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**TOWN OF CLARKSTOWN
DEPARTMENT OF ENVIRONMENTAL CONTROL**

**CLARKSTOWN SANITARY LANDFILL REMEDIATION
AND LANDFILL CAPPING**

CONTRACT NO. 34-1996

CONSTRUCTION CERTIFICATION REPORT

VOLUME 1 OF 6

(Narrative and Attachments)

*THIS FOLDER HAS
BEEN UPDATED PER
WESTON'S 02/09/01
RESPONSE TO COMMENTS
LETTER. B.Z.*

April 14, 2000

Prepared for:

Town of Clarkstown
Department of Environmental Control
10 Maple Avenue
New City, NY 10956

Submitted to:

New York State Department of Environmental Conservation
Division of Environmental Remediation
50 Wolf Road
Albany, NY 12233

Prepared by:

Roy F. Weston of New York, Inc.
130 West 30th Street
New York, NY 10001





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marked
C-2X

April 14, 2000

Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services, Room 267
Division of Environmental Remediation
NYS Department of Environmental Conservation
50 Wolf Road
Albany, NY 12233-7010

**RE: Clarkstown Landfill Remediation and Landfill Capping
NYSDEC Site No. 3-44-001
- Construction Certification Report**

Dear Mr. Knizek:

On behalf of the Town of Clarkstown, this correspondence and attached documentation will serve to certify that, ~~to the best of our knowledge and belief~~, the Clarkstown Landfill Remediation and Landfill Capping, Contract No. 34-1996, has been constructed in accordance with the applicable documents (as referenced by Section 1 of the attached Construction Certification Report), including some minor revisions, which do not significantly affect the intent of the landfill remediation and capping design. Please note that this certification report does not cover the parcel known as the Riveroso property.

Three (3) copies of this Construction Certification Report are enclosed for your review and files. The report consists of six (6) Volumes as follows:

- Volume 1 of 6 - Construction Certification Report Narrative and Attachments (1, 2 and 3)
- Volume 2 of 6 - Appendix A, B, C and D
- Volume 3 of 6 - Appendix E
- Volume 4 of 6 - Appendix F
- Volume 5 of 6 - Appendix G
- Volume 6 of 6 - Appendix H, I, J and K





Mr. Robert C. Knizek, P.E.
NYSDEC
April 14, 2000
Page 2

As always, please feel free to contact me at (212) 502-7800 should you have any questions or comments with respect to this letter and enclosure.

Very truly yours,

ROY F. WESTON OF NEW YORK, INC.



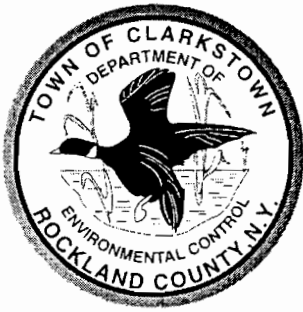
Timothy P. Leonard, P.E.
New York P.E. License # 73011

Enc.

cc: L. Kalarickal - Town of Clarkstown
J. Helmeset - NYSDEC
P. O'Connor, R. De Santis - WESTON

New York State Department of Environmental Conservation	
CLARKSTOWN LANDFILL	

☒ Approved ☐ Approved As Noted ☐ Resubmit With Revisions ☐ Disapproved	
COMMISSIONER OF ENVIRONMENTAL CONSERVATION	
Robert C. Knizek P.E.	
Date: APR 20 2001	Designated Representative



**TOWN OF CLARKSTOWN
DEPARTMENT OF ENVIRONMENTAL CONTROL**

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New York, NY 10001



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ATTACHMENT 2:	Copy of NYSDEC Correspondence Approving PVC Geomembrane Substitution
ATTACHMENT 3:	Copy of NYSDEC Correspondence Relating to PVC Geomembrane Field Seams and M&T Laboratory Geomembrane Testing Issues

**CLARKSTOWN LANDFILL REMEDIATION AND LANDFILL CAPPING
CONTRACT NO. 34-1996
CONSTRUCTION CERTIFICATION REPORT**

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**CLARKSTOWN LANDFILL REMEDIATION AND LANDFILL CAPPING
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1.0 INTRODUCTION

The purpose of this report is to describe the construction and inspection of the remediation of the Clarkstown Sanitary Landfill (the Landfill). The remediation of the Landfill was based on the remedy chosen in the Record of Decision (ROD) issued by the New York State Department of Environmental Conservation (NYSDEC), dated November 1995.

Also, this report provides a New York State Licensed Professional Engineer's certification that the remediation of the Landfill was conducted and completed in accordance with the relevant plans and specifications, including some minor revisions which do not significantly affect the intent of the design. The relevant design and contract documents are described in Section 1.4 of this report.

