedure. Ignore butressing effects of toe and swale benches.

Equation: $\text{Factor of Safety} = \tan\phi / \tan\beta$

where ϕ = min friction angle of 28 degrees
β = slope angle of 18.4 degrees

Factor of Safety = 1.6

METHOD - SEISMIC: Refer to method and references for liner stability in previous calculation.

REFERENCE: Matasovic, "Selection of Method for Seismic Slope Stability Analysis," Proceedings, Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, St. Louis, MO, 1991

Determine Seismic Cofficient

From relationships developed by Singh and Sun (attached), maximum acceleration at refuse surface equals 0.27g.

Determine Yield Acceleration (a_y)

Equation per Matasovic

$$F.S. = 1.0 = \frac{\tan\phi - a_y \tan\beta \tan\phi}{a_y + \tan\beta}$$

$$a_y = 0.172$$

Determine Cap Displacement

From Makdisi and Seed (attached), and maximum acceleration divided by yield acceleration equaling 0.64, displacement equals 2.5 centimeters or about one inch.

RESULTS Cap displacement resulting from the design earthquake will be one inch, which is less than the generally considered acceptable range of 6 inches to a foot.

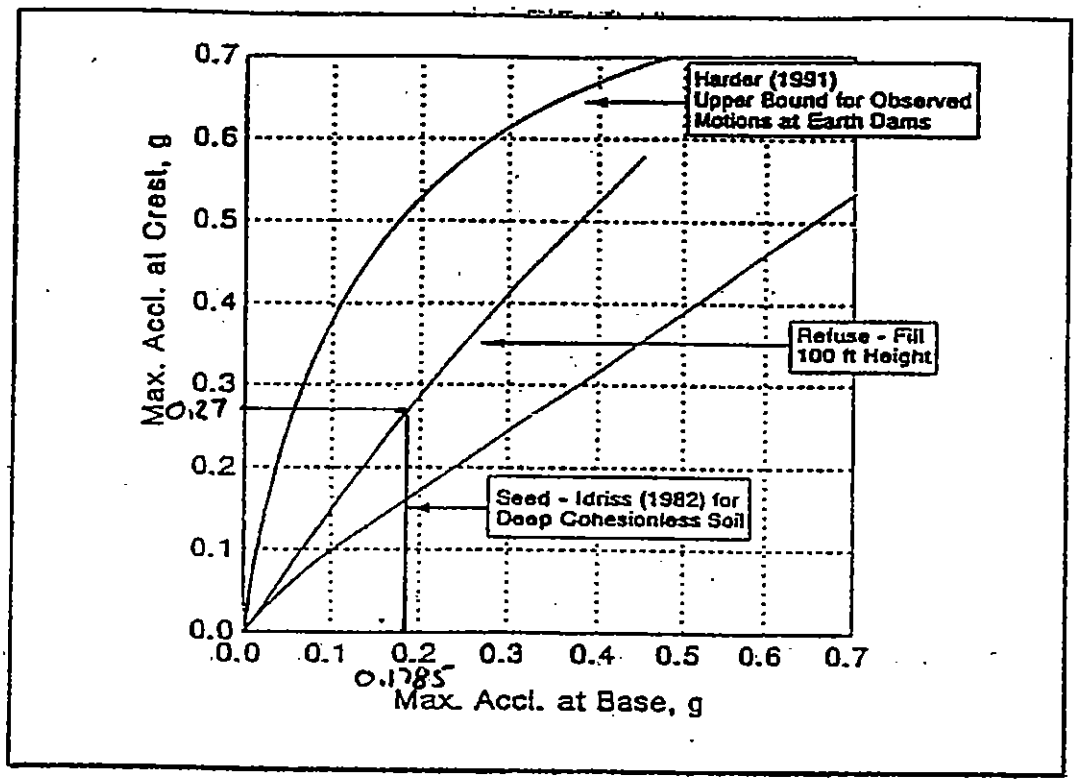


Figure 4.6 Approximate Relationship Between Maximum Accelerations at the Base and Crest for Various Ground Conditions (Singh and Sun, 1995)

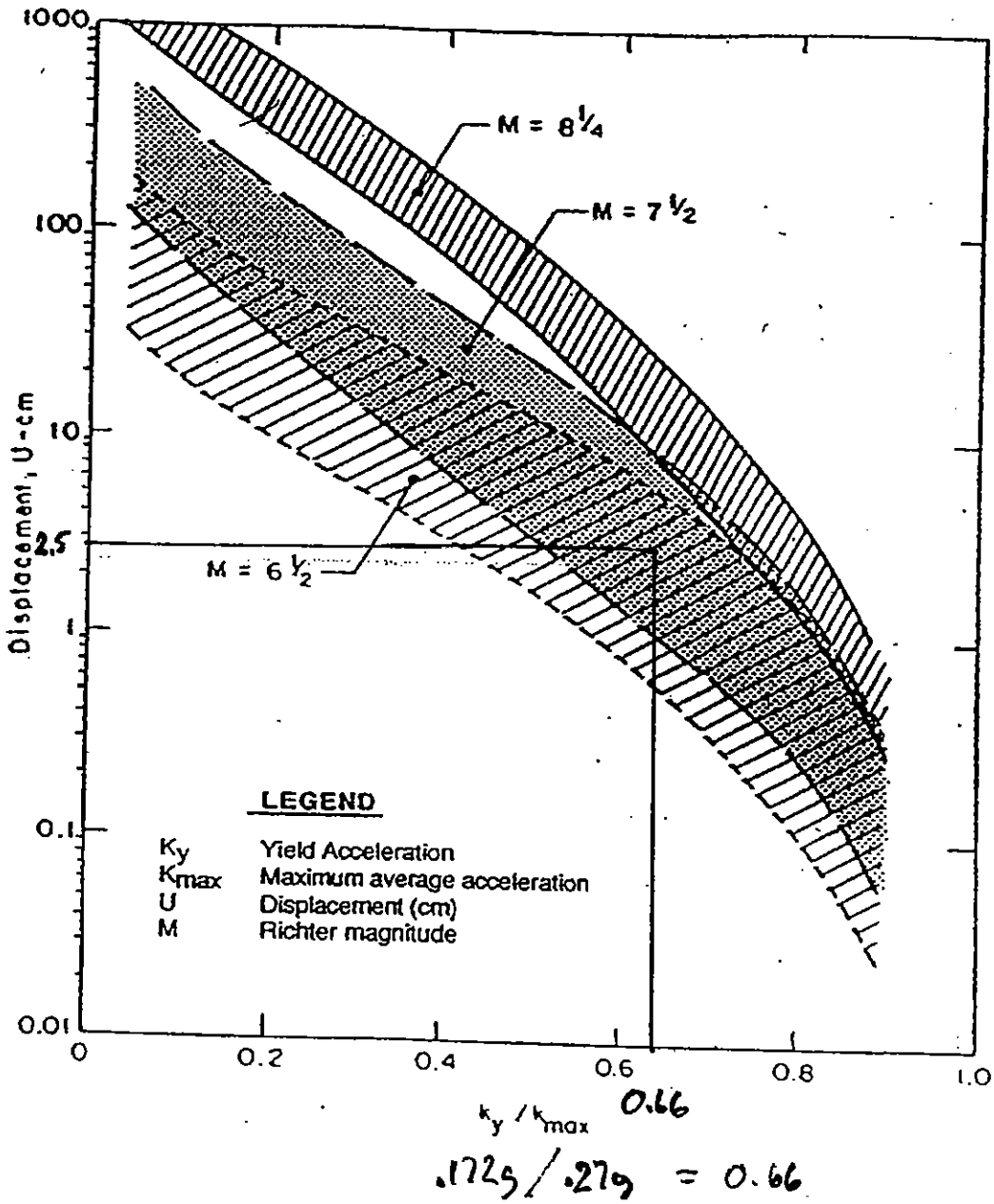


Figure 6.6 Makdisi and Seed Permanent Displacement Chart (Makdisi and Seed, 1978).

APPENDIX A.3

Stormwater Management

North Country Environmental Services, Inc.

Stormwater Management Report

NCES Solid Waste Landfill
Stage IV – Phase II Landfill
Bethlehem, New Hampshire

February 2009

Prepared by:

CMA Engineers, Inc.
Civil and Environmental Engineers
35 Bow Street
Portsmouth, New Hampshire 03801

Prepared for:

North Country Environmental
Services, Inc.
Bethlehem, New Hampshire

STORMWATER MANAGEMENT REPORT
North Country Environmental Services, Inc.
Solid Waste Landfill
Stage IV – Phase II Landfill
Bethlehem, New Hampshire

February 2009

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Post-Development Conditions	5
Detention Pond Analysis	10
Erosion Control During Construction	11
Conclusions	11

TABLES AND FIGURES

Table 1	2-Year Storm Event Pre and Post Development Flow Comparison
Table 2	10-Year Storm Event Pre and Post Development Flow Comparison
Table 3	25-Year Storm Event Pre and Post Development Flow Comparison
Figure 1	USGS Map – Pre Development Drainage Plan (See Appendix A.1)
Figure 2	Post Development Drainage Plan

APPENDICES

A.1	Pre-Development Drainage Analysis and Calculations
B.1	Post-Development Drainage Analysis and Calculations
B.2	Post-Development Swale, Drainage Bench and Drainage Line Calculations
B.3	Post-Development Detention Pond Calculations and Hydrographs
C	Supporting Tables and Charts
D	Construction Drawings (Bound Separately)

PROJECT DESCRIPTION

The North Country Environmental Services (NCES) landfill site is located off Trudeau Road in Bethlehem, NH, southeast from the center of town. As shown in the USGS Map as Figure 1, the site is situated south of Rt. 302 and the Ammonoosuc River and east of Trudeau Road. The land to the south is undeveloped National Forest.

The NCES landfill has been developed in four stages with the most recent construction of Stage IV, Phase I completed in 2008 (overlay liner) in accordance with the NHDES-WMD Type II Permit Modification. A site specific permit was received on July 30, 2008 for the Stage IV Phase II Construction. The proposed Stage IV Phase II project will disturb approximately 13.75-acres of the site. We note that this is less than the 20.4 acres initially anticipated and submitted for this project in the original application in May 2007. Other changes include elimination of the proposed 2,877 feet of paved roadway and reduction in the total impervious area.

The intent of this report is to present the design of the stormwater management system and erosion and sediment control practices for the overall Stave IV Phase II landfill project. The project is anticipated to be constructed in several phases of work which may include constructing portions the earth berms coordinated with the construction of the new landfill cell and leachate management area as appropriate. NCES anticipates revising the existing site specific permit as necessary in order to complete the construction of the Stage IV Phase II landfill project.

The proposed project will include a horizontal expansion around the north, west and south portions of Stage I by continuing the existing earth berms up at a 3:1 slope. The project will also include the elimination of existing Detention Pond #2 and existing Southern Treatment Swale. Site development will also include stormwater management features such as swales, and culverts.

The proposed construction has been designed so that no runoff outside the landfill area enters the landfill, erosion and sediment transport due to surface runoff is controlled, and the 25-year, 24-hour peak post-development stormwater flow does not exceed the pre-development condition. Precipitation falling into the active phase of the landfill will be collected as leachate until it can be shed as clean runoff from the intermediate or final cover systems. Precipitation falling onto inactive and closed portions of the landfill will continue to be discharged as stormwater to the detention ponds or off site through the treatment swale.

All stormwater flow leaving the site flows off to the north and northwest and infiltrates to groundwater or eventually discharges into the Ammonoosuc River. Prior to development of the landfill, the soils on the site were classified by the National Resources Conservation Service (NRCS) to include Adams loamy sand, Waumbeck loamy sand, Monadnock and Hermon soils, Croghan loamy fine sand, and Kinsman sand (See Appendix D). The soils are predominantly in hydrologic Group B, with some portion of the area beneath the existing landfill were Group C.

The area proposed for development is comprised primarily of the Monadnock and Hermon soils. Based on previous explorations and construction activities at the site, these soils consist of glacial till and stratified drift. The stratified drift varies widely in composition from fine to coarse sand to silty fine sand, with silt content ranging from less than 10 percent to as high as 30 to 40 percent. The gravel fraction ranges from none to approximately 20 percent in some of the soils.

To meet the requirements of RSA 485-A:17, Env-Ws 415 and Env-Sw 805.09, the pre- and post-development (following closure of Stage IV - Phase II) peak stormwater runoff flows were calculated for the 25-year, Type II, 24-hour storm event. Pre and post-development flows for the 2-year and 10-year 24 hour storm events were also analyzed and reported in this application. The 100-year storms were also analyzed for conformation of the detention pond sizing and the existing outlet structure design. The method used for all analyses was SCS TR55: Urban Hydrology for Small Watersheds, performed with Haestad Methods Pond Pack® modeling software. The results of the analyses are summarized in the following sections while all drainage areas and pertinent drainage structure calculations can be found in Appendixes A, B and C.

When calculating time of concentration, a maximum sheet flow length of 150 feet was assumed for well established vegetative stand on the capping system and a maximum sheet flow length of 100 feet was assumed for bare soils or wooded areas. A curve number for the capping system was conservatively assumed as CN=74, per previous NHDES requests. We note that in the previous application the predevelopment, and post development flows were all lower due to the assumption that all sheet flow would run a maximum length of 300 feet on all surfaces. The revisions to the sheet flow length have been made based on recent input received from the Department on other projects. With the revised assumptions, the post development 25-year storm flow does not exceed the pre development conditions. However, the 2- and 10-year storms, 17.34 cfs and 27.84 cfs, are above the predevelopment flow of 7.67 cfs and 21.41 cfs, respectively. The increase in the 2- and 10-year peak storm flows will not have any impact on downgradient structures and this flow will likely infiltrate prior to reaching the Ammonoosuc River.

Wetlands on the site were previously delineated by B.H. Keith Associates, Inc. of Freedom, NH. There are no proposed disturbances to delineated wetlands as a result of the proposed development.

NCES anticipates the first phase of construction to commence in 2009 or 2010. Subsequent phases of the landfill construction will be completed over the next 6 to 7 years with final operations and closure construction anticipated in 9 to 10 years. NCES will apply for renewal of the site specific permit as applicable. The construction sequence for each phase is as follows:

<u>Leachate Loadout Area</u>: **Construction to finish in the spring of 2009**

1. Establish vertical and horizontal control. Submit plan for layout and control of all

work to Engineer.

2. Install erosion control and sedimentation control devices required prior to starting work.
3. Clear and grub to the limits shown on the plan.
4. Strip existing topsoil materials in proposed areas to be disturbed and manage for reuse.
5. Construct gravel access roadway, leachate loadout station, tank access tower, forcemain, and air release and leak detection structures.
6. Install loam and stabilize disturbed areas.
7. Construct culverts and headwalls.
8. Site clean-up.

Horizontal Expansion to North, South and West: **To be constructed**

1. Establish vertical and horizontal control. Submit plan for layout and control of all work to Engineer.
2. Install erosion control and sedimentation control devices required prior to starting work.
3. Clear and grub to the limits shown on the plan.
4. Strip existing topsoil materials in proposed areas to be disturbed and manage for reuse.
5. Construct gravel access roadway and berms.
6. Install loam and stabilize disturbed areas.
7. Construct temporary culvers and headwalls.
8. Strip away intermediate cover in proposed waste excavation areas and manage materials for reuse (Note: may be completed in phases).
9. Excavate existing waste in specified locations and relocate to landfill (Note: may be completed in sections).
10. Install temporary HDPE tarp and extend gas collection system for odor control (Note: may be completed in phases).
11. Implement temporary measures for collection of leachate from Stage I piping
12. Prepare proposed Phase II landfill subgrade.
13. Install secondary liner, drainage geocomposite, select sand and the secondary leachate collection pipes.
14. Construct proposed Pump Station I.
15. Install primary liner, drainage geocomposite, select sand, and the primary leachate collection pipes and sump risers.
16. Extend primary and secondary leachate riser into proposed pump stations and connect to forcemains.
17. Construct leachate forcemain.
18. Loam and seed all disturbed areas
19. Site clean-up.

Overlay Liner Construction: **Stage IV, Phase I Overlay Liner was constructed in 2008, Stage IV, Phase II Overlay Liner remains to be constructed**

In order to comply with the Solid Waste Rules for continued operation over portions of the Stage I Landfill, an overlay liner system will be installed over the existing waste materials. The overlay liner will be completed in phases as necessary for developing the landfill operations. The construction sequence for the installation of the overlay liner system is as follows:

1. Establish vertical and horizontal control. Submit plan for layout and control of all work to Engineer.
2. Install erosion control and
3. Strip existing landfill capping materials in areas proposed for overlay liner construction, and regrade waste as necessary to achieve desired liner slopes.
4. Install daily cover materials over waste.
5. Install geotextile reinforcement and screened till.
6. Install secondary and primary geomembrane liners, drainage geocomposites, and select sand materials.
7. Install temporary geomembrane over select sand to divert clean stormwater away from active filling areas.
8. Install leachate collection piping.
9. Site clean up.

PRE-DEVELOPMENT CONDITIONS

Prior to development as a landfill site, the property consisted of wooded areas with a gravel pit operation on its eastern portion. A topographic survey of the site prior to development does not exist, but based on the United States Geological Survey (USGS) mapping (Figure 1), the ground surface sloped southerly on-site and then northwest to a natural drainage course that flows to the north and then east into the Ammonoosuc River. While it appears that a majority of the existing stormwater flow discharges to the north, a review of the USGS topographic plan in comparison to the existing conditions (surveyed) plan for the site reveals that a small portion of the existing site discharges to the south. The proposed site conditions also include a minor discharge to the south off the existing and proposed southern berm. This discharge infiltrates to groundwater and is not evaluated further.

The pre-development conditions would have included wooded areas in good condition, over Group B and C soils. The proposed Stage IV-Phase II landfill construction, the existing landfill area, and the surrounding watershed areas comprise approximately 62.07 acres. Previous pre-development calculations for site specific permit applications for the site evaluated flow from off a 43.24-acre area, which corresponded to the development within the existing 51-acre site. The pre-development peak flow off the site has been re-calculated for the applicable 62.07 acres and the soil classifications prior to development. The SCS TR-25 calculations of the pre-

development flow for the 24-hour 2, 10, and 25-year storm estimate a peak flow of 7.67 cfs, 21.41 cfs, and 40.32 cfs, respectively, off the site to the north.

The pre-development drainage area and the flow path from which the time of concentration and peak discharge rates were determined are shown on Figure 1. The calculations used to determine the pre-development drainage area flows are included in Appendix A. Figure 2 depicts the existing soil group classifications at the site prior to development as a landfill, when a gravel pit was operated at the site. See Appendix D for the SCS soil Map for the Site.

POST-DEVELOPMENT CONDITIONS

Following completion of the proposed construction of the Stage IV Phase II landfill and final operation of the landfill, a capping system will be constructed over the landfill. The analysis for the closed landfill is considered as the post-development conditions for the project.

During the development of the four stages of the lined landfill, four detention ponds had been constructed to reduce the peak flow off-site to rates lower than the pre-development flow. During the construction of Stage I, the detention pond designated as Detention Pond #2 was constructed to manage the run-off from a closed Stage I landfill. During construction of Stage II, Detention Pond #1 and #3 were constructed, located to the south and north of the landfill facility, respectively. Detention Pond #1 was eliminated and Detention Pond #3 was expanded during the development of Stage III. During the construction of Stage IV- Phase I, Detention Pond # 3 was relocated, and Detention Pond #4 was constructed to the northeast of Stage IV. The locations of the existing detention ponds are depicted on the permit drawings, as well as the attached Figure 2.

Detention Pond #2 receives flow from the southern and western portions of the landfill, and discharges to the north via an 18-inch diameter culvert into the grass lined treatment swale that flows off-site to the north. This detention pond will be eliminated during the construction of Stage IV-Phase II, and flow from off the contributing watersheds will be directed to Detention Pond #3 or directly into the grass lined treatment swale that flows off-site to the north.

Detention Pond #3 receives flow from the northern portions of the landfill and contributing watershed areas to the north. This pond discharges to the west through an outlet structure into the grass lined treatment swale.

Detention Pond #4 receives flow from the eastern portions of the landfill and discharges to the north via an outlet structure and level spreader. The size of the pond has been modified to provide area for the recent construction of the leachate loadout area and access roadway.

Construction of the proposed Stage IV-Phase II landfill, access roads, and associated structures will increase the amount of developed areas on the site, thus increasing the total stormwater

runoff. To mitigate the effects of the additional runoff, the proposed site has been designed to collect stormwater runoff from the proposed capping system, gravel and paved access roads, parking areas and buildings through a system of drainage benches, catch basins and drain manholes, and underground storm drain lines that direct the flow to constructed detention ponds. The detention ponds are designed to reduce the post-development peak flows to the pre-development peak flows, thereby mitigating any potential for downstream flooding as a result of run-off from the site and to provide treatment for the removal of suspended solids entrained in the run-off. Treatment of run-off from the existing impervious areas in the leachate loadout area is provided by the 28.6 hours of plug flow retention in Detention Pond #4, its sediment forebay, and the existing vegetated filter strip down gradient of the level spreader discharging the flow from the pond as sheet flow.

The post-development condition evaluated is for the worse case scenario after landfill closure construction is completed. Four post development drainage areas (A, B, C, and D) and 26 sub-drainage areas were created for analysis based on their slopes, ground cover, soil type, and discharge locations. The post-development watersheds are depicted on Figure 2 for reference.

Drainage Area A includes drainage areas located from the peak to the toe of the western side of the proposed landfill capping system. These areas are designated as Areas A1 through A8. Run-off from areas A1 – A7 sheet flows into intermediate drainage benches or toe drains that direct the flow to the proposed Northern Down-Chute into Detention Pond #3. Drainage Area A8 encompasses the area in which stormwater sheet flows directly into Detention Pond #3.

Drainage Area B includes drainage areas on the eastern portion of the landfill capping system. These areas are designated as Areas B1 through B8. Run-off from these areas discharge via sheet flow into toe drain swales or are collected in intermediate drainage benches on the capping system that discharge into a downchute. Flow from the downchute and the toe drain swales are routed to Detention Pond #4, which then discharges off site.

Drainage Area C includes drainage areas on the southern portion of the landfill capping system, the southern and western access roadways, and the area surrounding the partially constructed Detention Pond #5. These areas are designated as C1 through C5. Run-off from the proposed capping system sheet flows into the drainage swale adjacent to the roadway and eventually flows to the existing treatment swale in the northwest corner which junctions with discharged flow from Detention Pond #3 and exits the site to the north. Drainage Area C4 includes the drainage area surrounding a partially constructed detention pond (Detention Pond #5) with no outlet structure. The pond was permitted under the previous site specific permit, but its construction was not completed. Run-off from area C4 sheet flows into the partially constructed detention pond and then infiltrates into the ground or evaporates.