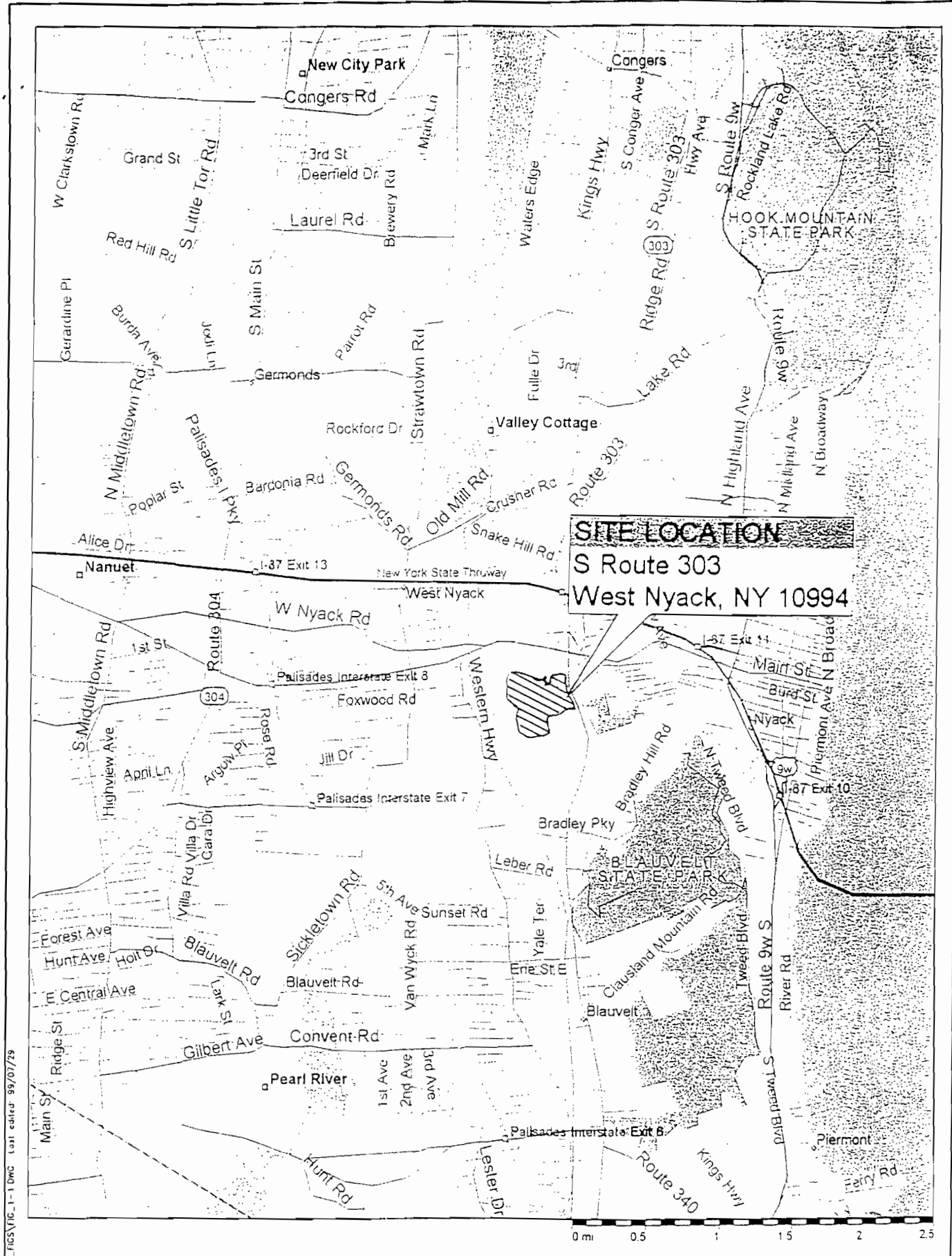
This certification report has been prepared to meet the requirements for preparation of a construction certification report as described in NYSDEC Solid Waste Regulations 6 NYCRR Part 360-2.13, effective December 31, 1988.

The following entities were involved with the remediation of the Landfill:

- Owner of the Landfill: The Landfill's owner is the Town of Clarkstown (TOWN).
- Regulatory Agency: NYSDEC was involved with the review and approval, of plans and specifications, as well as contributing partial payment for the remediation of the Landfill.
- Professional Engineer: Roy F. Weston of New York, Inc. (WESTON) was the owner's Design Engineer, Resident Engineer, Quality Assurance Inspector, and Construction Manager. Also, WESTON is providing the New York State Licensed Professional Engineer's certification that the remediation of the Landfill was conducted and completed in accordance with the relevant plans and specifications, including some minor revisions which do not significantly affect the intent of the design.
- General Contractor: Ogden Remediation Services Corporation, Inc. (ORSC or OGDEN) was the general contractor that was contracted by the TOWN to construct the remediation components as described in the document "*Remediation of the Clarkstown Sanitary Landfill and Landfill Capping Specifications and Bid Documents, Bid No. 34-1996*," dated March 29, 1996 and revised February 7, 1997, prepared by WESTON.