Drainage Area D includes drainage areas on the eastern portion of the landfill. These areas are designated as Areas D1 through D5. Run-off from the landfill capping system sheet flows into

the roadside swale and through culverts that direct the flow to the swale that runs along the eastern property line. This swale eventually discharges to Detention Pond #4.

The post-development drainage areas and the critical flow paths from which the times of concentration and peak discharge rates were determined are shown on Figure 2. The peak 2, 10, and 25-year, 24-hour post-development flow off-site is reduced by the proposed stormwater management system to 17.34 cfs, and 27.84 cfs, and 39.07 cfs, respectively. The total volume of stormwater run-off will be slightly greater than the pre-development volume, but it will be released slowly from the detention ponds so that there is no negative impact on downgradient features and structures.

A summary of the pre- and post-development peak discharge flows for the different discharge areas is shown in Tables 1-3.

The calculations used to determine the post-development drainage area flows are shown in Appendix B.1. Swale configurations were determined from the estimated flows generated from each of the drainage areas. The maximum capacity, estimated flow depth, and velocities determined for the swale configurations are shown in Appendix B.2.

The following is a summary of the post-development drainage areas and their peak individual discharge rates for the 25-year (24-hour) storm:

Drainage Area A1: 4.41 cfs
Drainage ***Area A1*** is located on the northern portion of the landfill cap from the peak down to a drainage bench. Stormwater from this area sheet flows into the drainage bench and is directed into the northern downchute that discharges into Detention Pond #3.

Drainage Area A2: 8.82 cfs
Drainage ***Area A2*** is located on the northern portion of the landfill cap from the peak down to a drainage bench, opposite Area A1. Stormwater from this area sheet flows into the drainage bench and is directed into the northern downchute that discharges into Detention Pond #3.

Drainage Area A3: 5.94 cfs
Drainage ***Area A3*** encompasses the area north of area A1 that sheet flows into the drainage bench below Area A1's drainage bench. A3's drainage bench also flows into the northern downchute and then into Pond #3.

Drainage Area A4: 17.76 cfs
Drainage ***Area A4*** includes the area south of the peak and everywhere stormwater sheet flows into the drainage bench below Area A2. This drainage bench wraps all the way

around the landfill and discharges to the northern downchute. The downchute discharges into Pond #3.

Drainage Area A5: 5.94 cfs
Drainage ***Area A5*** is located below Area A4. Stormwater sheet flows into a drainage bench parallel to A4's and discharges into the northern downchute as well.

Drainage Area A6: 5.94 cfs
Drainage ***Area A6*** is located north of Area A3. Stormwater sheet flows into a drainage bench and discharges into the northern downchute and eventually Pond #3.

Drainage Area A7: 5.94 cfs
Drainage ***Area A8*** encompasses a portion of the cap on the northern tip of the landfill as well as a small area in the leachate loadout area and a length along the existing northern gravel access road that drains into an existing grass lined swale. Stormwater sheet flows off of the cap and into the existing grass lined swale that travels south into the existing culvert EC-2 and then into Pond #3.

Drainage Area A8: 5.94 cfs
Drainage ***Area A8*** is includes the area that drains directly into Detention Pond #3.

Drainage Area B1: 5.90 cfs
Drainage ***Area B1*** is located on the eastern side of the peak of the landfill cap. Stormwater from this area sheet flows into a drainage bench that runs north to the northeastern downchute. the northeastern downchute discharges to an existing swale at the toe that leads to the existing 36" culvert EC-4 and into Detention Pond 4.

Drainage Area B2, B4 and B5: 1.89 cfs, 2.17 cfs, 2.17 cfs respectively
Drainage ***Areas B2, B4, and B5*** all lie on the northern side of the northeastern downchute. Stormwater for the individual areas sheet flows to their respective drainage bench who all drain to the northeastern downchute which discharges the existing northeastern perimeter swale and into Pond #4.

Drainage Area B3: 7.03 cfs
Drainage ***Area B3*** is located on the eastern side of the landfill. Stormwater sheet flows into a drainage bench that drains into the northeastern dropchute.

Drainage Area B6: 3.02 cfs
Drainage ***Area B7*** is includes the area that drains directly into the northeastern perimeter swale. The sheet flow generated from B6 combines with the flow from Areas B1 through B5 (from the northeastern downchute) in the swale before discharging into Pond 4 via the existing culvert EC-4.

Drainage Area B7: 0.71 cfs
Drainage ***Area B7*** is a small area south of the leachate loadout area. The area drains to an existing culvert that discharges to Pond #4.

Drainage Area B8: 7.32 cfs
Drainage ***Area B7*** encompasses the area surrounding Detention Pond #4 in which stormwater flows directly into the pond via sheet flow.

Drainage Area C1: 21.62 cfs
Drainage ***Area C1*** includes the southern portion of the landfill cap as well as the proposed southern and western gravel access roads. Stormwater sheet flows into the southern perimeter swale that wraps around the southwestern corner of the landfill and discharges into Area C2 via proposed culvert C-1.

Drainage Area C2: .86 cfs
Drainage ***Area C2*** contains a small portion of the northwestern corner of the landfill cap as well as a small portion of the proposed western gravel access road. Stormwater sheet flows into a proposed swale on the inboard side of the access road where it combines with the flow from Area C1 before discharging into the existing western treatment swale via proposed culvert C-2. The flow in the western treatment swale discharges off site to the north.

Drainage Area C3: 19.48 cfs
Drainage ***Area C3*** encompasses the area that drains directly to the western treatment swale. Stormwater from C3 combines with stormwater from C1 and C2 in the swale before existing off site.

Drainage Area C4: 12.72 cfs
Drainage ***Area C4*** includes the area that drains directly into the partially constructed Detention Pond #5. The pond was never completely finished and an outlet structure was never installed except for a 20' wide weir. The pond is able to provide detention for all stormwater generated from Area C4. Stormwater sheet flows directly into Pond #5 and either infiltrates or evaporates for up to the 100-yr storm without reaching the elevation of the existing weir.

Drainage Area C5: 4.23 cfs
Drainage ***Area C5*** is located in the southwester corner of the landfill. It includes the area of the new gravel access roadway. Stormwater from this area sheet flows to the west off of site.

Drainage Area D1, D3, and D5: 10.37 cfs, 2.47 cfs, 1.55 cfs respectfully

Drainage ***Areas D1, D3 and D5*** are located on the eastern portion of the landfill cap. Stormwater sheet flows from these areas to the eastern perimeter swale that leads to a series of existing culverts that all discharge to the eastern swale that runs along the eastern property line. This swale discharges into Pond 4 via existing culvert EC-6.

Drainage Area D2: 2.67 cfs

Drainage ***Area D2*** includes the area along the eastern property line. Stormwater discharges to the eastern property line swale and discharges into Pond 4 via existing culvert EC-6.

Drainage Area D4:

Drainage ***Area D4*** includes the area along the eastern property line north of area D2. Stormwater discharges to the eastern property line swale where it combines with the flow from D2 and discharges into Pond 4 via existing culvert EC-6.

DETENTION POND ANALYSIS

Stormwater runoff hydrographs for the drainage areas were generated using Haestad Methods' urban hydrology and detention pond modeling software, Pond Pack®. Design runoff hydrographs were based on the 25-year, Type II, 24-hour storm and calculated using the SCS unit hydrograph method. The detention pond calculations and hydrographs are included in Appendix B.3. Calculations for the 2, 10, 50, and 100-year storm were also completed to estimate the pond and existing outlet structure performance. The detention pond analyses were completed with a starting water elevation equal to the lowest invert out elevation, and neglected any infiltration. The estimated performance of each of the ponds is therefore conservative.

Detention Pond #2 (To Be Eliminated)

The existing detention pond will be eliminated with the construction of the western earth berm and access roadway. Stormwater run-off from this area will flow into the swale to be constructed adjacent to the maintenance roadway and directed north until it exits the site.

Detention Pond #3

The existing detention pond will continue to receive flow from the northwestern portions of the landfill capping system (Drainage Area A). No change to the pond or outlet structure is required. The detention pond will reduce the 25-year/24-hour storm peak of 79.47 to 5.43 cfs and provide a 59.7 hour weighted average plug flow detention time on the 2-year storm flow to provide treatment for removal of sediment. Additional treatment is provided by the existing grass lined discharge swale downstream of the outlet until the flow ultimately leaves the site to the north. The outlet structure maintains over 1-foot of freeboard for the 100-year/24-hour storm and therefore an emergency spillway is not required or provided.

Detention Pond #4

The proposed reconstruction of the leachate loadout areas an access roadway will require the modification of the pond size. The pond was regraded during the completion of the Leachate Management Improvements Project in 2008. Flow from the central and eastern portions of the closed landfill, and the leachate loadout and landfill gas control system areas will discharge into this detention pond (Drainage Areas C and D). The detention pond will reduce the 25-year/24-hour storm peak flow of 44.29 cfs to 0.84 cfs, and provide a 28.6 hour weighted average plug flow detention time on the 2-year storm flow to provide treatment for removal of sediment. Additional treatment is provided by the existing vegetated buffer strip downgradient of the existing level spreader. The existing level spreader is approximately 35 feet long which can adequately handle the 25-year storm peak discharge of 0.84 cfs. The outlet structure maintains over 2-feet of freeboard for the 100-year/24-hour storm and therefore an emergency spillway is not required or provided. The detention pond grading includes an access roadway for maintenance of the pond and removal of accumulated sediment.

Detention Pond #5

This existing partially constructed detention pond will manage stormwater from Area C4 and that is all. No other stormwater is directed to the partially constructed pond. The pond was permitted under the previous site specific permit, but its construction was not completed. During the 100-year/24-hour storm the water level is more than a foot below the outlet weir which discharges to the western treatment swale before leaving the site. Stormwater which accumulates in the pond will most likely infiltrate or evaporate.

EROSION CONTROL DURING CONSTRUCTION

The proposed construction of the Stage IV – Phase II landfill will include the installation of temporary and permanent erosion control devices to provide stormwater treatment and erosion control until the site is fully stabilized. The erosion control devices include: silt fencing, hay bales, stone check dams, stone outlet protection, and erosion control matting. The proposed erosion control plan and notes and erosion control and stormwater details are included on Figure 5 in the permit drawings.

CONCLUSIONS

The peak stormwater run-off flow rate for the 25-year storm for the proposed conditions are decreased from the existing conditions due to the establishment of the stormwater runoff collection and management system. The total run-off generated on site will increase with clearing, excavation, and construction of the Stage IV-Phase II landfill, access roads and associated structures; however, the detention ponds and drainage system have been designed to detain as much excess run-off for a 2, 10, and 25 year storm event as possible. The proposed grading plan and stormwater collection system will reduce the 25 and 100-year post-development off-site stormwater runoff to below pre-development conditions with only a slight increase in the 2- and 10-year storm flow.

An analysis of the 100-year/24-hr storm event demonstrated that the proposed stormwater management system would be able to sufficiently accommodate surface water runoff. The detention ponds and outlet structures are sized to manage the 100-year/24-hour storm flow without the need of an emergency spillway. NHDES regulations require a spillway if the pond is not able to manage the 50-year/24-hour storm with 1-foot of freeboard remaining. The 100-year/24-hr storm event will not however cause flooding on the site or permanent damage to stormwater management system components.

The proposed drainage system and erosion control measures depicted on the Drawings and described herein will provide adequate erosion and sedimentation control during construction, operation and post-closure.

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PROJECT:	NCES
PROJECT NO:	656.05
DATE:	February 5, 2009
CALC. BY:	BWS/MAM
	JSM

TABLE 3 - PRE AND POST-DEVELOPMENT DRAINAGE AREA ANALYSIS COMPARISON

LANDFILL AREA - 25-Year, 24-Hour Storm

Discharge Location	Pre-Development Drainage Area		*Drainage Area*	Detention Pond	Post-Development Drainage Area					Comments
	Area	25-Year Peak Flow				Area	25-Year Peak Flow (Individual)	Peak Discharge Into Pond (cfs)	Peak Discharege Out of Pond (cfs)	Overall Site Discharge (cfs)
North	62.07	40.32	A	Pond 3	A1	1.41	4.41	79.47	5.43	Post development area consists of the vegetative cover on the capping system and the area around Detention Pond 3.
					A2	3.02	8.82			
					A3	1.67	5.94			
					A4	6.84	17.76			
					A5	6.15	18.94			
					A6	2.05	7.06			
					A7	3.06	8.74			
					A8	4.98	16.35			
					Subtotal	29.18				
			B	Pond 4	B1	2.29	5.90	44.29	0.84	Post development area consists of the vegetative cover on the capping system and the paved leachate loadout area. Flow enters Pond 4 via an existing 36" culvert that goes under the leachate loadout area.
					B2	0.53	1.89			
					B3	2.08	7.03			
					B4	0.61	2.17			
					B5	0.61	2.17			
					B6	1.07	3.02			
					B7	0.29	0.71			
					B8	2.55	7.32			
					Subtotal	10.03				
			D	Pond 4	D1	3.10	10.37			Post development area consists of the vegetative cover on the capping system, the western gravel access road and the natural vegetative area to the east of the landfill. Culverts on the inboard side of the gravel access road divert storwater to the large swale adjacent to the eastern property line that eventually discaharges to Pond 4 via an 18" culvert.
					D2	1.25	2.67			
					D3	0.70	2.47			
					D4	0.73	1.55			
					D5	0.52	1.85			
					Subtotal	6.30				
			C	Pond 5	C1	7.11	21.62	12.72	0.00	Post development area consists of the vegetative cover on the capping system and the southern and western earth berms and gravel access roads as well as the area surrounding the partially constructed Detention Pond 5. There is no proposed flow to be directed into Pond 5. Pond 5 will only accept flow that currently drains into it (Area C4).
					C2	0.22	0.86			
					C3	6.12	19.48			
					C4	2.16	12.72			
					C5	0.97	4.23			
					Subtotal	16.58				
Total	**62.07**	**40.32**			**Total**	**62.09**	**39.07**		**6.27**	Overall decrease due to improved surface conditions and detention ponds.

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TABLE 3 - PRE AND POST-DEVELOPMENT DRAINAGE AREA ANALYSIS COMPARISON

LANDFILL AREA - 2-Year, 24-Hour Storm

Discharge Location	Pre-Development Drainage Area		*Drainage Area*	Detention Pond	Post-Development Drainage Area					Comments
	Area	25-Year Peak Flow				Area	2-Year Peak Flow (Individual)	Peak Discharge Into Pond (cfs)	Peak Discharege Out of Pond (cfs)	Overall Site Discharge (cfs)
North	62.07	7.67	A	Pond 3	A1	1.41	2.01	38.15	0.42	Post development area consists of the vegetative cover on the capping system and the area around Detention Pond 3.
					A2	3.02	4.28			
					A3	1.67	2.92			
					A4	6.84	8.59			
					A5	6.15	9.06			
					A6	2.05	3.38			
					A7	3.06	3.96			
					A8	4.98	8.00			
					Subtotal	29.18				
			B	Pond 4	B1	2.29	2.85	20.48	0.41	Post development area consists of the vegetative cover on the capping system and the paved leachate loadout area. Flow enters Pond 4 via an existing 36" culvert that goes under the leachate loadout area.
					B2	0.53	0.92			
					B3	2.08	3.40			
					B4	0.61	1.07			
					B5	0.61	1.07			
					B6	1.07	1.28			
					B7	0.29	0.27			
					B8	2.55	3.40			
					Subtotal	10.03				
			D	Pond 4	D1	3.10	5.05			Post development area consists of the vegetative cover on the capping system, the western gravel access road and the natural vegetative area to the east of the landfill. Culverts on the inboard side of the gravel access road divert storwater to the large swale adjacent to the eastern property line that eventually discaharges to Pond 4 via an 18" culvert.
					D2	1.25	1.06			
					D3	0.70	1.19			
					D4	0.73	0.55			
					D5	0.52	0.91			
					Subtotal	6.30				
			C	Pond 5	C1	7.11	10.19	6.13	0.00	Post development area consists of the vegetative cover on the capping system and the southern and western earth berms and gravel access roads as well as the area surrounding the partially constructed Detention Pond 5. There is no proposed flow to be directed into Pond 5. Pond 5 will only accept flow that currently drains into it (Area C4).
					C2	0.22	0.45			
					C3	6.12	8.94			
					C4	2.16	6.13			
					C5	0.97	2.28			
					Subtotal	16.58				
Total	**62.07**	**7.67**			**Total**	**62.09**	**17.34**		**0.83**	

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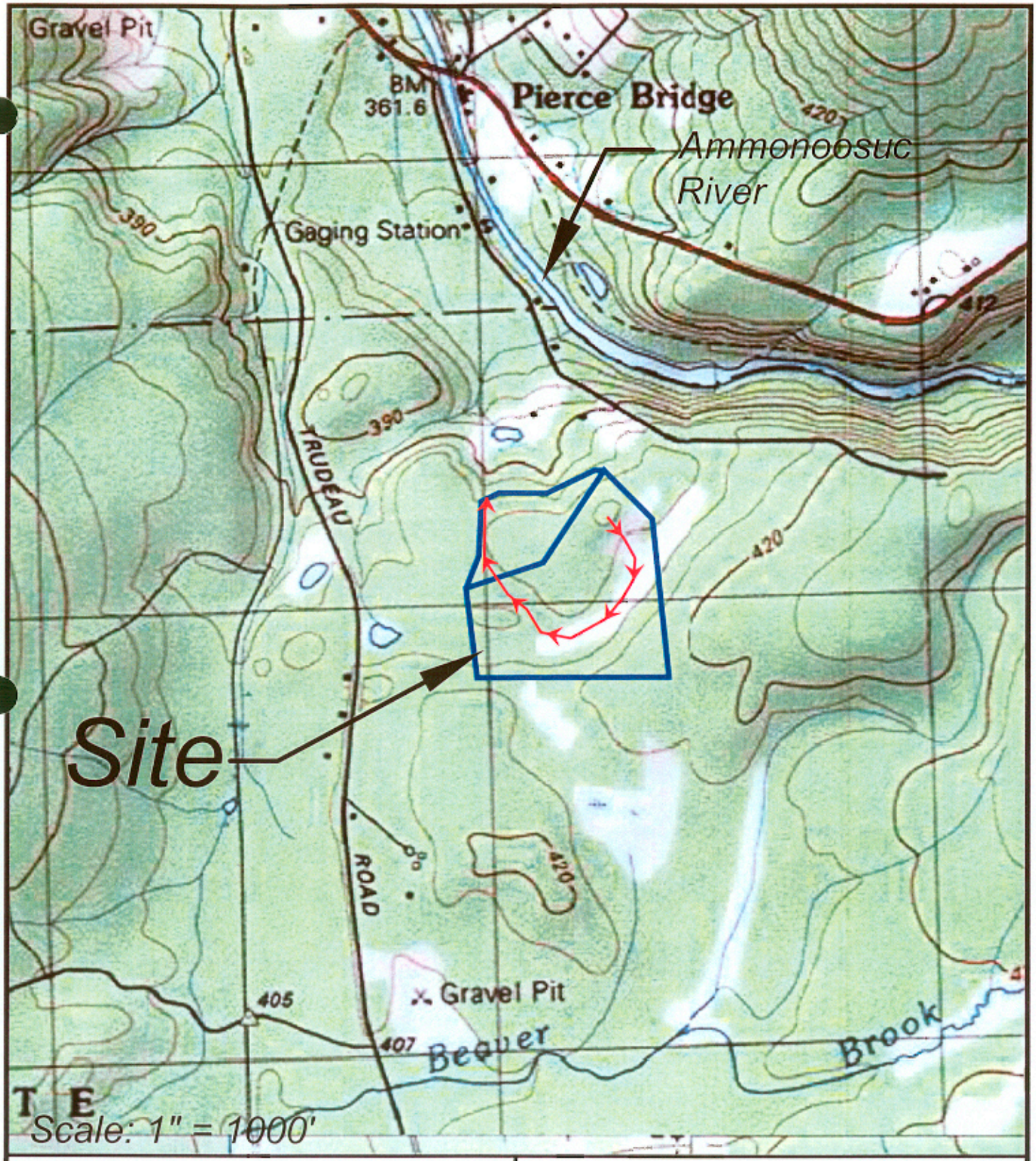
TABLE 3 - PRE AND POST-DEVELOPMENT DRAINAGE AREA ANALYSIS COMPARISON

LANDFILL AREA - 10-Year, 24-Hour Storm

Discharge Location	Pre-Development Drainage Area		*Drainage Area*	Detention Pond	Post-Development Drainage Area					Comments
	Area	25-Year Peak Flow				Area	10-Year Peak Flow (Individual)	Peak Discharge Into Pond (cfs)	Peak Discharege Out of Pond (cfs)	Overall Site Discharge (cfs)
North	62.07	21.41	A	Pond 3	A1	1.41	3.04	58.14	2.37	Post development area consists of the vegetative cover on the capping system and the area around Detention Pond 3.
					A2	3.02	6.48			
					A3	1.67	4.39			
					A4	6.84	13.03			
					A5	6.15	13.84			
					A6	2.05	5.16			
					A7	3.06	6.25			
					A8	4.98	12.05			
					Subtotal	29.18				
			B	Pond 4	B1	2.29	4.33	31.84	0.66	Post development area consists of the vegetative cover on the capping system and the paved leachate loadout area. Flow enters Pond 4 via an existing 36" culvert that goes under the leachate loadout area.
					B2	0.53	1.39			
					B3	2.08	5.13			
					B4	0.61	1.60			
					B5	0.61	1.60			
					B6	1.07	2.11			
					B7	0.29	0.48			
					B8	2.55	5.28			
					Subtotal	10.03				
			D	Pond 4	D1	3.10	7.56			Post development area consists of the vegetative cover on the capping system, the western gravel access road and the natural vegetative area to the east of the landfill. Culverts on the inboard side of the gravel access road divert storwater to the large swale adjacent to the eastern property line that eventually discaharges to Pond 4 via an 18" culvert.
					D2	1.25	1.82			
					D3	0.70	1.81			
					D4	0.73	1.00			
					D5	0.52	1.37			
					Subtotal	6.30				
			C	Pond 5	C1	7.11	15.71	9.29	0.00	Post development area consists of the vegetative cover on the capping system and the southern and western earth berms and gravel access roads as well as the area surrounding the partially constructed Detention Pond 5. There is no proposed flow to be directed into Pond 5. Pond 5 will only accept flow that currently drains into it (Area C4).
					C2	0.22	0.65			
					C3	6.12	14.01			
					C4	2.16	9.29			
					C5	0.97	3.22			
					Subtotal	16.58				
Total	**62.07**	**21.41**			**Total**	**62.09**	**27.84**		**3.03**	

APPENDIX A.1

PRE-DEVELOPMENT DRAINAGE ANALYSIS AND CALCULATIONS



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NCES Solid Waste Landfill
Bethlehem, NH