The Landfill is located in West Nyack, Rockland County, New York. The Landfill, which is located approximately 1,000 feet south of Route 59, is bounded on the East Side by New York State Route 303, and on the North, South and West sides by wetlands. The Landfill property encompasses approximately 100 acres. Vehicular access to the Landfill is restricted to an entrance road from Route 303. Refer to Figure No. 1, which illustrates the location of the Landfill on copy of a U.S.G.S. 7.5-minute quadrangle map.

approximate
(also - see 2 can
any picture does not
include this property) → site 4



File name: 04-FIGS\FIG_1-1.DWG Last edited: 99/07/29

TOWN OF CLARKSTOWN
SANITARY LANDFILL
WEST NYACK, NY

WESTON
MANAGERS DESIGNERS/CONSULTANTS
ROY F. WESTON OF NEW YORK, INC.

FIGURE 1-1
SITE LOCATION
MICROSOFT EXPEDIA, STREETS 98

1.1 Site History

Landfilling operations began at the site in the 1940's prior to ownership by the TOWN. The TOWN purchased the property in the 1950's and operated the landfill until December 31, 1990, when it ceased landfilling as required by the NYSDEC. Based on TOWN records, the Landfill received primarily municipal refuse at an average rate of 450 to 500 tons per day.

In February 1978, the TOWN applied for a permit from NYSDEC to operate the Landfill in compliance with the NYSDEC Part 360 Solid Waste Regulations, which were issued by NYSDEC in 1977. In September 1979, the permit to operate was denied by NYSDEC. In May 1980, NYSDEC issued an Order on Consent to close the Landfill in accordance with NYSDEC Regulations by December 31, 1983.

In July 1984, the Order on Consent was modified to allow landfilling to continue for an indefinite period of time while the TOWN acted to rectify conditions at the Landfill. Landfill conditions were not in compliance with the then current NYSDEC Part 360 solid waste regulations at that time. In August 1989, NYSDEC issued an Order on Consent to the TOWN to cease accepting waste at the Landfill on or before December 31, 1989. However, the Landfill was allowed by NYSDEC to remain open until a solid waste transfer facility which could handle the quantity of waste delivered and disposed of at the Landfill could be constructed and put into operation. The Landfill officially ceased accepting waste and closed on December 31, 1990.

The Landfill is listed on the NYSDEC Registry of Inactive Hazardous Waste Sites (Site No. 344001, Rockland County) as a Class 2 site (i.e. a site that poses significant hazard to public health or environment - action required).

NYSDEC entered into an agreement with the TOWN to partially fund, at 75 percent of the eligible costs of the work, the remediation of the Landfill under Title 3 of the 1986 NYSDEC Environmental Quality Bond Act (EQBA). The ROD document issued by NYSDEC included the remedial action required at the Landfill to be undertaken by the TOWN. The TOWN chose to advertise the construction activities associated with the chosen remedial action in contract documents for competitive public bid.

1.2 Remedial Construction History

Contract bid documents for the Landfill remediation construction were entitled "*Remediation of the Clarkstown Sanitary Landfill and Landfill Capping Specifications and Bid Documents (the Contract), Bid No. 34-1996,*" dated March 29, 1996, prepared by WESTON. The TOWN awarded the construction contract to Ogden Remediation Services Corporation, Inc. (ORSC) of Blue Bell, PA, the lowest bidder, in a contract amount of \$19,873,727.00. The Notice to Proceed was issued on September 11, 1996, which notified ORSC to fully complete the work on or before November 27, 1998 (808 consecutive calendar days).

ORSC commenced work on or about September 11, 1996 and claimed to be substantially complete with the work under the Contract on August 27, 1998. However, due to incomplete work items and outstanding submittals, substantial completion of the project was established on November 13, 1998.

It should be noted that due to unresolved property access issues regarding the Rivero Property (Block 106-A-17), which is partially located within the boundary of the Landfill, this specified area remains to be remediated as per the ROD. Resolution of the issue is pending future negotiations by the TOWN. This Certification Report was completed to include all areas of the Landfill remediation, except the Rivero Property, which will be certified when it is completed.

1.3 Components of the Remedial Construction Contract

The Contract No. 34-1996 consisted of the major items of work summarized in this section and in subsequent sections of this report, and as shown and specified in detail on the Drawings and Specifications of the Contract. The construction drawings used for this Contract were entitled "*Construction Drawings for Clarkstown Municipal Sanitary Landfill Remediation*," including any and all addenda, and attached references. These drawings were part of the Contract, which included the Specifications and were included as one Contract document entitled "*Remediation of Clarkstown Sanitary Landfill and Landfill Capping - Specifications and Bid Documents, BID No. 34-1996, March 29, 1996*".

The major components of the Contract performed by ORSC included the following work:

- **Site Preparation:** Surveying and Construction layout services; Erosion and Sediment Control measures, which were maintained throughout the duration of the Contract; Landfill grading, structural fill placement and subgrade preparation for liner placement; and Grading to establish required grades for positive drainage, including placement and compaction of the Lake Lucille dredge materials and RAIA material;
- **Landfill Gas Management** Construction of a landfill gas (LFG) collection system, including 52 vertical extraction wells placed into the Landfill mass, LFG surface collection piping where shallow waste was encountered, nine (9) landfill gas migration monitor probes located at various strategic locations around the perimeter of the Landfill, and approximately 23,000 linear feet of High Density Polyethylene (HDPE) piping (lateral and header pipe that connected all the vertical extraction wells and surface collection piping) for the conveyance of the LFG to the blower and flare facility;
- **Leachate Collection System:** Modification and upgrade of the existing Leachate Collection System (LCS) components, including installation of new leachate collection trench;
- **Slurry Wall Installation:** Construction of a portion of the vertical slurry wall installed into the ground down to low permeability layers of the sub-surface along specified sections of the landfill;
- **Wetlands Mitigation and Restoration:** Wetlands mitigation and restoration of areas located at or near the landfill;
- **Low Permeability Layer (Geosynthetics):** Installation of 40 mil Polyvinyl Chloride (PVC) geomembrane liner, including geosynthetic fabrics above and below the PVC geomembrane

liner, and a geosynthetic drainage netting above the PVC geomembrane liner. This configuration of materials forms a cover cap over the landfill and is therefore known as the geosynthetic cap. This geosynthetic cap was placed directly above approved compacted subbase layer;

- **Liner Protection Layer (Cover Soil):** Installation of a minimum 24-inch thick compacted cover soil layer over the geosynthetic cap;
not always 24 inches
- **Topsoil and Seeding:** Installation of a 6-inch thick layer of topsoil with seeding and mulching of the topsoil layer to establish a permanent vegetative cover;
- **Drainage Control Structures:** Construction of drainage channels and diversion dikes; including culverts and outfalls. Construction of detention/sedimentation basins including basin berms, flow control and outlet channels;
- **LFG Blower and Flare Facility:** Installation of a landfill gas blower and flare facility that destroys the LFG that is directed to the flare via the LFG collection piping;
- **Additional Site Work:** Installation of the site access roads; fencing; pre-cast concrete structures including the drainage trough, Jersey barriers, and headwalls; and installation of a cast-in-place concrete travelway.

All work under the Contract was completed by the ORSC workforce, which included the following major subcontractors:

Subcontractors	Activity Performed
Barbella Environmental Technologies (BET)	• Installation and upgrade of the Leachate Collection System; • Installation of the Slurry Wall; • Installation of the Landfill Gas Collection and Flare System.
Parker Electric, Inc.	Installation of all electrical requirements of the project.
Inquip	Technical guidance and specialty equipment to BET for the Slurry Wall Installation
Environmental Liners, Inc.	Liner Installation- Fabrication, and Installation of the geomembranes including field testing of liner seams.
Fairway Testing	Field QC testing services for soils, and concrete.
Charles H. Sells, Inc.	Surveying Services
Farr Crest Excavating & Landscaping	Seeding & Mulching Services
Moretrench Environmental Services	Installation of Gas Extraction Wells and Gas Monitoring Probes.
Ratto Pile Driving	Installation of pipe pile foundations for the Leachate Collection Structures and the Landfill Gas Blower and Flare system.

1.4 Existing Documents

The following documents describe the construction and quality control for the remediation of the Landfill, which ORSC used to complete the Contract:

- Remediation of Clarkstown Sanitary Landfill and Landfill Capping Specifications and Bid Documents, Bid No. 34-1996, March 29, 1996, Roy F. Weston of New York, Inc., Valhalla, New York.
- Construction Drawings for Clarkstown Municipal Sanitary Landfill Remediation March 1996, (Including Redesign and Addendum Drawings) , Roy F. Weston of New York, Inc., Valhalla, New York. Refer to Table 1-1, following this page, for a listing of all the drawings and associated redesign revisions.