Pre Development Drainage

November 2007 Figure 1

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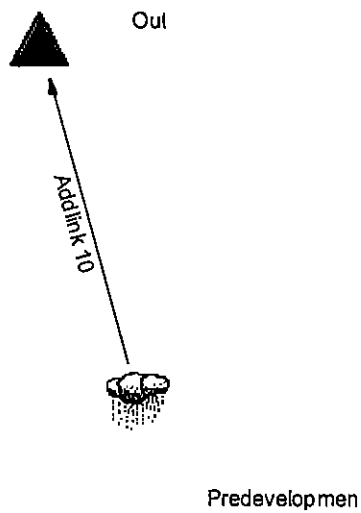
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Addlink 10
Predevelopmen

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Bethlehem, NH

Return Event	Total Depth in	Rainfall Type	RNF ID
2	3.0000	Synthetic Curve	TypeII 24hr
10	4.2000	Synthetic Curve	TypeII 24hr
25	5.0000	Synthetic Curve	TypeII 24hr
50	5.5000	Synthetic Curve	TypeII 24hr
100	6.0000	Synthetic Curve	TypeII 24hr

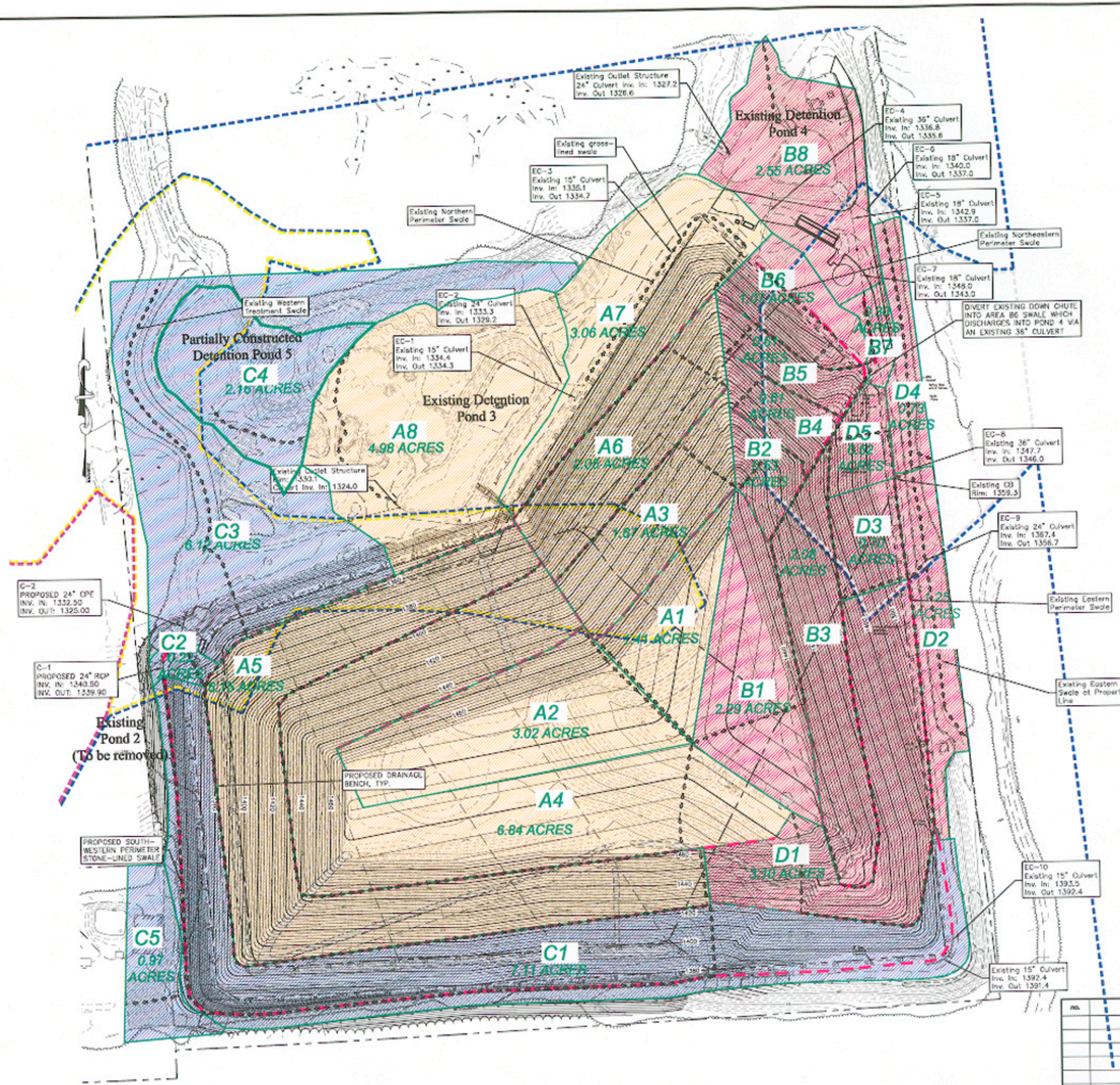
MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*OUT	JCT	2	1.007	--	12.8500	2.49		
*OUT	JCT	10	3.162		12.6000	13.68		
*OUT	JCT	25	5.066		12.6000	25.38		
*OUT	JCT	50	6.406		12.5500	33.92		
*OUT	JCT	100	7.846		12.5500	43.41		
PREDEVELOPMENT	AREA	2	1.007		12.8500	2.49		
PREDEVELOPMENT	AREA	10	3.162		12.6000	13.68		
PREDEVELOPMENT	AREA	25	5.066		12.6000	25.38		
PREDEVELOPMENT	AREA	50	6.406		12.5500	33.92		
PREDEVELOPMENT	AREA	100	7.846		12.5500	43.41		

APPENDIX B.1

POST-DEVELOPMENT DRAINAGE ANALYSIS AND CALCULATIONS



Legend:

- Existing 2' Contours
- Existing 10' Contour
- Existing Approximate Property Line
- Existing Tree Line
- Existing Guard Rail
- Existing Edge of Gravel
- Existing Retaining Wall
- Existing Limit of Wet
- Existing Drainage Bench/Downchute
- Proposed Drainage Bench/Downchute
- Proposed Drainage Area
- Proposed Drainage Path for Tc
- Proposed 2' Contours
- Proposed 10' Contours
- Type A Soil
- Type B Soil
- Type C Soil
- Not Rated Soil: Gravel Pit

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North Country
Environmental Services, Inc.
Bethlehem, NH

project:
Stage IV Phase II
Alteration of Terrain Application

title:
Post Development
Drainage Plan

(in feet)
1 inch = 100 ft

no.	revision	date	by

designed by: BWS/MAM	date: February 2009
drawn by: BWS/MAM	project no: 656.05
approved by: JSM/RJG	sheet no: Figure 2

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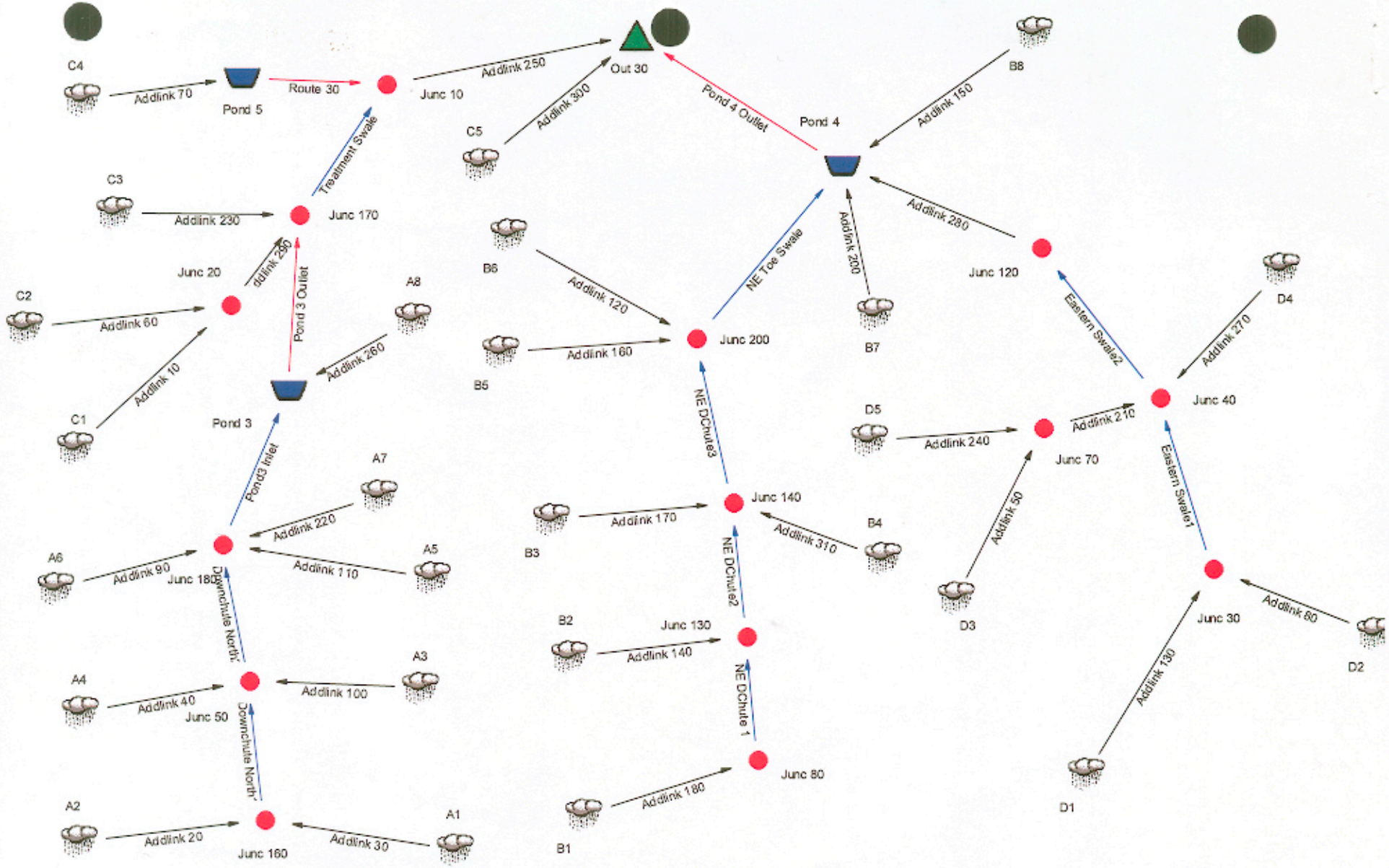

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Addlink 70
Pond 5
Route 30
Junc 10
Addlink 250
Out 30
Pond 4 Outlet
Pond 4
B8
Addlink 150
C5
Addlink 300
Treatment Swale
C3
Addlink 230
Junc 170
Addlink 280
Junc 120
Junc 20
Pond 3 Outlet
B6
Addlink 120
NE Toe Swale
Addlink 200
B7
D4
Eastern Swale2
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C2
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A8
Addlink 260
Junc 200
B5
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Addlink 10
C1
Pond 3
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D5
Addlink 240
Junc 70
Addlink 210
Junc 40
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A7
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Junc 140
B3
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Addlink 310
B4
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Eastern Swale1
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Junc 180
Addlink 110
A5
Downchute North
NE DChute2
D3
Junc 30
Addlink 80
D2
B2
Junc 130
Addlink 140
A3
A4
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Junc 50
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NE DChute 1
Addlink 130
Downchute North
Junc 80
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Addlink 20
Junc 160
Addlink 30
A1
Addlink 180
B1

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Bethlehem, NH... 2
Design Storms 2.02

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A6..... Tc Calcs 3.12
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B1..... Tc Calcs 3.18
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B6..... Tc Calcs 3.29
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C3..... Tc Calcs 3.39
C4..... Tc Calcs 3.42
C5..... Tc Calcs 3.44
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D2..... Tc Calcs 3.50
D3..... Tc Calcs 3.52
D4..... Tc Calcs 3.54
D5..... Tc Calcs 3.56

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A2..... Runoff CN-Area 4.02
A3..... Runoff CN-Area 4.03
A4..... Runoff CN-Area 4.04
A5..... Runoff CN-Area 4.05
A6..... Runoff CN-Area 4.06
A7..... Runoff CN-Area 4.07
A8..... Runoff CN-Area 4.08
B1..... Runoff CN-Area 4.09
B2..... Runoff CN-Area 4.10
B3..... Runoff CN-Area 4.11

B4..... Runoff CN-Area 4.12
B5..... Runoff CN-Area 4.13
B6..... Runoff CN-Area 4.14
B7..... Runoff CN-Area 4.15
B8..... Runoff CN-Area 4.16
C1..... Runoff CN-Area 4.17
C2..... Runoff CN-Area 4.18
C3..... Runoff CN-Area 4.19
C4..... Runoff CN-Area 4.20
C5..... Runoff CN-Area 4.21
D1..... Runoff CN-Area 4.22
D2..... Runoff CN-Area 4.23
D3..... Runoff CN-Area 4.24
D4..... Runoff CN-Area 4.25

```
D5............. Runoff CN-Area ..................... 4.26

********************** POND VOLUMES **********************

POND 3......... Vol: Elev-Area ..................... 5.01
POND 4......... Vol: Elev-Area ..................... 5.02
POND 5......... Vol: Elev-Area ..................... 5.03

******************* OUTLET STRUCTURES ********************

Pond 3 Outlet... Outlet Input Data ................. 6.01
Pond 4 Outlet... Outlet Input Data ................. 6.04
Pond 5 Outlet... Outlet Input Data ................. 6.08

********************** POND ROUTING **********************

POND 3       OUT 2
                 Detention Time ..................... 7.01
POND 4       OUT 2
                 Detention Time ..................... 7.02
```

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Bethlehem, NH

Return Event	Total Depth in	Rainfall Type	RNF ID
2	3.4000	Synthetic Curve	TypeII 24hr
10	4.2000	Synthetic Curve	TypeII 24hr
25	5.0000	Synthetic Curve	TypeII 24hr
100	6.0000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
A1	AREA	2	.138		12.0500	2.01		
A1	AREA	10	.205		12.0500	3.04		
A1	AREA	25	.278		12.0500	4.14		
A1	AREA	100	.374		12.0500	5.56		
A2	AREA	2	.295		12.0500	4.28		
A2	AREA	10	.439		12.0500	6.48		
A2	AREA	25	.595		12.0500	8.82		
A2	AREA	100	.801		12.0500	11.87		
A3	AREA	2	.163		11.9500	2.92		
A3	AREA	10	.243		11.9500	4.39		
A3	AREA	25	.329		11.9500	5.94		
A3	AREA	100	.443		11.9000	8.00		
A4	AREA	2	.668		12.1000	8.59		
A4	AREA	10	.994		12.1000	13.03		
A4	AREA	25	1.348		12.1000	17.76		
A4	AREA	100	1.815		12.0500	24.08		
A5	AREA	2	.600		12.0000	9.06		
A5	AREA	10	.894		12.0000	13.84		
A5	AREA	25	1.211		12.0000	18.94		
A5	AREA	100	1.632		12.0000	25.60		
A6	AREA	2	.200		11.9500	3.38		
A6	AREA	10	.298		11.9500	5.16		
A6	AREA	25	.404		11.9500	7.06		
A6	AREA	100	.544		11.9500	9.54		
A7	AREA	2	.242		12.0000	3.96		
A7	AREA	10	.374		12.0000	6.25		
A7	AREA	25	.519		11.9500	8.74		
A7	AREA	100	.715		11.9500	12.20		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
A8	AREA	2	.485		12.0000	8.00		
A8	AREA	10	.723		12.0000	12.05		
A8	AREA	25	.979		12.0000	16.35		
A8	AREA	100	1.319		12.0000	21.93		
B1	AREA	2	.224		12.1000	2.85		
B1	AREA	10	.333		12.1000	4.33		
B1	AREA	25	.451		12.1000	5.90		
B1	AREA	100	.608		12.0500	7.95		
B2	AREA	2	.052		11.9500	.92		
B2	AREA	10	.077		11.9500	1.39		
B2	AREA	25	.104		11.9500	1.89		
B2	AREA	100	.141		11.9500	2.54		
B3	AREA	2	.203		12.0000	3.40		
B3	AREA	10	.302		11.9500	5.13		
B3	AREA	25	.410		11.9500	7.03		
B3	AREA	100	.552		11.9500	9.51		
B4	AREA	2	.060		11.9500	1.07		
B4	AREA	10	.089		11.9500	1.60		
B4	AREA	25	.120		11.9500	2.17		
B4	AREA	100	.162		11.9000	2.92		
B5	AREA	2	.060		11.9500	1.07		
B5	AREA	10	.089		11.9500	1.60		
B5	AREA	25	.120		11.9500	2.17		
B5	AREA	100	.162		11.9000	2.92		
B6	AREA	2	.075		11.9500	1.28		
B6	AREA	10	.119		11.9500	2.11		
B6	AREA	25	.168		11.9500	3.02		
B6	AREA	100	.234		11.9500	4.22		
B7	AREA	2	.017		11.9500	.27		
B7	AREA	10	.028		11.9500	.48		
B7	AREA	25	.040		11.9500	.71		
B7	AREA	100	.057		11.9500	1.02		
B8	AREA	2	.225		12.0500	3.40		
B8	AREA	10	.342		12.0000	5.28		
B8	AREA	25	.469		12.0000	7.35		
B8	AREA	100	.639		12.0000	10.08		
C1	AREA	2	.659		12.0000	10.19		
C1	AREA	10	.991		12.0000	15.71		
C1	AREA	25	1.351		12.0000	21.62		
C1	AREA	100	1.830		12.0000	29.36		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
C2	AREA	2	.025		11.9500	.45		
C2	AREA	10	.036		11.9500	.65		
C2	AREA	25	.047		11.9000	.86		
C2	AREA	100	.063		11.9000	1.13		
C3	AREA	2	.509		11.9500	8.94		
C3	AREA	10	.780		11.9500	14.01		
C3	AREA	25	1.077		11.9500	19.48		
C3	AREA	100	1.476		11.9500	26.68		
C4	AREA	2	.365		12.0000	6.13		
C4	AREA	10	.544		11.9500	9.29		
C4	AREA	25	.737		11.9500	12.72		
C4	AREA	100	.993		11.9500	17.21		
C5	AREA	2	.126		11.9500	2.28		
C5	AREA	10	.178		11.9000	3.22		
C5	AREA	25	.234		11.9000	4.23		
C5	AREA	100	.306		11.9000	5.52		
D1	AREA	2	.303		12.0000	5.05		
D1	AREA	10	.451		11.9500	7.56		
D1	AREA	25	.611		11.9500	10.37		
D1	AREA	100	.823		11.9500	14.05		
D2	AREA	2	.077		12.0500	1.06		
D2	AREA	10	.125		12.0500	1.82		
D2	AREA	25	.179		12.0500	2.67		
D2	AREA	100	.252		12.0500	3.81		
D3	AREA	2	.068		11.9500	1.19		
D3	AREA	10	.102		11.9500	1.81		
D3	AREA	25	.138		11.9500	2.47		
D3	AREA	100	.186		11.9500	3.32		
D4	AREA	2	.035		12.0000	.55		
D4	AREA	10	.060		11.9500	1.00		
D4	AREA	25	.089		11.9500	1.55		
D4	AREA	100	.129		11.9500	2.31		
D5	AREA	2	.051		11.9500	.91		
D5	AREA	10	.076		11.9500	1.37		
D5	AREA	25	.102		11.9500	1.85		
D5	AREA	100	.138		11.9500	2.48		
JUNC 10	JCT	2	2.851		12.0500	15.76		
JUNC 10	JCT	10	4.766		12.0500	25.64		
JUNC 10	JCT	25	6.922		12.0500	36.18		
JUNC 10	JCT	100	9.787		12.0500	49.95		
JUNC 120	JCT	2	.534		12.0500	8.06		
JUNC 120	JCT	10	.813		12.0000	12.62		
JUNC 120	JCT	25	1.118		12.0000	17.62		
JUNC 120	JCT	100	1.528		12.0000	24.23		
JUNC 130	JCT	2	.275		12.0500	3.23		
JUNC 130	JCT	10	.410		12.0500	4.96		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
JUNC 130	JCT	25	.556		12.0500	6.81		
JUNC 130	JCT	100	.748		12.0500	9.24		
JUNC 140	JCT	2	.538		12.0000	7.10		
JUNC 140	JCT	10	.801		12.0000	10.82		
JUNC 140	JCT	25	1.085		12.0000	14.77		
JUNC 140	JCT	100	1.462		12.0000	19.94		
JUNC 160	JCT	2	.432		12.0500	6.29		
JUNC 160	JCT	10	.644		12.0500	9.52		
JUNC 160	JCT	25	.873		12.0500	12.96		
JUNC 160	JCT	100	1.176		12.0500	17.43		
JUNC 170	JCT	2	2.856		12.0000	19.11		
JUNC 170	JCT	10	4.773		12.0000	29.28		
JUNC 170	JCT	25	6.928		12.0000	40.26		
JUNC 170	JCT	100	9.794		11.9500	54.88		
JUNC 180	JCT	2	2.305		12.0500	31.37		
JUNC 180	JCT	10	3.447		12.0500	47.72		
JUNC 180	JCT	25	4.684		12.0500	65.15		
JUNC 180	JCT	100	6.325		12.0000	88.10		
JUNC 20	JCT	2	.684		12.0000	10.60		
JUNC 20	JCT	10	1.027		12.0000	16.29		
JUNC 20	JCT	25	1.398		12.0000	22.38		
JUNC 20	JCT	100	1.892		12.0000	30.34		
JUNC 200	JCT	2	.673		12.0000	9.08		
JUNC 200	JCT	10	1.008		12.0000	13.96		
JUNC 200	JCT	25	1.373		12.0000	19.19		
JUNC 200	JCT	100	1.858		12.0000	26.02		
JUNC 30	JCT	2	.380		12.0000	6.01		
JUNC 30	JCT	10	.575		12.0000	9.29		
JUNC 30	JCT	25	.789		12.0000	12.81		
JUNC 30	JCT	100	1.075		12.0000	17.43		
JUNC 40	JCT	2	.534		12.0000	8.37		
JUNC 40	JCT	10	.813		12.0000	13.06		
JUNC 40	JCT	25	1.118		12.0000	18.10		
JUNC 40	JCT	100	1.528		12.0000	24.73		
JUNC 50	JCT	2	1.263		12.0500	16.43		
JUNC 50	JCT	10	1.881		12.0500	25.05		
JUNC 50	JCT	25	2.549		12.0500	34.24		
JUNC 50	JCT	100	3.434		12.0500	46.25		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
JUNC 70	JCT	2	.119		11.9500	2.10		
JUNC 70	JCT	10	.177		11.9500	3.18		
JUNC 70	JCT	25	.240		11.9500	4.32		
JUNC 70	JCT	100	.324		11.9500	5.81		
JUNC 80	JCT	2	.224		12.1000	2.85		
JUNC 80	JCT	10	.333		12.1000	4.33		
JUNC 80	JCT	25	.451		12.1000	5.90		
JUNC 80	JCT	100	.608		12.0500	7.95		
*OUT 30	JCT	2	4.433		12.0500	17.34		
*OUT 30	JCT	10	7.106		12.0500	27.84		
*OUT 30	JCT	25	10.068		12.0500	39.07		
*OUT 30	JCT	100	13.991		12.0000	54.67		
POND 3 IN	POND	2	2.790		12.0500	38.15		
POND 3 IN	POND	10	4.169		12.0500	58.14		
POND 3 IN	POND	25	5.663		12.0500	79.47		
POND 3 IN	POND	100	7.644		12.0500	107.31		
POND 3 OUT	POND	2	1.663		23.9500	.42	1329.36	2.735
POND 3 OUT	POND	10	2.966		15.5000	2.37	1329.88	3.194
POND 3 OUT	POND	25	4.452		13.5000	5.43	1330.27	3.547
POND 3 OUT	POND	100	6.426		13.0500	9.23	1331.25	4.488
POND 4 IN	POND	2	1.449		12.0500	20.48		
POND 4 IN	POND	10	2.191		12.0000	31.84		
POND 4 IN	POND	25	3.000		12.0000	44.29		
POND 4 IN	POND	100	4.081		12.0000	60.70		
POND 4 OUT	POND	2	1.456		21.3500	.41	1329.85	1.309
POND 4 OUT	POND	10	2.161		19.5500	.66	1330.62	1.832
POND 4 OUT	POND	25	2.913		19.2500	.84	1331.50	2.451
POND 4 OUT	POND	100	3.897		19.4000	1.03	1332.66	3.325
POND 5 IN	POND	2	.365		12.0000	6.13		
POND 5 IN	POND	10	.544		11.9500	9.29		
POND 5 IN	POND	25	.737		11.9500	12.72		
POND 5 IN	POND	100	.993		11.9500	17.21		
POND 5 OUT	POND	2	.000		10.6500	.00	1322.37	.365
POND 5 OUT	POND	10	.000		9.7500	.00	1322.85	.544
POND 5 OUT	POND	25	.000		8.9000	.00	1323.31	.737
POND 5 OUT	POND	100	.000		8.0000	.00	1323.85	.993

File.... F:\SHARED\Old Storm Water Files\656\65605\
Title... Project Date: 10/12/2007
Project Engineer: CMA
Project Title: 656 Closure Grades071012
Project Comments:

DESIGN STORMS SUMMARY

Design Storm File,ID = Bethlehem, NH

Storm Tag Name = 2

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 2 yr
Total Rainfall Depth= 3.4000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 10

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 10 yr
Total Rainfall Depth= 4.2000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 25

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 25 yr
Total Rainfall Depth= 5.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 100

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 100 yr
Total Rainfall Depth= 6.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

DESIGN STORMS SUMMARY

Design Storm File,ID = Bethlehem, NH

Storm Tag Name = 2

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 2 yr
Total Rainfall Depth= 3.4000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 10

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 10 yr
Total Rainfall Depth= 4.2000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 25

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 25 yr
Total Rainfall Depth= 5.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 100

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 100 yr
Total Rainfall Depth= 6.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

```
Type.... Tc Calcs                                                Page 3.01
Name.... A1
File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .2400
 Hydraulic Length   150.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .050000 ft/ft

 Avg.Velocity          .19 ft/sec
                                          Segment #1 Time:     .2212 hrs
 ----------------------------------------------------------------------

 Segment #2:  Tc: TR-55 Shallow

 Hydraulic Length    87.00 ft
 Slope             .050000 ft/ft
 Unpaved

 Avg.Velocity         3.61 ft/sec
                                          Segment #2 Time:     .0067 hrs
 ----------------------------------------------------------------------

 Segment #3:  Tc: TR-55 Shallow

 Hydraulic Length    53.00 ft
 Slope             .333300 ft/ft
 Unpaved

 Avg.Velocity         9.31 ft/sec
                                          Segment #3 Time:     .0016 hrs
 ----------------------------------------------------------------------

                                                 ========================
                                                  Total Tc:     .2295 hrs
                                                 ========================


Type.... Tc Calcs                                                Page 3.02
Name.... A1
File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
 ----------------------------------------------------------------------
 Tc Equations used...
 ----------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %

 ==== SCS TR-55 Shallow Concentrated Flow ===============================

      Unpaved surface:
      V  = 16.1345 * (Sf**0.5)
      Paved surface:
      V  = 20.3282 * (Sf**0.5)
      Tc = (Lf / V) / (3600sec/hr)
      Where:  V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   150.00 ft
2yr, 24hr P        3.4000 in
Slope             .050000 ft/ft

Avg.Velocity          .19 ft/sec
                                        Segment #1 Time:     .2212 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Shallow

Hydraulic Length    91.00 ft
Slope             .050000 ft/ft
Unpaved

Avg.Velocity         3.61 ft/sec
                                        Segment #2 Time:     .0070 hrs
----------------------------------------------------------------------

Segment #3:  Tc: TR-55 Shallow

Hydraulic Length    89.00 ft
Slope             .333300 ft/ft
Unpaved

Avg.Velocity         9.31 ft/sec
                                        Segment #3 Time:     .0027 hrs
----------------------------------------------------------------------
                                                 =========================
                                                  Total Tc:     .2309 hrs
                                                 =========================
```


File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------
==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %

==== SCS TR-55 Shallow Concentrated Flow ===============================

     Unpaved surface:
     V  = 16.1345 * (Sf**0.5)
     Paved surface:
     V  = 20.3282 * (Sf**0.5)
     Tc = (Lf / V) / (3600sec/hr)
     Where:  V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .0240
Hydraulic Length   150.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft

Avg.Velocity         2.54 ft/sec
                                        Segment #1 Time:     .0164 hrs
-------------------------------------------------------------------------
Segment #2:  Tc: TR-55 Channel

Flow Area          3.9400 sq.ft
Wetted Perimeter     6.05 ft
Hydraulic Radius      .65 ft
Slope            1.800000 ft/ft
Mannings n          .0350
Hydraulic Length   387.00 ft

Avg.Velocity        42.91 ft/sec
                                        Segment #2 Time:     .0025 hrs
-------------------------------------------------------------------------

                                              ========================
                                               Total Tc:     .0189 hrs

                                               Calculated Tc < Min.Tc:
                                               Use Minimum Tc...
                                               Use Tc =      .0833 hrs
                                              ========================
```


File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
-------------------------------------------------------------------------
Tc Equations used...
-------------------------------------------------------------------------

==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %

==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n
     Tc = (Lf / V) / (3600sec/hr)
     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   150.00 ft
2yr, 24hr P        3.4000 in
Slope             .050000 ft/ft
Avg.Velocity          .19 ft/sec
                                        Segment #1 Time:     .2212 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Shallow

Hydraulic Length    73.00 ft
Slope             .050000 ft/ft
Unpaved
Avg.Velocity         3.61 ft/sec
                                        Segment #2 Time:     .0056 hrs
----------------------------------------------------------------------

Segment #3:  Tc: TR-55 Channel

Flow Area          3.9400 sq.ft
Wetted Perimeter     6.05 ft
Hydraulic Radius      .65 ft
Slope             .044000 ft/ft
Mannings n          .0350
Hydraulic Length  1817.00 ft
Avg.Velocity         6.71 ft/sec
                                        Segment #3 Time:     .0752 hrs
----------------------------------------------------------------------
                                                 ========================
                                                  Total Tc:     .3021 hrs
                                                 ========================
```


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```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------
==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %

==== SCS TR-55 Shallow Concentrated Flow ===============================

     Unpaved surface:
     V  = 16.1345 * (Sf**0.5)
     Paved surface:
     V  = 20.3282 * (Sf**0.5)
     Tc = (Lf / V) / (3600sec/hr)
     Where:  V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

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```
==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```


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TIME OF CONCENTRATION CALCULATOR
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----------------------------------------------------------------------

Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   116.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft

Avg.Velocity          .38 ft/sec

                                        Segment #1 Time:     .0843 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Channel

Flow Area          3.9400 sq.ft
Wetted Perimeter     6.05 ft
Hydraulic Radius      .65 ft
Slope             .032000 ft/ft
Mannings n          .0350
Hydraulic Length  2305.00 ft

Avg.Velocity         5.72 ft/sec

                                        Segment #2 Time:     .1119 hrs
----------------------------------------------------------------------

                                          ========================
                                           Total Tc:     .1962 hrs
                                          ========================
```

Type.... Tc Calcs
Name.... A5

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

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 ---------------------------------------------------------------------
 Tc Equations used...
 ---------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %
 ==== SCS Channel Flow ==================================================

      R  = Aq / Wp
      V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

      Tc = (Lf / V) / (3600sec/hr)

      Where:  R  = Hydraulic radius
              Aq = Flow area, sq.ft.
              Wp = Wetted perimeter, ft
              V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              n  = Mannings n
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```

Type.... Tc Calcs
Name.... A6

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

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 TIME OF CONCENTRATION CALCULATOR
 :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 Segment #1:  Tc: TR-55 Sheet

 Mannings n           .2400
 Hydraulic Length    150.00 ft
 2yr, 24hr P         3.4000 in
 Slope              .333300 ft/ft

 Avg.Velocity           .40 ft/sec

                                        Segment #1 Time:     .1036 hrs
 ---------------------------------------------------------------------

 Segment #2:  Tc: TR-55 Channel

 Flow Area           3.9400 sq.ft
 Wetted Perimeter      6.05 ft
 Hydraulic Radius       .65 ft
 Slope              .050000 ft/ft
 Mannings n           .0350
 Hydraulic Length    480.00 ft

 Avg.Velocity          7.15 ft/sec
                                        Segment #2 Time:     .0186 hrs
 ---------------------------------------------------------------------

                                       ========================
                                        Total Tc:     .1222 hrs
                                       ========================
```

```
 ---------------------------------------------------------------------
 Tc Equations used...
 ---------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %
 ==== SCS Channel Flow ==================================================

      R  = Aq / Wp
      V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

      Tc = (Lf / V) / (3600sec/hr)

      Where:  R  = Hydraulic radius
              Aq = Flow area, sq.ft.
              Wp = Wetted perimeter, ft
              V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              n  = Mannings n
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```



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 TIME OF CONCENTRATION CALCULATOR
 :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .2400
 Hydraulic Length   112.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .333300 ft/ft

 Avg.Velocity          .38 ft/sec
                                        Segment #1 Time:     .0820 hrs
 ---------------------------------------------------------------------

 Segment #2:  Tc: TR-55 Channel

 Flow Area         12.0000 sq.ft
 Wetted Perimeter    10.90 ft
 Hydraulic Radius     1.10 ft
 Slope             .012300 ft/ft
 Mannings n          .0600
 Hydraulic Length   545.00 ft

 Avg.Velocity         2.94 ft/sec
                                        Segment #2 Time:     .0516 hrs
 ---------------------------------------------------------------------

                                        ========================
                                         Total Tc:     .1335 hrs
                                        ========================
```

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---------------------------------------------------------------------
Tc Equations used...
---------------------------------------------------------------------
==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %
==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```


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TIME OF CONCENTRATION CALCULATOR
:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Segment #1:  Tc: TR-55 Sheet

Mannings n           .1500
Hydraulic Length   100.00 ft
2yr, 24hr P        3.4000 in
Slope             .053000 ft/ft

Avg.Velocity          .26 ft/sec

                                        Segment #1 Time:     .1073 hrs
---------------------------------------------------------------------

Segment #2:  Tc: TR-55 Shallow

Hydraulic Length   308.00 ft
Slope             .015600 ft/ft
Unpaved

Avg.Velocity         2.02 ft/sec

                                        Segment #2 Time:     .0425 hrs
---------------------------------------------------------------------

                                          ========================
                                           Total Tc:     .1497 hrs
                                          ========================
```

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 ---------------------------------------------------------------------
 Tc Equations used...
 ---------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %
 ==== SCS TR-55 Shallow Concentrated Flow ===============================

      Unpaved surface:
      V  = 16.1345 * (Sf**0.5)

      Paved surface:
      V  = 20.3282 * (Sf**0.5)

      Tc = (Lf / V) / (3600sec/hr)

      Where:  V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```


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 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
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 Segment #1:  Tc: TR-55 Sheet
 Mannings n          .2400
 Hydraulic Length   150.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .050000 ft/ft
 Avg.Velocity          .19 ft/sec
                                        Segment #1 Time:     .2212 hrs
 ---------------------------------------------------------------------
 Segment #2:  Tc: TR-55 Shallow
 Hydraulic Length    99.00 ft
 Slope             .050000 ft/ft
 Unpaved
 Avg.Velocity         3.61 ft/sec
                                        Segment #2 Time:     .0076 hrs
 ---------------------------------------------------------------------
 Segment #3:  Tc: TR-55 Channel
 Flow Area          3.9400 sq.ft
 Wetted Perimeter     6.05 ft
 Hydraulic Radius      .65 ft
 Slope             .012000 ft/ft
 Mannings n          .0350
 Hydraulic Length   970.00 ft
 Avg.Velocity         3.50 ft/sec
                                        Segment #3 Time:     .0769 hrs
 ---------------------------------------------------------------------

                                        ========================
                                         Total Tc:     .3057 hrs
                                        ========================
```

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 ---------------------------------------------------------------------------
 Tc Equations used...
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 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %


 ==== SCS TR-55 Shallow Concentrated Flow ===============================

      Unpaved surface:
      V  = 16.1345 * (Sf**0.5)

      Paved surface:
      V  = 20.3282 * (Sf**0.5)

      Tc = (Lf / V) / (3600sec/hr)

      Where:  V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```



```
 ==== SCS Channel Flow ==================================================

      R  = Aq / Wp
      V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

      Tc = (Lf / V) / (3600sec/hr)

      Where:  R  = Hydraulic radius
              Aq = Flow area, sq.ft.
              Wp = Wetted perimeter, ft
              V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              n  = Mannings n
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```

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::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
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Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   123.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft
Avg.Velocity          .39 ft/sec
                                        Segment #1 Time:     .0884 hrs
----------------------------------------------------------------------
Segment #2:  Tc: TR-55 Channel

Flow Area          3.9400 sq.ft
Wetted Perimeter     6.05 ft
Hydraulic Radius      .65 ft
Slope             .048000 ft/ft
Mannings n          .0350
Hydraulic Length   104.00 ft
Avg.Velocity         7.01 ft/sec
                                        Segment #2 Time:     .0041 hrs
----------------------------------------------------------------------

                                              ========================
                                               Total Tc:     .0925 hrs
                                              ========================
```


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----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------
==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %
==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

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TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   125.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft

Avg.Velocity          .39 ft/sec
                                        Segment #1 Time:     .0895 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Channel

Flow Area          3.9400 sq.ft
Wetted Perimeter     6.05 ft
Hydraulic Radius      .65 ft
Slope             .044000 ft/ft
Mannings n          .0350
Hydraulic Length   991.00 ft

Avg.Velocity         6.71 ft/sec
                                        Segment #2 Time:     .0410 hrs
----------------------------------------------------------------------
                                                 ==========================
                                                  Total Tc:     .1306 hrs
                                                 ==========================
```


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----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------

==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %

==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

Type.... Tc Calcs Page 3.25
Name.... B4

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::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length    95.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft

Avg.Velocity          .37 ft/sec
                                        Segment #1 Time:     .0719 hrs
-------------------------------------------------------------------------
Segment #2:  Tc: TR-55 Channel

Flow Area          3.9400 sq.ft
Wetted Perimeter     6.05 ft
Hydraulic Radius      .65 ft
Slope             .040000 ft/ft
Mannings n          .0350
Hydraulic Length   189.00 ft

Avg.Velocity         6.40 ft/sec
                                        Segment #2 Time:     .0082 hrs
-------------------------------------------------------------------------

                                              ========================
                                               Total Tc:     .0801 hrs

                                               Calculated Tc < Min.Tc:
                                               Use Minimum Tc...
                                               Use Tc =      .0833 hrs
                                              ========================
```


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```
-------------------------------------------------------------------------
Tc Equations used...
-------------------------------------------------------------------------
==== SCS TR-55 Sheet Flow ============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %
==== SCS Channel Flow ================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

```
Type.... Tc Calcs                                                  Page 3.27
Name.... B5

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 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .2400
 Hydraulic Length    85.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .333300 ft/ft
 Avg.Velocity          .36 ft/sec
                                          Segment #1 Time:     .0658 hrs
 ------------------------------------------------------------------------

 Segment #2:  Tc: TR-55 Channel

 Flow Area          3.9400 sq.ft
 Wetted Perimeter     6.05 ft
 Hydraulic Radius      .65 ft
 Slope             .023000 ft/ft
 Mannings n          .0350
 Hydraulic Length   263.00 ft
 Avg.Velocity         4.85 ft/sec
                                          Segment #2 Time:     .0151 hrs
 ------------------------------------------------------------------------

                                                ========================
                                                 Total Tc:     .0808 hrs

                                                 Calculated Tc < Min.Tc:
                                                 Use Minimum Tc...
                                                 Use Tc =      .0833 hrs
                                                ========================


Type.... Tc Calcs                                                  Page 3.28
Name.... B5

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

 ------------------------------------------------------------------------
 Tc Equations used...
 ------------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %

 ==== SCS Channel Flow ================================================
      R  = Aq / Wp
      V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

      Tc = (Lf / V) / (3600sec/hr)

      Where:  R  = Hydraulic radius
              Aq = Flow area, sq.ft.
              Wp = Wetted perimeter, ft
              V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              n  = Mannings n
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::


----------------------------------------------------------------------


Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length    71.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft

Avg.Velocity          .35 ft/sec

                                        Segment #1 Time:     .0569 hrs
----------------------------------------------------------------------

                                                 ========================
                                                  Total Tc:     .0569 hrs

                                                  Calculated Tc < Min.Tc:
                                                  Use Minimum Tc...
                                                  Use Tc =      .0833 hrs
                                                 ========================
```



```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------


==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %
```

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::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length    25.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft
Avg.Velocity          .28 ft/sec
                                        Segment #1 Time:     .0247 hrs
----------------------------------------------------------------------
Segment #2:  Tc: TR-55 Channel

Flow Area         31.2500 sq.ft
Wetted Perimeter    20.80 ft
Hydraulic Radius     1.50 ft
Slope             .200000 ft/ft
Mannings n          .0350
Hydraulic Length   136.00 ft
Avg.Velocity        24.97 ft/sec
                                        Segment #2 Time:     .0015 hrs
----------------------------------------------------------------------

                                        ========================
                                         Total Tc:     .0262 hrs

                                         Calculated Tc < Min.Tc:
                                         Use Minimum Tc...
                                         Use Tc =      .0833 hrs
                                        ========================
```


File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------

==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %

==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   100.00 ft
2yr, 24hr P        3.4000 in
Slope             .034000 ft/ft

Avg.Velocity          .15 ft/sec
                                        Segment #1 Time:     .1866 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Shallow

Hydraulic Length    79.00 ft
Slope             .034000 ft/ft
Unpaved

Avg.Velocity         2.98 ft/sec
                                        Segment #2 Time:     .0074 hrs
----------------------------------------------------------------------
                                                 =========================
                                                  Total Tc:     .1940 hrs
                                                 =========================
```



```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------


==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %


==== SCS TR-55 Shallow Concentrated Flow ===============================

     Unpaved surface:
     V  = 16.1345 * (Sf**0.5)

     Paved surface:
     V  = 20.3282 * (Sf**0.5)

     Tc = (Lf / V) / (3600sec/hr)

     Where:  V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

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::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   146.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft

Avg.Velocity          .40 ft/sec
                                        Segment #1 Time:     .1014 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Channel

Flow Area         12.0000 sq.ft
Wetted Perimeter    10.90 ft
Hydraulic Radius     1.10 ft
Slope             .018000 ft/ft
Mannings n          .0350
Hydraulic Length  1774.00 ft

Avg.Velocity         6.09 ft/sec
                                        Segment #2 Time:     .0809 hrs
----------------------------------------------------------------------

                                        =========================
                                         Total Tc:     .1823 hrs
                                        =========================
```


File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------

==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %

==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

```
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .2400
 Hydraulic Length   115.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .333300 ft/ft

 Avg.Velocity          .38 ft/sec

                                         Segment #1 Time:     .0837 hrs
 ----------------------------------------------------------------------

                                                 ========================
                                                  Total Tc:     .0837 hrs
                                                 ========================
```



```
 ----------------------------------------------------------------------
 Tc Equations used...
 ----------------------------------------------------------------------


 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %
```

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n .2400
Hydraulic Length 50.00 ft
2yr, 24hr P 3.4000 in
Slope .333300 ft/ft

Avg.Velocity .32 ft/sec

Segment #1 Time: .0430 hrs

Segment #2: Tc: TR-55 Sheet

Mannings n .2400
Hydraulic Length 37.00 ft
2yr, 24hr P 3.4000 in
Slope .500000 ft/ft

Avg.Velocity .36 ft/sec

Segment #2 Time: .0287 hrs

Segment #3: Tc: TR-55 Sheet

Mannings n .0110
Hydraulic Length 13.00 ft
2yr, 24hr P 3.4000 in
Slope .030000 ft/ft

Avg.Velocity 1.11 ft/sec

Segment #3 Time: .0033 hrs

Segment #4: Tc: TR-55 Shallow

Hydraulic Length 111.00 ft
Slope .030000 ft/ft
Unpaved

Avg.Velocity 2.79 ft/sec

Segment #4 Time: .0110 hrs

==========
Total Tc: .0860 hrs
==========

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
 ---------------------------------------------------------------------------
 Tc Equations used...
 ---------------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %


 ==== SCS TR-55 Shallow Concentrated Flow ===============================

      Unpaved surface:
      V  = 16.1345 * (Sf**0.5)

      Paved surface:
      V  = 20.3282 * (Sf**0.5)

      Tc = (Lf / V) / (3600sec/hr)

      Where:  V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```


File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .1500
 Hydraulic Length   100.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .040000 ft/ft

 Avg.Velocity          .23 ft/sec

                                         Segment #1 Time:     .1201 hrs
 ---------------------------------------------------------------------------

 Segment #2:  Tc: TR-55 Shallow

 Hydraulic Length   121.00 ft
 Slope             .060000 ft/ft
 Unpaved

 Avg.Velocity         3.95 ft/sec

                                         Segment #2 Time:     .0085 hrs
 ---------------------------------------------------------------------------

                                                  ========================
                                                   Total Tc:     .1286 hrs
                                                  ========================
```