These additional documents describe the basis of the design of the remediation of the Landfill:

- Clarkstown Sanitary Landfill Remediation Final Engineering Design Report, November 28, 1995, Roy F. Weston of New York, Inc., Valhalla, New York.
- Town of Clarkstown Landfill Remediation Final Engineering Design Report, Addendum No. 1 to November 28, 1995 Report, March 29, 1996, Roy F. Weston of New York, Inc., Valhalla, New York.
- Remediation of Clarkstown Landfill Quality Assurance and Quality Control Program, March 29, 1996, Roy F. Weston of New York, Inc., Valhalla, New York.
- Attached Appendices to this Report

TABLE 1-1

**CONSTRUCTION DRAWINGS FOR CLARKSTOWN MUNICIPAL SANITARY
LANDFILL REMEDIATION
INDEX OF REDESIGN DRAWINGS**

Dwg. No.	Rev. No.	Date Issues	Title & Revision Description
	1	2-7-97	Added Drawing 2028A Cover Sheet
2001			Existing Site Conditions and Boring Location Plan
	1	2-7-97	Added geotechnical borings
2002			Existing Site Conditions and Boring Locations Plan
	1	2-7-97	Added geotechnical borings
2005			Gravel Road, Geomembrane and Slurry Wall Control Plan
	1	2-7-97	- Gravel Road "B" is widened from 12' to 15' beginning at sta. 53+00. - Gravel Road "B" widened for passing zone to 24' from sta. 51+65 to 52+45.
2006			Gravel Road, Geomembrane and Slurry Wall Control Plan
	1	2-7-97	- Gravel Road "B" to be offset from the geomembrane 7', sta. 17+65 to 36+34. - Install passing zone on Gravel Road "B" from sta. 30+90 to 31+70. Offset Gravel Road "B" 7' from geomembrane.
2007			Erosion and Sedimentation Control Plan
	1	2-7-97	- Eliminate temporary sediment basin # 7. - Sediment basin construction modified per preparatory grading plans and the sediment basin plans. Sediment basin 2: - No longer a permanent basin, is now a temporary basin. - Revised dwg indicates to install berm and rock dam. Sediment Basin 3: - Revised "proceed with work up the slope". Sediment Basin 4: - Revised rock dam and berm installation. - Revised "Proceed with work up slope". Temporary Sediment Basin # 5: - Revised construction of temporary diversion dike D-16. - Revised dwg. Notes to proceed with work in phase I area, revised from "proceed with work up slope".

TABLE 1-1

**CONSTRUCTION DRAWINGS FOR CLARKSTOWN MUNICIPAL SANITARY
LANDFILL REMEDIATION
INDEX OF REDESIGN DRAWINGS**

Dwg. No.	Rev. No.	Date Issues	Title & Revision Description
2007 <i>(cont.)</i>	1	2-7-97	Erosion and Sedimentation Control Plan Temporary Basin # 6: - Revised rock dam and berm installation. - Revised J and L and notes that L exists on the final grades as D-22. - Revised dwg. Notes to proceed with work over the phase 1 area. - Revised dwg. Adds to construction of temporary Perimeter Dike "M" on existing grade. - Revised dwg. Adds to construct diversion Dike D – 18. - Revised dwg. Notes G exits on the final grades as D – 21. Sediment Basins: - Down chute clause eliminated. - Revised Phase II Note, Construct Basin # 1, Construct temporary Dikes A, Q, and D-1 and D-5. and Install landfill cap over phase I area. Around the basin, the cap shall begin at the temporary geosynthetic termination and extend up the landfill slope.
2007 A	1	2-7-97	Erosion and Sedimentation Control Plan Temporary diversion ditch M at Riverco Property extended.
2008	1	2-7-97	Erosion and Sedimentation Control Plan Revised to show new phasing, notes that sediment basin 2 to be capped following stabilization of phase II.
2009	1	11-25-96	Preparatory Grading Plan - Landfill perimeter slope control changed from detail 6/2025 to 50/2011. - Road relocated closer to perimeter berm. - Road relocated towards the outer berm and ends on either side of sediment basin 6. - Revised outlet protection shown for basin # 6. - Edge of anchorage bench noted at edge of gravel road. - Temporary diversion dike indicated on revised dwg. Going west into basin # 6. - Revised Note 10. References preparatory grades changed to be worked in conjunction with original preparatory grading plan.
	2	2-7-97	Revised Note 11. Refer to dwg. 2024 for out let protection detail.