```
 ---------------------------------------------------------------------
 Tc Equations used...
 ---------------------------------------------------------------------


 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %


 ==== SCS TR-55 Shallow Concentrated Flow ===============================

      Unpaved surface:
      V  = 16.1345 * (Sf**0.5)

      Paved surface:
      V  = 20.3282 * (Sf**0.5)

      Tc = (Lf / V) / (3600sec/hr)

      Where:  V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```



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 :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::


 ---------------------------------------------------------------------


 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .0110
 Hydraulic Length   112.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .020000 ft/ft

 Avg.Velocity         1.45 ft/sec

                                        Segment #1 Time:     .0215 hrs
 ---------------------------------------------------------------------

                                                 ========================
                                                  Total Tc:     .0215 hrs

                                                  Calculated Tc < Min.Tc:
                                                  Use Minimum Tc...
                                                  Use Tc =      .0833 hrs
                                                 ========================
```

```
 ---------------------------------------------------------------------
 Tc Equations used...
 ---------------------------------------------------------------------


 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %
```



```
 :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::


 ---------------------------------------------------------------------


 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .2400
 Hydraulic Length   150.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .333300 ft/ft

 Avg.Velocity          .40 ft/sec

                                         Segment #1 Time:     .1036 hrs
 ---------------------------------------------------------------------

 Segment #2:  Tc: TR-55 Shallow

 Hydraulic Length    60.00 ft
 Slope             .333300 ft/ft
 Unpaved

 Avg.Velocity         9.31 ft/sec

                                         Segment #2 Time:     .0018 hrs
 ---------------------------------------------------------------------

 Segment #3:  Tc: TR-55 Channel

 Flow Area          3.9400 sq.ft
 Wetted Perimeter     6.05 ft
 Hydraulic Radius      .65 ft
 Slope             .050000 ft/ft
 Mannings n          .0350
 Hydraulic Length   453.00 ft

 Avg.Velocity         7.15 ft/sec

                                         Segment #3 Time:     .0176 hrs
 ---------------------------------------------------------------------
```

```
Type.... Tc Calcs                                                  Page 3.47
Name.... D1
File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
 Segment #4:  Tc: TR-55 Channel
 Flow Area          12.0000 sq.ft
 Wetted Perimeter     10.90 ft
 Hydraulic Radius      1.10 ft
 Slope              .059000 ft/ft
 Mannings n           .0350
 Hydraulic Length    502.00 ft

 Avg.Velocity         11.03 ft/sec

                                          Segment #4 Time:     .0126 hrs
 ------------------------------------------------------------------------

                                                ========================
                                                 Total Tc:     .1356 hrs
                                                ========================


Type.... Tc Calcs                                                  Page 3.48
Name.... D1

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

 ------------------------------------------------------------------------
 Tc Equations used...
 ------------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %


 ==== SCS TR-55 Shallow Concentrated Flow ==============================

      Unpaved surface:
      V  = 16.1345 * (Sf**0.5)
      Paved surface:
      V  = 20.3282 * (Sf**0.5)
      Tc = (Lf / V) / (3600sec/hr)
      Where:  V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              Tc = Time of concentration, hrs
              Lf = Flow length, ft


Type.... Tc Calcs                                                  Page 3.49
Name.... D1

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
 ==== SCS Channel Flow ================================================
      R  = Aq / Wp
      V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

      Tc = (Lf / V) / (3600sec/hr)
      Where:  R  = Hydraulic radius
              Aq = Flow area, sq.ft.
              Wp = Wetted perimeter, ft
              V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              n  = Mannings n
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length    73.00 ft
2yr, 24hr P        3.4000 in
Slope             .013330 ft/ft

Avg.Velocity          .10 ft/sec
                                        Segment #1 Time:     .2110 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Channel

Flow Area         40.0000 sq.ft
Wetted Perimeter    21.54 ft
Hydraulic Radius     1.86 ft
Slope             .065000 ft/ft
Mannings n          .0220
Hydraulic Length   307.00 ft

Avg.Velocity        26.09 ft/sec
                                        Segment #2 Time:     .0033 hrs
----------------------------------------------------------------------

                                          =========================
                                           Total Tc:     .2143 hrs
                                          =========================
```


File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------

==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %

==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n
     Tc = (Lf / V) / (3600sec/hr)
     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
Segment #1:  Tc: TR-55 Sheet

Mannings n          .2400
Hydraulic Length   148.00 ft
2yr, 24hr P        3.4000 in
Slope             .333300 ft/ft

Avg.Velocity          .40 ft/sec

                                        Segment #1 Time:     .1025 hrs
----------------------------------------------------------------------
Segment #2:  Tc: TR-55 Channel

Flow Area         12.0000 sq.ft
Wetted Perimeter    10.90 ft
Hydraulic Radius     1.10 ft
Slope             .048000 ft/ft
Mannings n          .0350
Hydraulic Length   209.00 ft

Avg.Velocity         9.94 ft/sec
                                        Segment #2 Time:     .0058 hrs
----------------------------------------------------------------------

                                          =========================
                                           Total Tc:     .1083 hrs
                                          =========================
```



```
----------------------------------------------------------------------
Tc Equations used...
----------------------------------------------------------------------
==== SCS TR-55 Sheet Flow ==============================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %


==== SCS Channel Flow ==================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

```
Type.... Tc Calcs                                                Page 3.54
Name.... D4

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .2400
 Hydraulic Length    45.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .200000 ft/ft
 Avg.Velocity          .26 ft/sec
                                          Segment #1 Time:     .0485 hrs
 ---------------------------------------------------------------------
                                                 ========================
                                                  Total Tc:     .0485 hrs

                                                  Calculated Tc < Min.Tc:
                                                  Use Minimum Tc...
                                                  Use Tc =      .0833 hrs
                                                 ========================


Type.... Tc Calcs                                                Page 3.55
Name.... D4
File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
 ---------------------------------------------------------------------
 Tc Equations used...
 ---------------------------------------------------------------------
 ==== SCS TR-55 Sheet Flow ==============================================

      Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))
      Where:  Tc = Time of concentration, hrs
              n  = Mannings n
              Lf = Flow length, ft
              P  = 2yr, 24hr Rain depth, inches
              Sf = Slope, %


Type.... Tc Calcs                                                Page 3.56
Name.... D5
File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 TIME OF CONCENTRATION CALCULATOR
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 Segment #1:  Tc: TR-55 Sheet

 Mannings n          .2400
 Hydraulic Length   114.00 ft
 2yr, 24hr P        3.4000 in
 Slope             .333300 ft/ft

 Avg.Velocity          .38 ft/sec
                                          Segment #1 Time:     .0832 hrs
 ---------------------------------------------------------------------
 Segment #2:  Tc: TR-55 Channel
 Flow Area         12.0000 sq.ft
 Wetted Perimeter    10.90 ft
 Hydraulic Radius     1.10 ft
 Slope             .044000 ft/ft
 Mannings n          .0350
 Hydraulic Length    90.00 ft
 Avg.Velocity         9.52 ft/sec
                                          Segment #2 Time:     .0026 hrs
 ---------------------------------------------------------------------

                                                 ========================
                                                  Total Tc:     .0858 hrs
                                                 ========================
```

Type.... Tc Calcs
Name.... D5

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow ==========

```
Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

Where:  Tc = Time of concentration, hrs
        n  = Mannings n
        Lf = Flow length, ft
        P  = 2yr, 24hr Rain depth, inches
        Sf = Slope, %
```

==== SCS Channel Flow ==========

```
R  = Aq / Wp
V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

Tc = (Lf / V) / (3600sec/hr)

Where:  R  = Hydraulic radius
        Aq = Flow area, sq.ft.
        Wp = Wetted perimeter, ft
        V  = Velocity, ft/sec
        Sf = Slope, ft/ft
        n  = Mannings n
        Tc = Time of concentration, hrs
        Lf = Flow length, ft
```

Type.... Runoff CN-Area
Name.... A1

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	1.410			74.00
COMPOSITE AREA & WEIGHTED CN --->		1.410			74.00 (74)

::

Type.... Runoff CN-Area
Name.... A2

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	3.020			74.00
COMPOSITE AREA & WEIGHTED CN --->		3.020			74.00 (74)

Type.... Runoff CN-Area
Name.... A3

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	1.670			74.00
COMPOSITE AREA & WEIGHTED CN --->		1.670			74.00 (74)

Type.... Runoff CN-Area
Name.... A4

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	6.840			74.00
COMPOSITE AREA & WEIGHTED CN --->		6.840			74.00 (74)

Type.... Runoff CN-Area Page 4.05
Name.... A5

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	6.150			74.00

COMPOSITE AREA & WEIGHTED CN ---> 6.150 74.00 (74)
::

Type.... Runoff CN-Area Page 4.06
Name.... A6

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	2.050			74.00

COMPOSITE AREA & WEIGHTED CN ---> 2.050 74.00 (74)
::

Type.... Runoff CN-Area Page 4.07
Name.... A7

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	1.140			74.00
Open space (Lawns,parks etc.) - Goo	61	1.370			61.00
Impervious Areas - Gravel (w/ right	85	.480			85.00
Impervious Areas - Paved parking lo	98	.070			98.00

COMPOSITE AREA & WEIGHTED CN ---> 3.060 70.45 (70)
::

Name.... A8

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	2.300			61.00
Impervious Areas - Gravel (w/ right	85	.490			85.00
Newly graded area (pervious only -	86	1.840			86.00
Open space (Lawns,parks etc.) - Goo	74	.230			74.00
Impervious Areas - Gravel (w/ right	89	.110			89.00
COMPOSITE AREA & WEIGHTED CN --->		4.970			73.84 (74)

Name.... B1

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	2.290			74.00
COMPOSITE AREA & WEIGHTED CN --->		2.290			74.00 (74)

Name.... B2

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	.530			74.00
COMPOSITE AREA & WEIGHTED CN --->		.530			74.00 (74)

Type.... Runoff CN-Area
Name.... B3

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	2.080			74.00

COMPOSITE AREA & WEIGHTED CN ---> 2.080 74.00 (74)
::

Type.... Runoff CN-Area
Name.... B4

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	.610			74.00

COMPOSITE AREA & WEIGHTED CN ---> .610 74.00 (74)
::

Type.... Runoff CN-Area
Name.... B5

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	.610			74.00

COMPOSITE AREA & WEIGHTED CN ---> .610 74.00 (74)
::

Type.... Runoff CN-Area
Name.... B6

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	.540			74.00
Open space (Lawns,parks etc.) - Goo	61	.500			61.00
Impervious Areas - Gravel (w/ right	85	.030			85.00
COMPOSITE AREA & WEIGHTED CN --->		1.070			68.23 (68)

Type.... Runoff CN-Area
Name.... B7

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	.240			61.00
Impervious Areas - Gravel (w/ right	85	.050			85.00
COMPOSITE AREA & WEIGHTED CN --->		.290			65.14 (65)

Type.... Runoff CN-Area
Name.... B8

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	1.660			61.00
Open space (Lawns,parks etc.) - Poo	79	.320			79.00
Impervious Areas - Paved parking lo	98	.580			98.00
COMPOSITE AREA & WEIGHTED CN --->		2.560			71.63 (72)

Type.... Runoff CN-Area
Name.... C1

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	4.620			74.00
Open space (Lawns,parks etc.) - Goo	61	1.450			61.00
Impervious Areas - Gravel (w/ right	85	1.040			85.00

COMPOSITE AREA & WEIGHTED CN ---> 7.110 72.96 (73)
::

Type.... Runoff CN-Area
Name.... C2

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	.150			74.00
Impervious Areas - Gravel (w/ right	89	.060			89.00

COMPOSITE AREA & WEIGHTED CN ---> .210 78.29 (78)
::

Type.... Runoff CN-Area
Name.... C3

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	.460			61.00
Open space (Lawns,parks etc.) - Goo	74	2.060			74.00
Impervious Areas - Gravel (w/ right	89	.080			89.00
Woods - good	70	3.510			70.00

COMPOSITE AREA & WEIGHTED CN ---> 6.110 70.92 (71)
::

Type.... Runoff CN-Area Page 4.20
Name.... C4

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	.690			61.00
Open space (Lawns,parks etc.) - Goo	74	2.170			74.00
Impervious Areas - Gravel (w/ right	85	.090			85.00
Newly graded area (pervious only -	86	.730			86.00
Impervious Areas - Gravel (w/ right	89	.060			89.00
COMPOSITE AREA & WEIGHTED CN --->		3.740			74.45 (74)

Type.... Runoff CN-Area Page 4.21
Name.... C5

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Fai	69	.370			69.00
Impervious Areas - Gravel (w/ right	85	.500			85.00
Impervious Areas - Paved parking lo	98	.100			98.00
COMPOSITE AREA & WEIGHTED CN --->		.970			80.24 (80)

Type.... Runoff CN-Area Page 4.22
Name.... D1

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	3.100			74.00
COMPOSITE AREA & WEIGHTED CN --->		3.100			74.00 (74)

Type.... Runoff CN-Area
Name.... D2

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	.850			61.00
Impervious Areas - Gravel (w/ right	85	.290			85.00
Woods - good	55	.100			55.00
COMPOSITE AREA & WEIGHTED CN --->		1.240			66.13 (66)

Type.... Runoff CN-Area
Name.... D3

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	.700			74.00
COMPOSITE AREA & WEIGHTED CN --->		.700			74.00 (74)

Type.... Runoff CN-Area
Name.... D4

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	.490			61.00
Impervious Areas - Gravel (w/ right	85	.070			85.00
Woods - good	55	.180			55.00
COMPOSITE AREA & WEIGHTED CN --->		.740			61.81 (62)

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

RUNOFF CURVE NUMBER DATA
::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	74	.520			74.00
COMPOSITE AREA & WEIGHTED CN --->		.520			74.00 (74)

::

APPENDIX B.2

POST-DEVELOPMENT SWALE, DRAINAGE BENCH, AND CULVERT CALCULATIONS

CMA ENGINEERS, Inc.	PROJECT:	NCES
Civil/Environmental Engineers		
35 Bow Street	FILE:	656.05
Portsmouth, NH 03801	DATE:	February 5, 2009
Phone: (603) 431-6196	CALC. BY:	BWS/MAM
Fax: (603) 431-5376	CHECKED BY:	JSM

POST DEVELOPMENT SWALE CALCULATIONS

Proposed Southwestern Perimeter Roadway Swale - Inboard

Flow from Junction 20

Q100 = 30.34 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	2	FT
Base width (B)	2	FT
Maximum swale elevation	1398	FT
Minimum swale elevation	1334	FT
Swale length	2583	FT

Top width
T = B+d(Z+Y)
T = 10.00 FT

Area
A = 1/2d(2B+d(Z+Y))
A = 12 SF

Wetted perimeter
Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)
Wp = 10.94 FT

Hydraulic radius
Rh = A/Wp
Rh = 1.10 FT

Slope (S) 0.025
Mannings (n) 0.035 riprap

Flow capacity
Q = (1.49/n)*A*Rh^2/3*S^1/2
Q = 85.28 CFS

Velocity
V = Q/A
V = 7.11 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A'*Rh'^2/3	4.540	
	2.785	
Depth	0.98	ft
Area	1.53	sf
Velocity	19.81	fps
WP/Rh	26.61	
Median d	3.46	

Existing Northern Perimeter Swale

Flow from A7

Q100 = 12.20 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	2	FT
Base width (B)	2	FT
Maximum swale elevation	1340	FT
Minimum swale elevation	1336	FT
Swale length	545	FT

Top width
T = B+d(Z+Y)
T = 10.00 FT

Area
A = 1/2d(2B+d(Z+Y))
A = 12 SF

Wetted perimeter
Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)
Wp = 10.94 FT

Hydraulic radius
Rh = A/Wp
Rh = 1.10 FT

Slope (S) 0.007
Mannings (n) 0.060 Grass

Flow capacity
Q = (1.49/n)*A*Rh^2/3*S^1/2
Q = 27.07 CFS

Velocity
V = Q/A
V = 2.26 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A'*Rh'^2/3	5.750	
	2.671	
Depth	0.96	ft
Area	1.53	sf
Velocity	7.97	fps
WP/Rh	25.87	
Median d	0.85	

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Existing Northeastern Perimeter Swale
From Junction 200

Q100 = 26.02 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	2	FT
Base width (B)	2	FT
Maximum swale elevation	1348	FT
Minimum swale elevation	1340	FT
Swale length	230	FT

Top width
T = B+d(Z+Y)
T = 10.00 FT

Area
A = 1/2d(2B+d(Z+Y))
A = 12 SF

Wetted perimeter
Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)
Wp = 10.94 FT

Hydraulic radius
Rh = A/Wp
Rh = 1.10 FT

Slope (S) 0.035
Mannings (n) 0.060 Grass

Flow capacity
Q = (1.49/n)*A*Rh^2/3*S^1/2
Q = 58.94 CFS

Velocity
V = Q/A
V = 4.91 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A*Rh^2/3	5.633	
	0.431	
Depth	0.37	ft
Area	1.53	sf
Velocity	16.99	fps
WP/Rh	8.72	
Median d	6.82	

Existing Eastern Perimeter Swale
From D1

Q100 = 14.05 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	2	FT
Base width (B)	2	FT
Maximum swale elevation	1398	FT
Minimum swale elevation	1368	FT
Swale length	502	FT

Top width
T = B+d(Z+Y)
T = 10.00 FT

Area
A = 1/2d(2B+d(Z+Y))
A = 12 SF

Wetted perimeter
Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)
Wp = 10.94 FT

Hydraulic radius
Rh = A/Wp
Rh = 1.10 FT

Slope (S) 0.060
Mannings (n) 0.035 riprap

Flow capacity
Q = (1.49/n)*A*Rh^2/3*S^1/2
Q = 132.44 CFS

Velocity
V = Q/A
V = 11.04 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A*Rh^2/3	1.354	
	2.843	
Depth	0.99	ft
Area	1.53	sf
Velocity	9.18	fps
WP/Rh	26.98	
Median d	5.42	

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Existing Eastern Swale at Property Line
From Junction 40

Q100 = 24.73 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	6	FT
Base width (B)	3	FT
Maximum swale elevation	1376	FT
Minimum swale elevation	1340	FT
Swale length	1009	FT

Top width
T = B+d(Z+Y)
T = 27.00 FT

Area
A = 1/2d(2B+d(Z+Y))
A = 90 SF

Wetted perimeter
Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)
Wp = 29.83 FT

Hydraulic radius
Rh = A/Wp
Rh = 3.02 FT

Slope (S) 0.036
Mannings (n) 0.022 Short Grass/Gravel

Flow capacity
Q = (1.49/n)*A*Rh^2/3*S^1/2
Q = 2397.41 CFS

Velocity
V = Q/A
V = 26.64 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A'*Rh'^2/3	1.938	
	3.058	
Depth	0.89	ft
Area	1.53	sf
Velocity	16.15	fps
WP/Rh	31.82	
Median d	4.07	

Existing Western Treatment Swale
From Junction 170

Q100 = 54.88 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	2	FT
Base width (B)	10	FT
Maximum swale elevation	1324	FT
Minimum swale elevation	1318	FT
Swale length	771	FT

Top width
T = B+d(Z+Y)
T = 18.00 FT

Area
A = 1/2d(2B+d(Z+Y))
A = 28 SF

Wetted perimeter
Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)
Wp = 18.94 FT

Hydraulic radius
Rh = A/Wp
Rh = 1.48 FT

Slope (S) 0.008
Mannings (n) 0.035 riprap

Flow capacity
Q = (1.49/n)*A*Rh^2/3*S^1/2
Q = 136.07 CFS

Velocity
V = Q/A
V = 4.86 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A'*Rh'^2/3	14.653	
	8.156	
Depth	0.86	ft
Area	1.53	sf
Velocity	35.84	fps
WP/Rh	125.20	
Median d	0.86	

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Typical Drainage Bench on Landfill Slope (Worst Case Scenario)

From A5

Q100 = 25.60 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	1.5	
Side slope 2 (Y:1)	2	
Depth (d)	2	FT
Base width (B)	0	FT
Maximum swale elevation	1424	FT
Minimum swale elevation	1350	FT
Swale length	2312	FT

Top width

T = B+d(Z+Y)

T = 7.00 FT

Area

A = 1/2d(2B+d(Z+Y))

A = 7 SF

Wetted perimeter

Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)

Wp = 8.08 FT

Hydraulic radius

Rh = A/Wp

Rh = 0.87 FT

Slope (S) 0.032

Mannings (n) 0.035 riprap

Flow capacity

Q = (1.49/n)*A*Rh^2/3*S^1/2

Q = 48.33 CFS

Velocity

V = Q/A

V = 6.90 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A*Rh^2/3	3.370	
	0.924	
Depth	0.97	ft
Area	1.53	sf
Velocity	16.72	fps
WP/Rh	10.02	
Median d	5.96	

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POST-DEVELOPMENT CULVERT and PIPE CALCULATIONS (100 Year Storm)

Western Culvert Calculation: C-1

Flow from Drainage Area C1 29.36 cfs

Diameter (D):	24	
Length of Pipe (L):	30	ft
Upstream Invert Elev. (UIE):	1340.50	ft
Downstream Invert Elev. (DIE):	1339.90	ft
Manning's Coefficient (n):	0.013	RCP

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 3.14 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 6.28 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.50 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.02 ft/ft

Full Flow
Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 31.99 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.00
Flow Capacity (Q): — Q = 32.08

Western Culvert Calculation: C-2

Flow from Drainage Area C1 and C2 (June20) 30.34 cfs

Diameter (D):	24	in.
Length of Pipe (L):	52	ft
Upstream Invert Elev. (UIE):	1332.50	ft
Downstream Invert Elev. (DIE):	1325.00	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 3.14 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 6.28 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.50 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.14 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 93.07 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.00
Flow Capacity (Q): — Q = 93.32

Existing Culvert Calculation (Northern Perimeter Swale): EC-1

Flow from Drainage Area A7 12.2 cfs

Diameter (D):	15	in.
Length of Pipe (L):	21	ft
Upstream Invert Elev. (UIE):	1334.40	ft
Downstream Invert Elev. (DIE):	1334.30	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 1.23 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 3.93 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.31 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.00 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 4.83 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.00
Flow Capacity (Q): — Q = 14.12

Existing Culvert Calculation (Northern Perimeter Swale): EC-2

Flow from Area A7 12.2 cfs

Diameter (D):	24	in.
Length of Pipe (L):	78	ft
Upstream Invert Elev. (UIE):	1333.30	ft
Downstream Invert Elev. (DIE):	1329.20	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 3.14 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 6.28 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.50 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.05 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 56.19 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.00
Flow Capacity (Q): — Q = 56.34

Existing Culvert Calculation (Northern Perimeter Swale): EC-3

Flow from a portion of Area A7 >1/2(12.2) cfs

Diameter (D):	15	in.
Length of Pipe (L):	49	ft
Upstream Invert Elev. (UIE):	1335.10	ft
Downstream Invert Elev. (DIE):	1334.70	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 1.23 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 3.93 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.31 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.01 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 6.32 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.00
Flow Capacity (Q): — Q = 10.75

Existing Culvert Calculation (Inlet to Pond 4): EC-4

Flow from Areas D1 through B6 (June 200) 26.02 cfs

Diameter (D):	36	in.
Length of Pipe (L):	139	ft
Upstream Invert Elev. (UIE):	1336.80	ft
Downstream Invert Elev. (DIE):	1335.60	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 7.07 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 9.42 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.75 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.01 ft/ft

Flow Capacity (Q)
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 67.14 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 3.00
Flow Capacity (Q): — Q = 67.32

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POST-DEVELOPMENT CULVERT and PIPE CALCULATIONS (100 Year Storm)

Existing Culvert Calculation (Inlet to Pond 4): EC-5
Flow from Area B7 1.02 cfs

Diameter (D):	18	in.
Length of Pipe (L):	103	ft
Upstream Invert Elev. (UIE):	1342.90	ft
Downstream Invert Elev. (DIE):	1337.00	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 1.77 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 4.71 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.38 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.06 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 27.24 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 1.50
Flow Capacity (Q): — Q = 27.31

Existing Culvert Calculation (Inlet to Pond 4): EC-6
Flow from Drainage Area D1-D5 (June120) 24.23 cfs

Diameter (D):	18	in.
Length of Pipe (L):	82	ft
Upstream Invert Elev. (UIE):	1340.00	ft
Downstream Invert Elev. (DIE):	1337.00	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 1.77 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 4.71 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.38 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.04 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 21.77 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.50
Flow Capacity (Q): — Q = 25.28

Existing Culvert Calculation (North): EC-7
Flow from Drainage Area B7 1.02 cfs

Diameter (D):	18	in.
Length of Pipe (L):	96	ft
Upstream Invert Elev. (UIE):	1348.00	ft
Downstream Invert Elev. (DIE):	1343.00	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 1.77 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 4.71 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.38 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.05 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 25.97 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 1.50
Flow Capacity (Q): — Q = 26.04

Existing Culvert Calculation (to Western PL Swale): EC-8
Flow from Drainage Areas D3 and D5 (June 70) 5.81 cfs

Diameter (D):	36	in.
Length of Pipe (L):	42	ft
Upstream Invert Elev. (UIE):	1347.70	ft
Downstream Invert Elev. (DIE):	1346.00	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 7.07 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 9.42 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.75 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.04 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 145.37 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.00
Flow Capacity (Q): — Q = 93.53

Existing Culvert Calculation (to Western PL Swale): EC-9
Flow from Drainage Area D1 14.05 cfs

Diameter (D):	24	in.
Length of Pipe (L):	63	ft
Upstream Invert Elev. (UIE):	1367.40	ft
Downstream Invert Elev. (DIE):	1356.70	ft
Manning's Coefficient (n):	0.012	CPE

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 3.14 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 6.28 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.50 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.17 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 101.00 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 2.00
Flow Capacity (Q): — Q = 101.27

Existing Culvert Calculation (Southeastern culverts): EC-10 & E-11
Flow from small portion of Drainage Area C1 >1/4(29.36) cfs

Diameter (D):	15	in.
Length of Pipe (L):	112	ft
Upstream Invert Elev. (UIE):	1393.50	ft
Downstream Invert Elev. (DIE):	1391.40	ft
Manning's Coefficient (n):	0.013	RCP

Gravity Flow: Flow Through Pipe
Assuming no head over crown of pipe

Area (A):
Area = (Pi x D^2) / 4 — A = 1.23 ft^2

Wetted Perimeter (WP):
WP = Pi x D — WP = 3.93 ft

Hydraulic Radius (Rh):
Rh = A / WP — Rh = 0.31 ft

Slope (S_o):
S_o = (UIE - DIE) / L — S_o = 0.02 ft/ft

Flow Capacity (Q):
Q = (1.486 x A x $Rh^{2/3}$ x $S_o^{1/2}$) / n — Q = 8.85 ft^3/sec

Surcharged Flow
Head Above Invert (ft) — Head 1.25
Flow Capacity (Q): — Q = 8.87

CMA ENGINEERS, Inc.	PROJECT:	NCES
Civil/Environmental Engineers		
35 Bow Street	FILE:	656.05
Portsmouth, NH 03801	DATE:	February 5, 2009
Phone: (603) 431-6196	CALC. BY:	MAM
Fax: (603) 431-5376	CHECKED BY:	RJG

POST DEVELOPMENT DOWNCHUTE CALCULATIONS

North Eastern Berm Downchute

Flow from Junc 200

Q100 = 26.02 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	2.5	FT
Base width (B)	10	FT
Maximum swale elevation	1446	FT
Minimum swale elevation	1362	FT
Swale length	417	FT

Top width

T = B+d(Z+Y)

T = 20.00 FT

Area

A = 1/2d(2B+d(Z+Y))

A = 37.5 SF

Wetted perimeter

Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)

Wp = 21.18 FT

Hydraulic radius

Rh = A/Wp

Rh = 1.77 FT

Slope (S) 0.333

Mannings (n) 0.045 riprap

Flow capacity

Q = (1.49/n)*A*Rh^2/3*S^1/2

Q = 1046.35 CFS

Velocity

V = Q/A

V = 27.90 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A'*Rh'^2/3	1.365	
	4.782	
Depth	0.63	ft
Area	1.53	sf
Velocity	16.99	fps
WP/Rh	107.29	
Median d	17.71	

Northern Berm Downchute

Flow from Junction 180

Q100 = 88.10 CFS

Typical Cross Section: Trapezoid with Stone

Side slope 1 (Z:1)	2	
Side slope 2 (Y:1)	2	
Depth (d)	2.5	FT
Base width (B)	10	FT
Maximum swale elevation	1444	FT
Minimum swale elevation	1338	FT
Swale length	300	FT

Top width

T = B+d(Z+Y)

T = 20.00 FT

Area

A = 1/2d(2B+d(Z+Y))

A = 37.5 SF

Wetted perimeter

Wp = B+SQRT(d^2+(d*Z)^2)+SQRT(d^2+(d*Y)^2)

Wp = 21.18 FT

Hydraulic radius

Rh = A/Wp

Rh = 1.77 FT

Slope (S) 0.333

Mannings (n) 0.045 riprap

Flow capacity

Q = (1.49/n)*A*Rh^2/3*S^1/2

Q = 1046.35 CFS

Velocity

V = Q/A

V = 27.90 FPS

Estimated Depth and Velocity		
	25-yr Storm	
A'*Rh'^2/3	4.621	
	3.227	
Depth	0.50	ft
Area	1.53	sf
Velocity	57.54	fps
WP/Rh	97.78	
Median d	29.94	

APPENDIX B.3

POST-DEVELOPMENT DETENTION POND CALCULATIONS AND HYDROGRAPHS

Type.... Vol: Elev-Area
Name.... POND 3

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1325.00	-----	.0000	.0000	.000	.000
1326.00	-----	.6446	.6454	.215	.215
1328.00	-----	.7705	2.1200	1.413	1.628
1330.00	-----	.9018	2.5059	1.671	3.299
1332.00	-----	1.0570	2.9351	1.957	5.256

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

Type.... Vol: Elev-Area
Name.... POND 4

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1327.00	-----	.0001	.0000	.000	.000
1328.00	-----	.5609	.5685	.189	.189
1330.00	-----	.6623	1.8327	1.222	1.411
1332.00	-----	.7495	2.1164	1.411	2.822
1334.00	-----	.8429	2.3872	1.591	4.414
1336.00	-----	1.0446	2.8258	1.884	6.298

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1320.00	-----	.0060	.0000	.000	.000
1322.00	-----	.3130	.3623	.242	.242
1324.00	-----	.5240	1.2420	.828	1.070
1326.00	-----	.6450	1.7504	1.167	2.236

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 1325.00 ft
Increment = .10 ft
Max. Elev.= 1332.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Area	O3	--->	C1	1329.800	1332.000
Orifice-Circular	O2	--->	C1	1328.400	1332.000
Orifice-Circular	O1	--->	C1	1327.500	1332.000
Culvert-Circular	C1	--->	TW	1326.700	1332.000
TW SETUP, DS Channel					

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O3
Structure Type     = Orifice-Area
-----------------------------------
# of Openings      =        40
Invert Elev.       =   1329.80 ft
Area               =     .0360 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =   1329.80 ft
Orifice Coeff.     =      .620


Structure ID       = O2
Structure Type     = Orifice-Circular
-----------------------------------
# of Openings      =         3
Invert Elev.       =   1328.40 ft
Diameter           =     .1250 ft
Orifice Coeff.     =      .620


Structure ID       = O1
Structure Type     = Orifice-Circular
-----------------------------------
# of Openings      =         3
Invert Elev.       =   1327.50 ft
Diameter           =     .1250 ft
Orifice Coeff.     =      .620
```

File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW

OUTLET STRUCTURE INPUT DATA

```
Structure ID      = C1
Structure Type    = Culvert-Circular
-----------------------------------
No. Barrels       =         1
Barrel Diameter   =    2.0000 ft
Upstream Invert   =   1326.70 ft
Dnstream Invert   =   1323.20 ft
Horiz. Length     =    175.00 ft
Barrel Length     =    175.04 ft
Barrel Slope      =    .02000 ft/ft

OUTLET CONTROL DATA...
Mannings n        =     .0240
Ke                =     .9000  (forward entrance loss)
Kb                =   .042300  (per ft of full flow)
Kr                =     .9000  (reverse entrance loss)
HW Convergence    =      .001  +/- ft

INLET CONTROL DATA...
Equation form     =         1
Inlet Control K   =     .0078
Inlet Control M   =    2.0000
Inlet Control c   =    .03790
Inlet Control Y   =     .6900
T1 ratio (HW/D)   =     1.126
T2 ratio (HW/D)   =     1.286
Slope Factor      =     -.500

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =   1328.95 ft  --->  Flow =     15.55 cfs
At T2 Elev =   1329.27 ft  --->  Flow =     17.77 cfs


Structure ID      = TW
Structure Type    = TW SETUP, DS Channel
-----------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    30
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .10 cfs
Max.  Q tolerance =    .10 cfs
```

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 1327.00 ft
Increment = .10 ft
Max. Elev.= 1336.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Weir-Rectangular	W1	--->	C1	1336.000	1336.000
Weir-Rectangular	W2	--->	C1	1333.000	1336.000
Orifice-Circular	O3	--->	C1	1330.000	1336.000
Orifice-Circular	O2	--->	C1	1329.000	1336.000
Orifice-Circular	O1	--->	C1	1328.000	1336.000
Culvert-Circular	C1	--->	TW	1327.200	1336.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

Structure ID = W1
Structure Type = Weir-Rectangular

# of Openings = 1
Crest Elev. = 1336.00 ft
Weir Length = 90.00 ft
Weir Coeff. = 3.367000

Weir TW effects (Use adjustment equation)

Structure ID = W2
Structure Type = Weir-Rectangular

# of Openings = 1
Crest Elev. = 1333.00 ft
Weir Length = 8.00 ft
Weir Coeff. = 3.367000

Weir TW effects (Use adjustment equation)

Structure ID = O3
Structure Type = Orifice-Circular

# of Openings = 3
Invert Elev. = 1330.00 ft
Diameter = .1250 ft
Orifice Coeff. = .620

```
OUTLET STRUCTURE INPUT DATA

Structure ID      = O2
Structure Type    = Orifice-Circular
-----------------------------------
# of Openings     =         3
Invert Elev.      =   1329.00 ft
Diameter          =     .1250 ft
Orifice Coeff.    =      .620

Structure ID      = O1
Structure Type    = Orifice-Circular
-----------------------------------
# of Openings     =         3
Invert Elev.      =   1328.00 ft
Diameter          =     .1250 ft
Orifice Coeff.    =      .620

Structure ID      = C1
Structure Type    = Culvert-Circular
-----------------------------------
No. Barrels       =         1
Barrel Diameter   =    2.0000 ft
Upstream Invert   =   1327.20 ft
Dnstream Invert   =   1326.60 ft
Horiz. Length     =     65.00 ft
Barrel Length     =     65.00 ft
Barrel Slope      =    .00923 ft/ft

OUTLET CONTROL DATA...
Mannings n        =     .0120
Ke                =     .5000  (forward entrance loss)
Kb                =   .010575  (per ft of full flow)
Kr                =     .5000  (reverse entrance loss)
HW Convergence    =      .001  +/- ft

INLET CONTROL DATA...
Equation form     =         1
Inlet Control K   =     .0078
Inlet Control M   =    2.0000
Inlet Control c   =    .03790
Inlet Control Y   =     .6900
T1 ratio (HW/D)   =     1.131
T2 ratio (HW/D)   =     1.292
Slope Factor      =     -.500

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =   1329.46 ft  --->  Flow =     15.55 cfs
At T2 Elev =   1329.78 ft  --->  Flow =     17.77 cfs

Structure ID      = TW
Structure Type    = TW SETUP, DS Channel
-----------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    30
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .10 cfs
Max.  Q tolerance =    .10 cfs
```

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 1320.00 ft
Increment = .10 ft
Max. Elev.= 1326.00 ft

```
*********************************************
                OUTLET CONNECTIVITY
*********************************************

 ---> Forward Flow Only (UpStream to DnStream)
<---  Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed
```

Structure	No.		Outfall	E1, ft	E2, ft
Weir-Rectangular		--->	TW	1325.000	1326.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID      =
Structure Type    = Weir-Rectangular
-----------------------------------
# of Openings     =         1
Crest Elev.       =   1325.00 ft
Weir Length       =     20.00 ft
Weir Coeff.       =  3.360000

Weir TW effects     (Use adjustment equation)
```

```
Structure ID      = TW
Structure Type    = TW SETUP, DS Channel
-----------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    30
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .10 cfs
Max.  Q tolerance =    .10 cfs
```

```
Type.... Detention Time                                        Page 7.01
Name.... POND 3       OUT   Tag:      2                      Event: 2 yr
File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
Storm... TypeII  24hr   Tag:      2

                      DETENTION TIMES SUMMARY

 HYG Dir          = F:\SHARED\Old Storm Water Files\656\65605\
 Inflow  HYG file = NONE STORED - POND 3       IN  2
 Outflow HYG file = NONE STORED - POND 3       OUT 2

 Pond Node   Data = POND 3
 Pond Volume Data = POND 3
 Pond Outlet Data = Pond 3 Outlet

 No Infiltration

 APPROXIMATE DETENTION TIME
 --------------------------------------
 Tp, Outflow + Infilt.   =   24.1500 hrs
 Tp, Total Inflow        =   12.0500 hrs
 Peak to Peak            =   12.1000 hrs

 Qout+Infilt. Centroid   =   47.5831 hrs
 Inflow Centroid         =   14.3724 hrs
 Centroid to Centroid    =   33.2108 hrs

 Weighted Avg. Plug Time =   59.7407 hrs
 Max.Plug Vol. Plug Time =   20.8503 hrs
 Max.Inflow Plug Volume  =      .153 ac-ft   (From 12.0000 to 12.0500 hrs)
 --------------------------------------
```

```
Type.... Detention Time                                        Page 7.02
Name.... POND 4       OUT   Tag:      2                      Event: 2 yr
File.... F:\SHARED\Old Storm Water Files\656\65605\POST09.PPW
Storm... TypeII  24hr   Tag:      2

                      DETENTION TIMES SUMMARY

 HYG Dir          = F:\SHARED\Old Storm Water Files\656\65605\
 Inflow  HYG file = NONE STORED - POND 4       IN  2
 Outflow HYG file = NONE STORED - POND 4       OUT 2

 Pond Node   Data = POND 4
 Pond Volume Data = POND 4
 Pond Outlet Data = Pond 4 Outlet

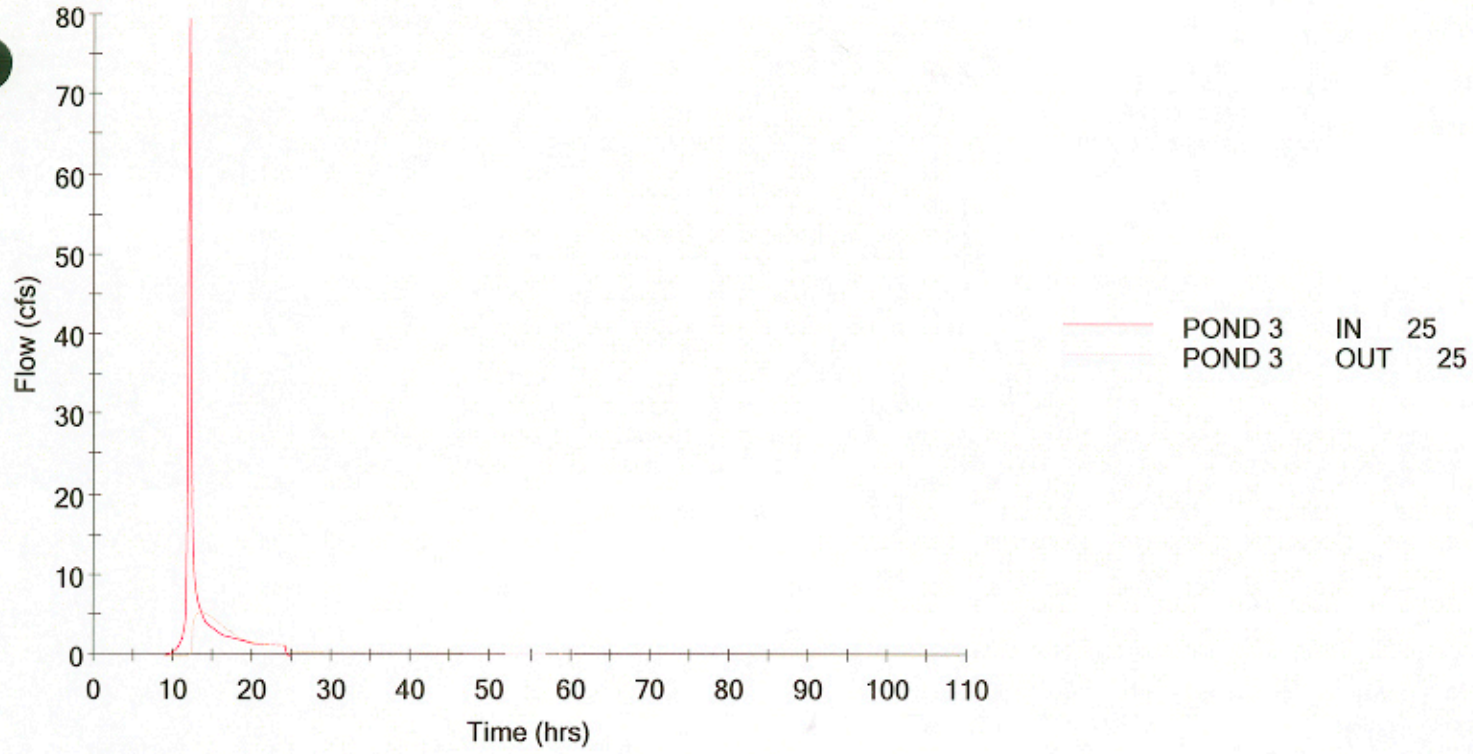
 No Infiltration

 APPROXIMATE DETENTION TIME
 --------------------------------------
 Tp, Outflow + Infilt.   =   23.5000 hrs
 Tp, Total Inflow        =   12.0500 hrs
 Peak to Peak            =   11.4500 hrs

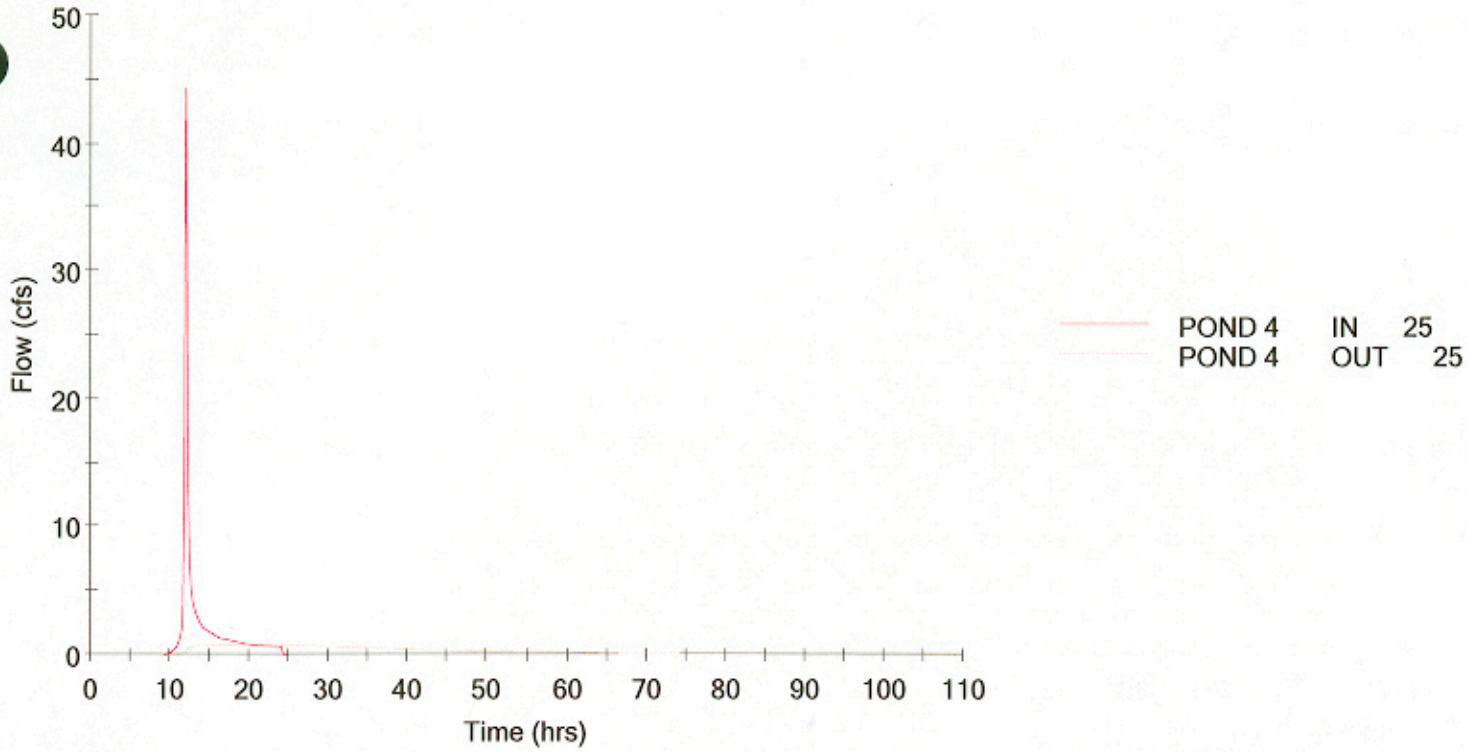
 Qout+Infilt. Centroid   =   42.8709 hrs
 Inflow Centroid         =   14.4229 hrs
 Centroid to Centroid    =   28.4480 hrs