TABLE 1-1

CONSTRUCTION DRAWINGS FOR CLARKSTOWN MUNICIPAL SANITARY LANDFILL REMEDIATION INDEX OF REDESIGN DRAWINGS

Dwg. No.	Rev. No.	Date Issues	Title & Revision Description
2009 <i>(cont.)</i>			Preparatory Grading Plan
	2	2-7-97	- Revised Note 12. - Revised Note 13.
	3	4-17-97	Revised preparatory grades/dredge spoils fill area by KK & DP.
2010			Preparatory Grading Plan
	1	11-25-96	Revised existing and preparatory grades.
	2	2-7-97	- Added sediment basin # 3, rock dam, outlet protection outlet weir data. - Landfill perimeter slope control revised from 6/2025, slope control along gravel road, to 50/2011. - Detail 1/2024 rip rap slope protection deleted, culvert 21/2026 pipe PC-5 deleted and gravel road typical cross-section no longer referenced.
	3	4-17-97	Revised prep. Grades/dredge spoils fill area by KK & DP.
	4	4-22-97	Revised prep. Grades for parcel 8 by KK & DP.
2011			Preparatory Grading Plan
	1	11-25-96	Revised existing and preparatory grades.
	2	2-7-97	Landfill perimeter slope control detail changed from 14/2034 typical gravel road cross-section to 50/2011.
	3	4-17-97	Revised prep. Grades/dredge spoils fill area by KK & DP & added Note 2.
2012			Preparatory Grading Plan
	1	2-7-97	- Rip rap slope protection deleted, culvert PC-2 deleted. - Delete slope control 6/2025 along gravel road. - Top of slurry wall elevation revised at northern leg.
	2	4-17-97	Revised prep. Grades/dredge spoils fill area by KK & DP.
2013			Preparatory Grading Plan
	1	4-22-97	Revised prep. Grades by KK & DP
2013 A			Preparatory Grading Plan (RAIA Fill)
	1	4-22-97	Revised prep. Grades by KK & DP
	2	4-14-98	Revised prep. Grades in LFP-8 & scale area (RAIA fill)
2014			Preparatory Grading Plan
	1	10-11-96	Slurry wall relocated slightly west of culvert PC-10.
	2	2-7-97	- Delete temporary sediment basin # 7. - Delete (rip-rap) slope protection.

TABLE 1-1

**CONSTRUCTION DRAWINGS FOR CLARKSTOWN MUNICIPAL SANITARY
LANDFILL REMEDIATION
INDEX OF REDESIGN DRAWINGS**

Dwg. No.	Rev. No.	Date Issues	Title & Revision Description
2014 (cont.)	2	2-7-97	Preparatory Grading Plan - Delete channel C-10. - Delete forcemain - Realign 24" RCP and install less pipe, PC-11, ref. detail 21/2026. - Delete new manhole - Delete abandonment of 6" drain line. - Delete installation of pipe through slurry wall. - Provide slope protection into basin # 8 per 1/2024, (rip rap) outlet.
2014 A			Preparatory Grading Plan (Riverso Property)
	1	10-11-96	Revised end of slurry wall east of Riverso property.
	2	2-7-97	Revised grading around Riverso property.
	3	4-22-97	Revised prep. Grades by KK & DP.
2015			Final Grading Plan
	1	2-7-97	Note added stating "This dwg. schematically represents the final layout of the proposed geosynthetic cover system.
2016			Final Grading Plan
	1	2-7-97	Note added stating "This dwg. schematically represents the final layout of the proposed geosynthetic cover system.
2017			Final Grading Plan and Final Cover System Layout
	1	2-7-97	- Slope control changed from 6/2025, slope control along Gravel Road to 50/2011. - Widen Road to 24'. - Provide slope control per 7/2025 west of Gravel Road. - Rip rap lined channel C-17 shortened. - Rip rap lined channel C-16 shortened. - Added diversion D-22. - Realign channel C-14 and add rip-rap slope.
2018			Final Grading Plan and Final Cover System Layout
	1	2-7-97	- Revised rip-rap channel at HW-6, plans as 10' wide, 18" thick. - Basin # 3 spill way revised from 58.0 to 58.5. - Roadway shifted west. - Top of permanent berm lowered from 64.0 to 60.0. - Revised rip-rap channel at HW-8, plans per detail 1/2024. - PC-5 deleted. - Diversion D-21 extended. - Add rip-rap 18" depth, 10' long at asphalt swale, upstream of asphalt swale.

TABLE 1-1

**CONSTRUCTION DRAWINGS FOR CLARKSTOWN MUNICIPAL SANITARY
LANDFILL REMEDIATION
INDEX OF REDESIGN DRAWINGS**

Dwg. No.	Rev. No.	Date Issues	Title & Revision Description
2019			Final Grading Plans and Final Cover System Layout
	1	2-7-97	- Widen road to 24' for passing zone. - Slope control detail revised from 6/2025, slope control along Gravel Road (includes geosynthetics below road) to 50/2011.
2020			Final Grading Plans and Final Cover System Layout
	1	2-7-97	- Delete HW-3, HW-4, and PC-2. - Added asphalt swale, rip-rap slope protection upstream of asphalt swale, rip-rap slope protection down stream of asphalt swale (formerly HW-4) to be installed per 1/2024 detail. - Revised dwg. notes geosynthetic tie-in is type II per 41/2038.
2021			Final Grading Plans and Final Cover System Layout
	1	5-15-98	Revised final grades for RAIA fill and scale area.
2022			Final Grading Plans and Final Cover System Layout
	1	10-11-96	- Delete channel C-10. - Delete basin # 7. - Eliminated 2 ea. Final cover system drain outlet tubing. - Delete note "End gravel road begin paved access". - Delete new manhole. - Delete final cover system penetration (typ.). - Delete note for "end geosynthetic drain". - Delete detail 44/2039, Cover System (Type I) Termination at Slurry Wall.
	2	2-7-97	Revised grading around Rivero property.
2022 A			Final Grading Plan and Final Cover System Layout (Rivero Property)
	1	10-11-96	Realign slurry wall around Rivero property.
	2	2-7-97	Revised grading around Rivero property.
2024			Stormwater Management Details
	1	2-7-97	Revised Table 1 for sediment basins and all other aprons shown and added outlet protection detail.
2025			Stormwater Management Details
	1	2-7-97	- Revised Table 1 "Note". - Revised detail 4 notes 2 & 4. - Revised Grading along landfill perimeter.

TABLE 1-1

CONSTRUCTION DRAWINGS FOR CLARKSTOWN MUNICIPAL SANITARY LANDFILL REMEDIATION INDEX OF REDESIGN DRAWINGS

Dwg. No.	Rev. No.	Date Issues	Title & Revision Description
2026			Stormwater Management Details
	1	10-11-96	• Revised 24" rcp location and tables.
	2	2-7-97	• Revised Table 2, headwall structure at PC-8 has been changed from Type "C" to Type "A". • Deleted PC-2 and PC-5, Table 2. • Revised Table 3, delete 15" cmp and 18" cmp.
2027			Temporary Sediment Basin Plans
	1	2-7-97	• Revised grading along landfill perimeter.
2029			Temporary Sediment Basin Plans
	1	2-7-97	• Voided sediment basin # 7 (Riverso property).
2030			Temporary Sediment Basin Profiles
	1	2-7-97	• Voided sediment basin # 2 (Section C).
2032			Temporary Sediment Basin Profiles / Details
	1	2-7-97	• Voided Sections 4, added Section A, B, and basin outlet structure.
2033			Temporary Sediment Basin and General Details
	1	2-7-97	• Table 1: Temporary sediment basin elevations and dimensions deleted basin information for basins 2 through 7. • Revised detail 12 sediment basin dewatering device and detail 13, Typical Anti-Seep Collar, note applies to basin 1 and 8 only.
2034			General Details
	1	2-7-97	• Revise road width of Gravel Road on detail 14.
2039			Final Cover System Details
	1	2-7-97	• Add 4" asphalt swale section for flow crossing.
2040			Final Cover System Details
	1	2-7-97	• Replaced detail 46 with new detail.
	2	11-10-97	• Revised detail #46.
	3	3-11-99	• Conforms to construction records (Ogden).
2041			Landfill Cross-Sections
	1	2-7-97	• Revised Cross-sections A through I.

TABLE 1-1

**CONSTRUCTION DRAWINGS FOR CLARKSTOWN MUNICIPAL SANITARY
LANDFILL REMEDIATION
INDEX OF REDESIGN DRAWINGS**

Dwg. No.	Rev. No.	Date Issues	Title & Revision Description
2042			Landfill Cross-Sections
	1	10-11-96	• Revised SW relocations and references.
	2	2-7-97	• Revised section J and K (grading) and section L (Riverso property).
2043			Slurry Wall Subsurface Profiles
	1	2-7-97	• Revised North Slurry Wall Profile
4001			Collection Piping Plan and Profile Collection Chamber No. 2N
	1	10-11-96	• Note 4 added.
	2	2-7-97	• Note 5 and 6 added, revised plan and profile.
4003			Force Main Piping Plan & Sections, Collection Chambers 3 & 4
	1	2-7-97	• Revised force main and grading.
4004			Force Main Piping Plan & Section Collection Chamber # 2N
	1	2-7-97	• Revised bedding detail, added Riverso property.
4004 A			Force Main Piping Plan & Section Collection Chamber # 2N
	1	2-7-97	• Revised bedding detail.
4005			Force Main Piping Plan & Section Collection Chambers # 5, 6, & 7
	1	2-7-97	• Revised force main and grading.
4008			Leachate Collection System, Leachate Collection Chamber Plan & Section
	1	2-7-97	• Added drain valve.
	2	4-29-97	• Revised table of elevations.
4101			Landfill Gas Collection System Layout (Sheet 1 of 2)
	1	2-7-97	• Added note.
4101 A			Landfill Gas Collection System Layout (Sheet 1 of 2)
	1	2-7-97	• Added Note and plan (Riverso property).
4102			Landfill Gas Collection System Layout (Sheet 2 of 2)
	1	2-7-97	• Added note.
5002			Electrical Site Plan
	1	2-7-97	• Revised electrical layout, added Riverso property.
5002 A			Electrical Site Plan
	1	2-7-97	• Revised electrical layout.

2.0 SITE PREPARATION

Prior to the arrival of ORSC on site, the TOWN's equipment and personnel were used to maintain the landfill cover. The site work performed by the TOWN consisted of rough grading the access roads, and placing general backfill material to rough grade the side slopes as necessary.