 Weighted Avg. Plug Time =   28.5787 hrs
 Max.Plug Vol. Plug Time =   10.7784 hrs
 Max.Inflow Plug Volume  =      .084 ac-ft   (From 12.0000 to 12.0500 hrs)
 --------------------------------------
```

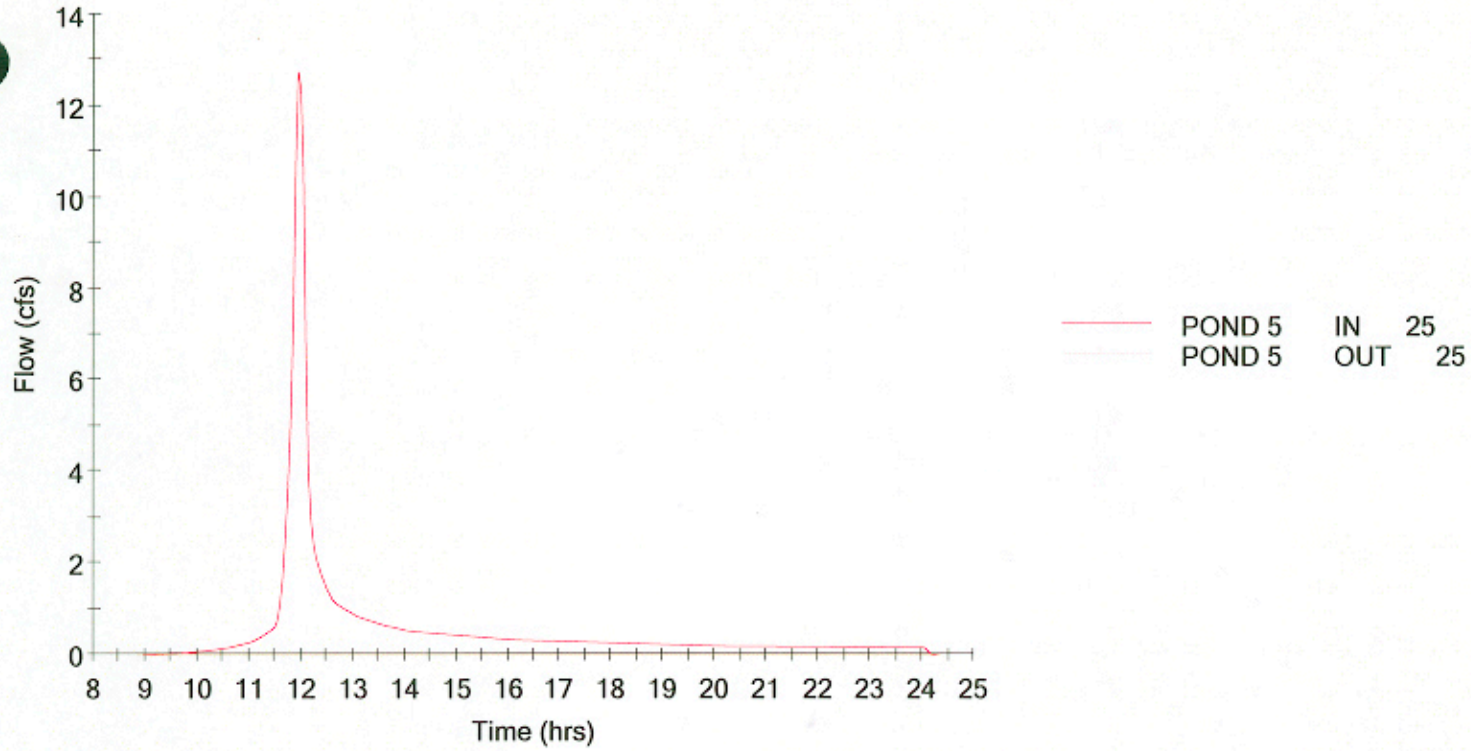
Hydrograph
POND 3 OUT 25



Hydrograph
POND 4 OUT 25



Hydrograph
POND 5 OUT 25



APPENDIX D

SUPPORTING TABLES
&
CHARTS

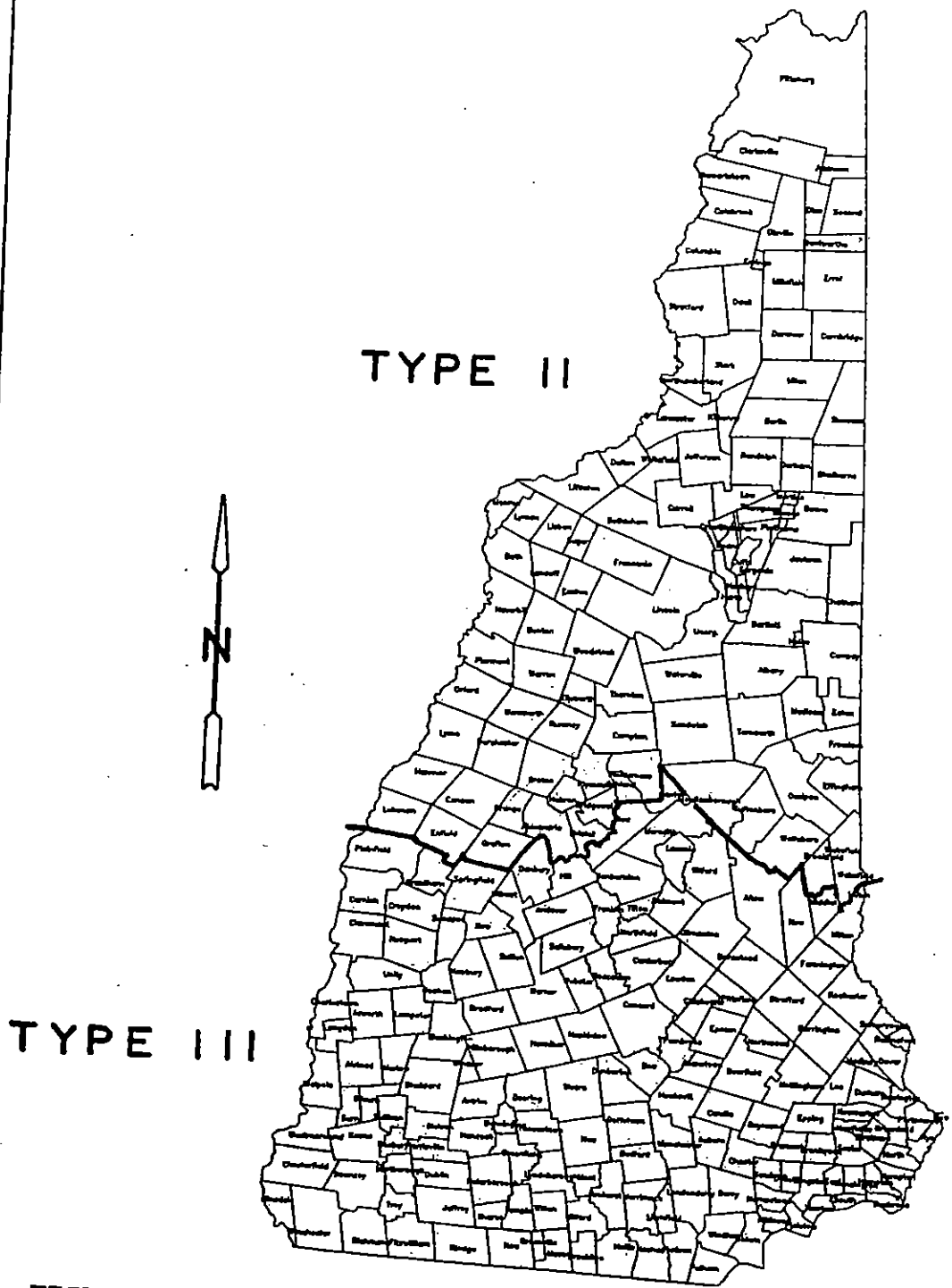


FIGURE 6-5 -- BOUNDARY FOR SCS RAINFALL DISTRIBUTION

Source: USDA Soil Conservation Service

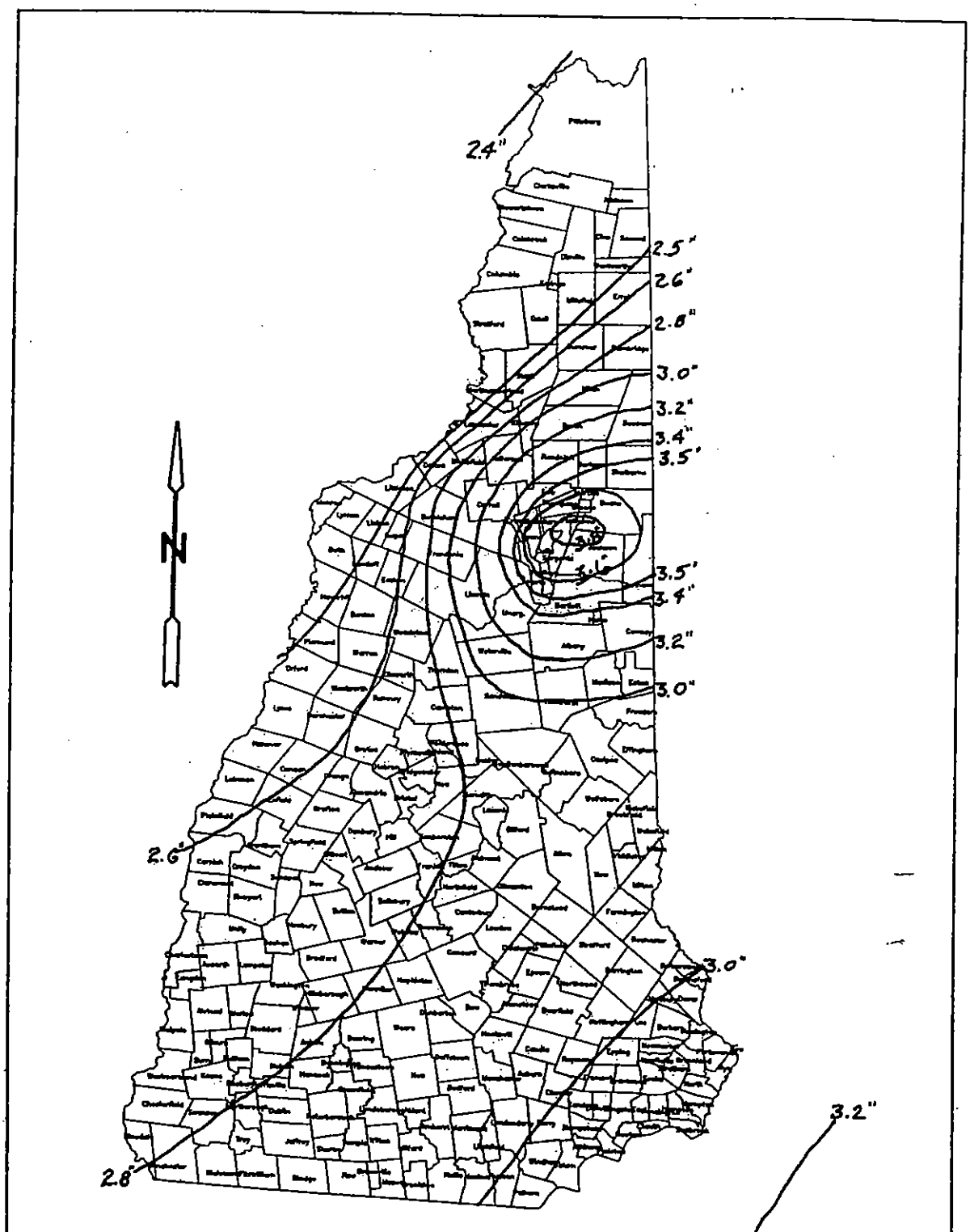


FIGURE 6-6 -- 2-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

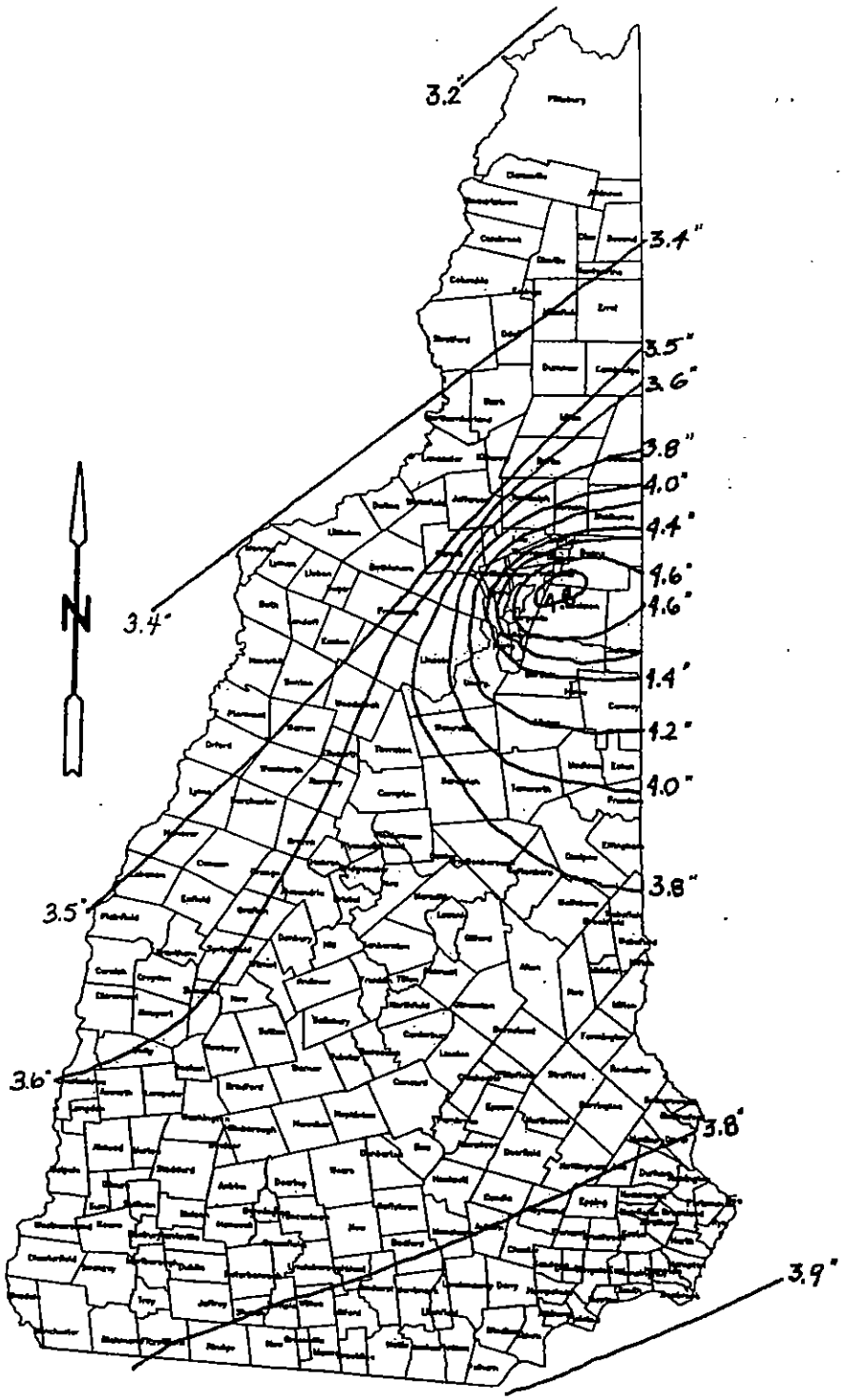


FIGURE 6-7 -- 5-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

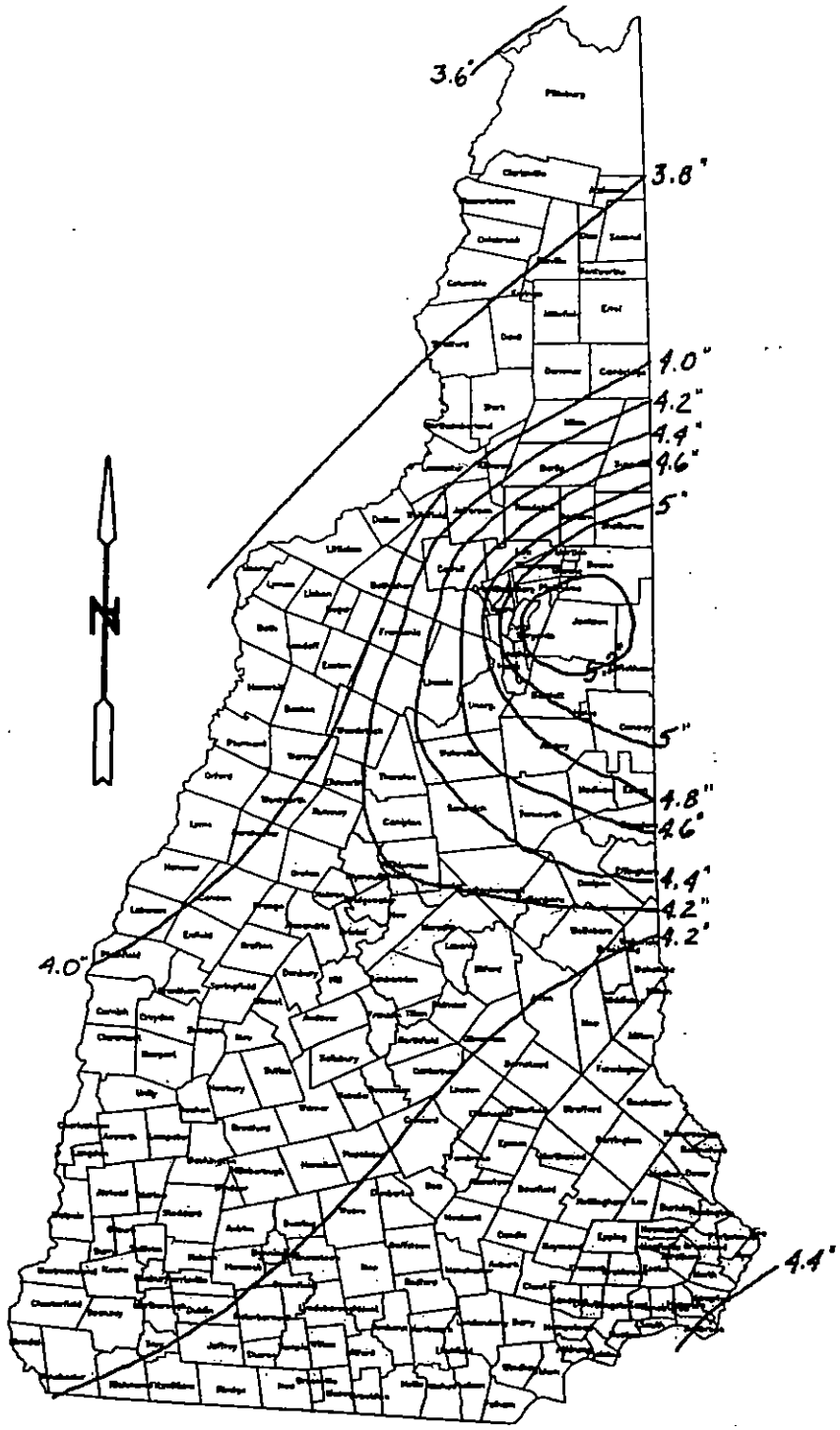


FIGURE 6-8 -- 10-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

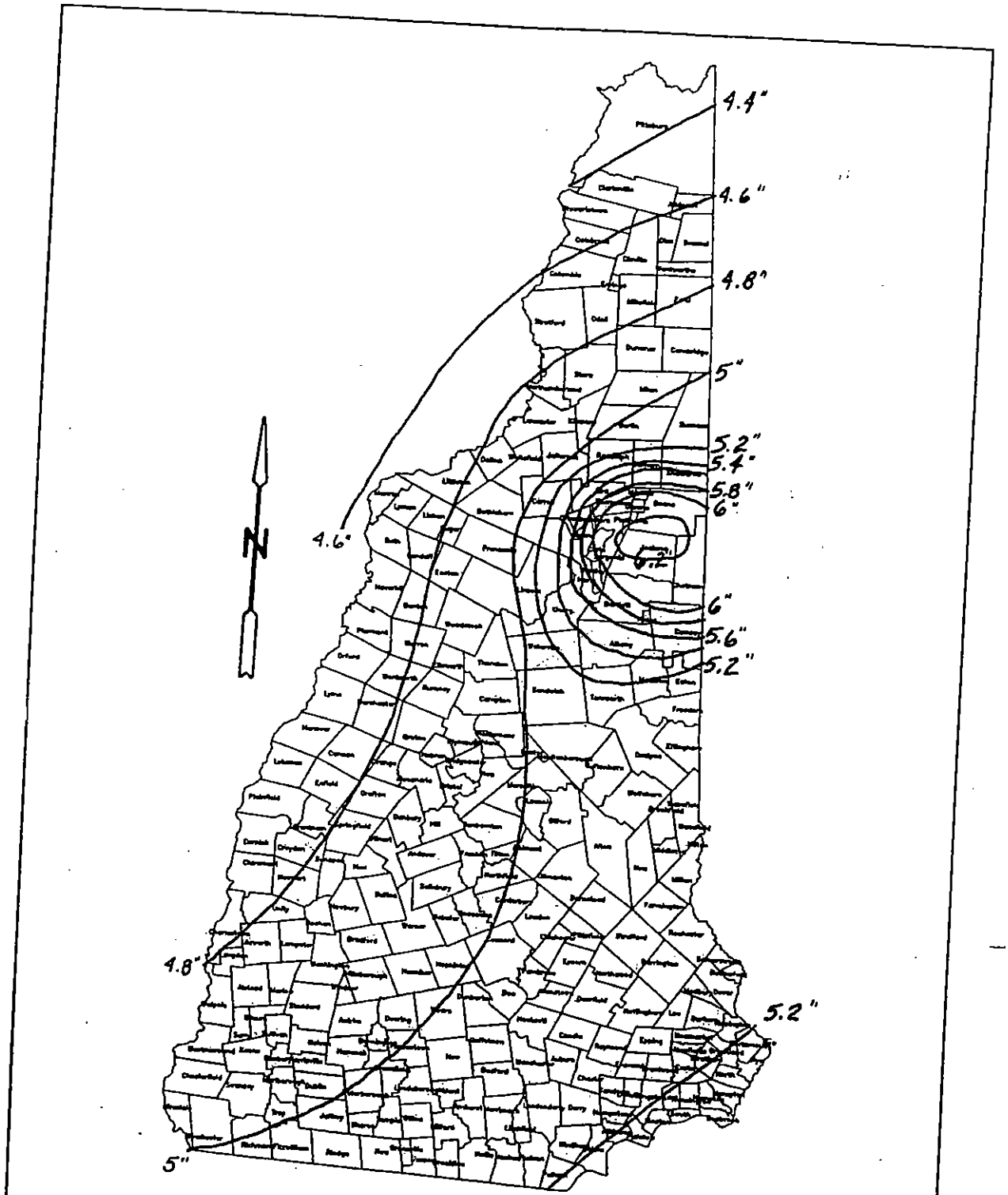


FIGURE 6-9 -- 25-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

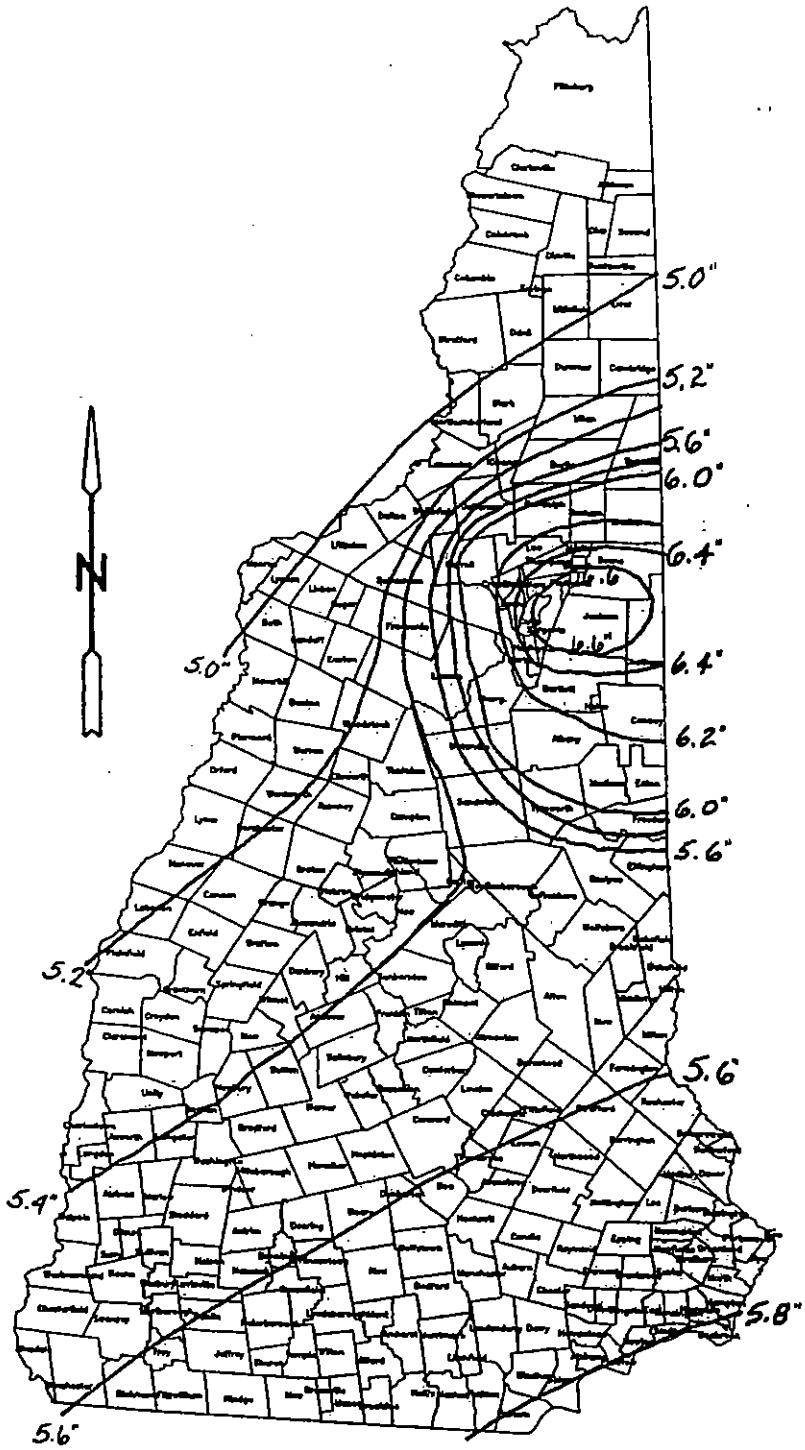


FIGURE 6-10 -- 50-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

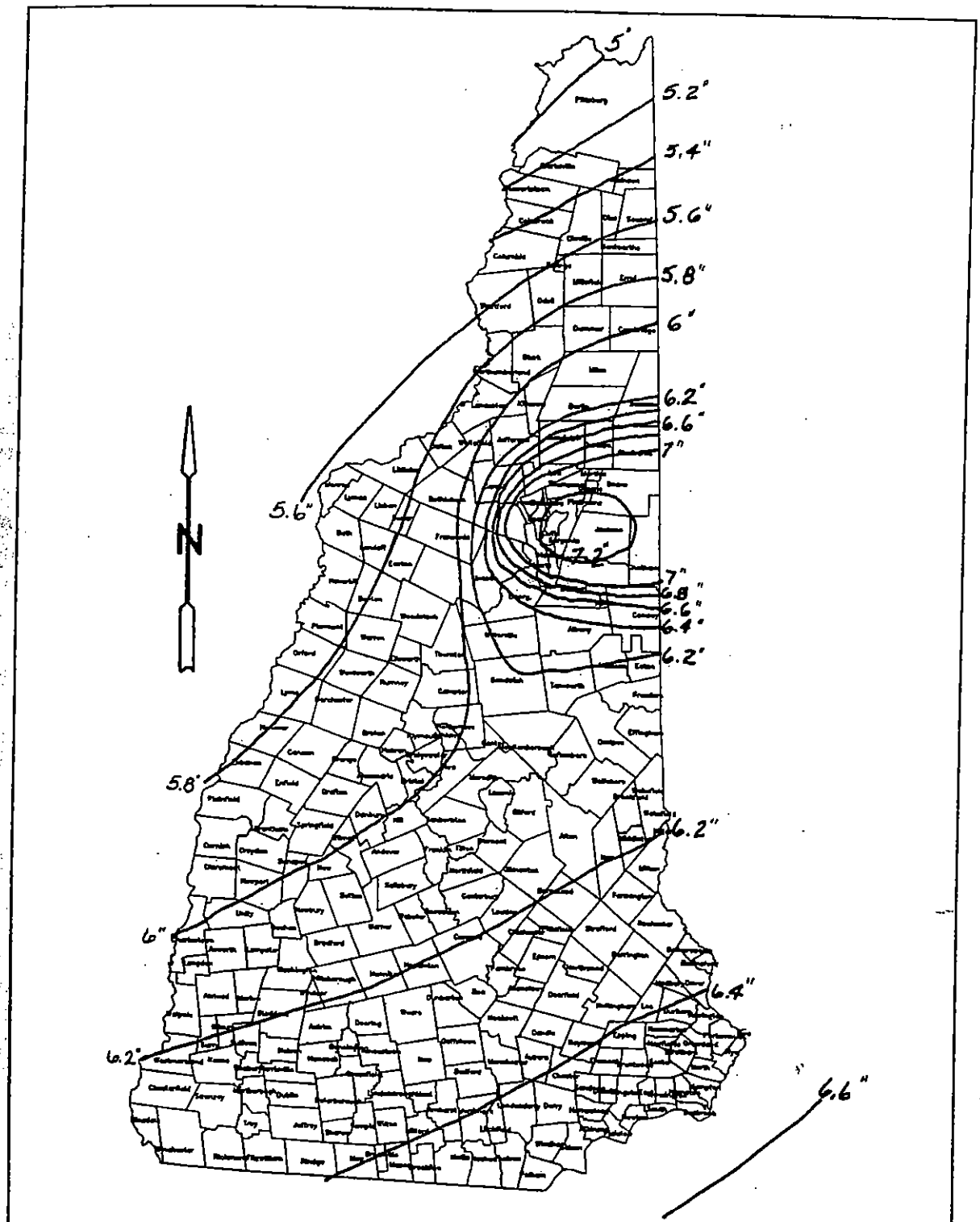
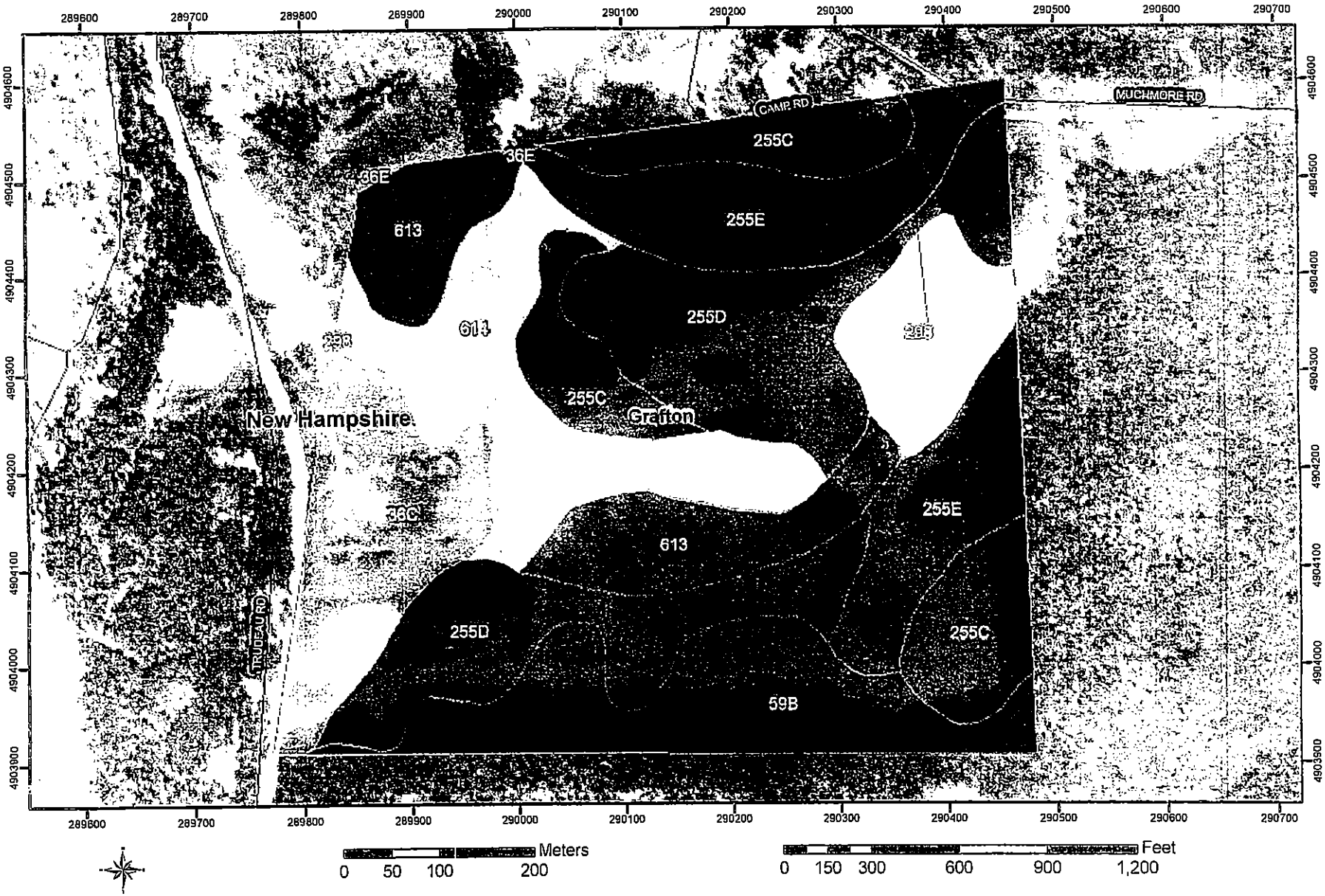


FIGURE 6-11 -- 100-YEAR FREQUENCY 24-HOUR DURATION RAINFALL

Source: USDA Soil Conservation Service

HYDROLOGIC GROUP RATING FOR G. .FTON COUNTY, NEW HAMPSHIRE



MAP LEGEND

Hydrologic Group

{Dominant Condition, <}

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available
- Soil Map Units
- Cities
- Detailed Counties
- Detailed States
- Interstate Highways
- Roads
- Rails
- Water
- Hydrography
- Oceans

MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 19

Soil Survey Area: Grafton County, New Hampshire
Spatial Version of Data: 2
Soil Map Compilation Scale: 1:24000

Map comprised of aerial images photographed on these dates:
5/9/1993; 5/14/1994

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables - Hydrologic Group

Summary by Map Unit - Grafton County, New Hampshire

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
36C	Adams loamy sand, 8 to 15 percent slopes	A	11.9	10.2
36E	Adams loamy sand, 15 to 60 percent slopes	A	0.2	0.2
59B	Waumbek loamy sand, 3 to 8 percent slopes, very stony	B	14.1	12.1
255C	Monadnock and Hermon soils, 8 to 15 percent, very stony	B	13.9	11.9
255D	Monadnock and Hermon soils, 15 to 25 percent slopes, very stony	B	26.1	22.3
255E	Monadnock and Hermon soils, 25 to 35 percent slopes, very stony	B	17.5	14.9
298	Pits, gravel	Null	6.8	5.8
613	Croghan loamy fine sand	B	12.0	10.2
614	Kinsman sand	C	14.7	12.5

Description - Hydrologic Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are placed into four groups A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Definitions of the classes are as follows:

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water

Table 1.—Manning roughness coefficients, n [1]

	Manning's n range [2]
I. Closed conduits:	
A. Concrete pipe	0.011–0.013
B. Corrugated-metal pipe or pipe-arch:	
1. 2⅔ by ½-in. corrugation (riveted pipe): [3]	
a. Plain or fully coated	0.024
b. Paved invert (range values are for 25 and 50 percent of circumference paved):	
(1) Flow full depth	0.021–0.018
(2) Flow 0.8 depth	0.021–0.016
(3) Flow 0.6 depth	0.019–0.013
2. 6 by 2-in. corrugation (field bolted)	0.03
C. Vitrified clay pipe	0.012–0.014
D. Cast-iron pipe, uncoated	0.013
E. Steel pipe	0.009–0.011
F. Brick	0.014–0.017
G. Monolithic concrete:	
1. Wood forms, rough	0.015–0.017
2. Wood forms, smooth	0.012–0.014
3. Steel forms	0.012–0.013
H. Cemented rubble masonry walls:	
1. Concrete floor and top	0.017–0.022
2. Natural floor	0.019–0.025
I. Laminated treated wood	0.015–0.017
J. Vitrified clay liner plates	0.013
II. Open channels, lined [4] (straight alinement): [5]	
A. Concrete, with surfaces as indicated:	
1. Formed, no finish	0.013–0.017
2. Trowel finish	0.012–0.014
3. Float finish	0.013–0.018
4. Float finish, some gravel on bottom	0.015–0.017
5. Gunite, good section	0.016–0.019
6. Gunite, wavy section	0.018–0.022
B. Concrete, bottom float finished, sides as indicated:	
1. Dressed stone in mortar	0.015–0.017
2. Random stone in mortar	0.017–0.020
3. Cement rubble masonry	0.020–0.025
4. Cement rubble masonry, plastered	0.016–0.020
5. Dry rubble (riprap)	0.020–0.030
C. Gravel bottom, sides as indicated:	
1. Formed concrete	0.017–0.020
2. Random stone in mortar	0.020–0.023
3. Dry rubble (riprap)	0.023–0.033
D. Brick	0.014–0.017
E. Asphalt:	
1. Smooth	0.013
2. Rough	0.016
F. Wood, planed, clean	0.011–0.013
G. Concrete-lined excavated rock:	
1. Good section	0.017–0.020
2. Irregular section	0.023–0.027
III. Open channels, excavated [4] (straight alinement,[5] natural lining):	
A. Earth, uniform section:	
1. Clean, recently completed	0.016–0.018
2. Clean, after weathering	0.018–0.020
3. With short grass, few weeds	0.022–0.027
4. In gravelly soil, uniform section, clean	0.022–0.025
B. Earth, fairly uniform section:	
1. No vegetation	0.022–0.025
2. Grass, some weeds	0.025–0.030
3. Dense weeds or aquatic plants in deep channels	0.030–0.035
4. Sides clean, gravel bottom	0.025–0.030
5. Sides clean, cobble bottom	0.030–0.040
C. Dragline excavated or dredged:	
1. No vegetation	0.028–0.033
2. Light brush on banks	0.035–0.050
D. Rock:	
1. Based on design section	0.035
2. Based on actual mean section:	
a. Smooth and uniform	0.035–0.040
b. Jagged and irregular	0.040–0.045
E. Channels not maintained, weeds and brush uncut:	
1. Dense weeds, high as flow depth	0.08–0.12
2. Clean bottom, brush on sides	0.05–0.08
3. Clean bottom, brush on sides, highest stage of flow	0.07–0.11
4. Dense brush, high stage	0.10–0.14
IV. Highway channels and swales with maintained vegetation [6 7] (values shown are for velocities of 2 and 6 f.p.s.):	
A. Depth of flow up to 0.7 foot:	
1. Bermudagrass, Kentucky bluegrass, buffalograss:	
a. Mowed to 2 inches	0.07–0.045
b. Length 4–6 inches	0.09–0.05
2. Good stand, any grass:	
a. Length about 12 inches	0.18–0.09
b. Length about 24 inches	0.30–0.15
3. Fair stand, any grass:	
a. Length about 12 inches	0.14–0.08
b. Length about 24 inches	0.25–0.13
B. Depth of flow 0.7–1.5 feet:	
1. Bermudagrass, Kentucky bluegrass, buffalograss:	
a. Mowed to 2 inches	0.05–0.035
b. Length 4 to 6 inches	0.06–0.04
2. Good stand, any grass:	
a. Length about 12 inches	0.12–0.07
b. Length about 24 inches	0.20–0.10
3. Fair stand, any grass:	
a. Length about 12 inches	0.10–0.06
b. Length about 24 inches	0.17–0.09
V. Street and expressway gutters:	
A. Concrete gutter, troweled finish	0.012
B. Asphalt pavement:	
1. Smooth texture	0.013
2. Rough texture	0.016
C. Concrete gutter with asphalt pavement:	
1. Smooth	0.013
2. Rough	0.015
D. Concrete pavement:	
1. Float finish	0.014
2. Broom finish	0.016
E. For gutters with small slope, where sediment may accumulate, increase above values of n by	*0.002*
VI. Natural stream channels: [8]	
A. Minor streams [9] (surface width at flood stage less than 100 ft.):	
1. Fairly regular section:	
a. Some grass and weeds, little or no brush	0.030–0.035
b. Dense growth of weeds, depth of flow materially greater than weed height	0.035–0.05
c. Some weeds, light brush on banks	0.035–0.05
d. Some weeds, heavy brush on banks	0.05–0.07
e. Some weeds, dense willows on banks	0.06–0.08
f. For trees within channel, with branches submerged at high stage, increase all above values by	*0.01–0.02*
2. Irregular sections, with pools, slight channel meander; increase values given in 1a–e about	*0.01–0.02*
3. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stage:	
a. Bottom of gravel, cobbles, and few boulders	0.04–0.05
b. Bottom of cobbles, with large boulders	0.05–0.07
B. Flood plains (adjacent to natural streams):	
1. Pasture, no brush:	
a. Short grass	0.030–0.035
b. High grass	0.035–0.05
2. Cultivated areas:	
a. No crop	0.03–0.04
b. Mature row crops	0.035–0.045
c. Mature field crops	0.04–0.05
3. Heavy weeds, scattered brush	0.05–0.07
4. Light brush and trees: [10]	
a. Winter	0.05–0.06
b. Summer	0.06–0.08
5. Medium to dense brush: [10]	
a. Winter	0.07–0.11
b. Summer	0.10–0.16
6. Dense willows, summer, not bent over by current	0.15–0.20
7. Cleared land with tree stumps, 100–150 per acre:	
a. No sprouts	0.04–0.05
b. With heavy growth of sprouts	0.06–0.08
8. Heavy stand of timber, a few down trees, little undergrowth:	
a. Flood depth below branches	0.10–0.12
b. Flood depth reaches branches	0.12–0.16
C. Major streams (surface width at flood stage more than 100 ft.): Roughness coefficient is usually less than for minor streams of similar description on account of less effective resistance offered by irregular banks or vegetation on banks. Values of n may be somewhat reduced. Follow recommendation in publication cited [8] if possible. The value of n for larger streams of most regular section, with no boulders or brush, may be in the range of	0.028–0.033

Footnotes to table 1 appear at the top of page 101.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}\, s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

A is the drainage area of the watershed contributing runoff to the point being investigated or the design point expressed in acres.

While the formula is not dimensionally correct, values obtained differ by less than 1% when used to express the more common units of cubic feet per second.

TABLE 6-1 - RUNOFF COEFFICIENTS FOR DEVELOPED AREAS

Type of Drainage Area	Runoff Coefficient, C
Business	
Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential	
Single-family areas	0.30 - 0.50
Multi-units, detached	0.40 - 0.60
Multi-units, attached	0.60 - 0.75
Suburban	0.25 - 0.40
Apartment dwelling areas	0.50 - 0.70
Industrial	
Light areas	0.50 - 0.80
Heavy areas	0.60 - 0.90
Parks, Cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.35
Railroad yard areas	0.20 - 0.40
Unimproved areas	0.10 - 0.30
Streets	0.70 - 0.95
Brick drives and walks	0.75 - 0.85

TABLE 6-2 - RUNOFF COEFFICIENTS FOR UNDEVELOPED AREAS

Topography and Vegetation	Soil Texture		
	Sandy Loam	Clay and Silt Loam	Clay
Woodland			
Flat, 0-5% slope	0.10	0.30	0.40
Rolling, 5-10% slope	0.25	0.35	0.50
Hilly, 10-30% slope	0.30	0.50	0.60
Pasture			
Flat, 0-5% slope	0.10	0.30	0.40
Rolling, 5-10% slope	0.16	0.36	0.55
Hilly, 10-30% slope	0.22	0.42	0.60
Cultivated			
Flat, 0-5% slope	0.30	0.50	0.60
Rolling, 5-10% slope	0.40	0.60	0.70
Hilly, 10-30% slope	0.52	0.72	0.82

transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only soils that are rated D in their natural condition are assigned to dual classes.

Parameter Summary - Hydrologic Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

APPENDIX E

CONSTRUCTION DRAWINGS
(BOUND SEPERATELY)