The primary objective for ORSC with respect to site preparation involved the rough grading of the landfill followed by subgrade preparation of the surface to receive the low permeability geosynthetic layer. As presented in subsequent sections of this report, site preparation is divided into a progression of steps including erosion and sedimentation control, clearing and grubbing, rough grading, and subgrade preparation.

Both the rough grading and subgrade preparation sections of this report describe the placement of structural fill to achieve the preparatory landfill grades, however, the distinction is made to differentiate the layers due to the inclusion of on-site and alternative fill materials (RAIA and Lake Lucille) in the deep fill locations of the rough grading layer. The on-site and alternative fill materials included structurally sound and stable materials used to offset the need for placement of imported soils in deep fill areas of the site.

2.1 Landfill Parcels (LFP's)

In order to facilitate construction and minimize the amount of land disturbance, ORSC divided the landfill into 9 manageable parcels identified as follows:

- Landfill Parcel (LFP) 1 is located at the northeast corner of the landfill and generally covers the area of the new paved compost facility.
- LFP2 is located at the northwest corner of the landfill and covers only the area of the Pyramid property, which was the area used for waste excavation and relocation during the project. No capping took place over LFP2.
- LFP3 is located to the north and west of the landfill and generally covers the side slopes starting at the transition from smooth to embossed PVC and extending down to the wetlands.
- LFP4 is located to the west and south of the landfill and generally covers the side slopes starting at the transition from smooth to embossed PVC and extending down to the wetlands.
- LFP5 is located to the southeast of the landfill in the area also known as the "Ballfield."
- LFP6 is located on the top of the landfill and generally covers the northern half of the smooth PVC-lined area.
- LFP7 is located on the top of the landfill and generally covers the southern half of the smooth PVC-lined area.
- LFP8 is located to the east of the landfill and generally covers the side slopes down to the transfer station area.
- LFP9 is located to the east and is comprised of the transfer station area.

2.2 Erosion and Sedimentation Control

Prior to any excavation work or land disturbance activities, ORSC was required to prepare and submit a Storm Water Pollution Prevention Plan (SWPPP) for review and approval by WESTON. The initial plan was submitted on August 2, 1996 and was given final approval by WESTON on October 10, 1996. In accordance with the approved SWPPP and Specification Section 02930 ORSC installed and maintained erosion and sediment control measures around the entire site. The SWPPP and Specifications required ORSC to control erosion and the discharge of silt-laden runoff from stockpiles and from all areas under construction.

The SWPPP required that ORSC provide and maintain temporary erosion control structures. The temporary erosion control structures utilized by ORSC consisted of hay bales, silt fence, temporary seeding, turbidity barriers, diversion channels, and sedimentation basins.

Silt fence was placed at the toe of slope surrounding the entire perimeter of the landfill from Sedimentation Basin #8 to the north east corner of LFP #5. Silt fence was also installed around the perimeter of LFP #5. Silt fence was maintained throughout the project by ORSC. Turbidity barrier was installed as indicated in the approved SWPPP in the wetland area north of LFP #1, along the southern and western perimeter of LFP #2 to protect the neighboring waterway from silt and debris resulting from the excavation of the parcel for wetland mitigation, and along the southern edge of LFP #4 also known as Muddy Brook.

During construction, temporary sedimentation basins (Basins) were constructed, as indicated on the design plans, at strategic locations around the Landfill. Basin construction began with Basin #8 located in the northeast corner of the site and continued counterclockwise around the Landfill. The discharge ends of the Basins were protected by means of riprap spillways. Crescent shaped rock dams were constructed within the Basins to restrict flow over the spillways and promote settlement of suspended sediment.

Supplemental flow restriction was constructed prior to and during storm events to mitigate developing flows and prevent offsite migration of sediment. Typically hay bales and silt fence were spiked across developing flow channels to filter and slow open channel flow development.

On side slopes and in diversion dike flow channels, erosion control blankets and turf reinforcing mats were installed depending on the anticipated flow velocity. Once installed the slopes and channels were seeded to protect them from erosion until the vegetative cover became established.

2.3 Clearing and Grubbing

Site preparation began with the clearing of trees, brush, shrubs, other vegetation, rubbish and debris; grubbing of stumps, buried logs, two inch diameter roots, root mats and organic materials; and stripping of surface soils within the Contract Limits of Work and in accordance with the contract documents. All trees and shrubs within the limit of the work were removed, unless designated to remain, as was the case in Sedimentation Basin #3. Trees and shrubs were mulched after removal. Mulch resulting from the clearing process was spread across large fill areas in a three to four inch lift.

Earthwork operations did not start in areas where clearing and grubbing was not complete, with the exception of stumps and large roots that were removed concurrent with excavation.

Areas that received less than 2 feet of fill and areas upon which the landfill final cover systems and associated items were to be directly constructed were grubbed and stripped. Stumps were removed and stockpiled for later placement in the waste disposal area. Stumps in deep fill areas (i.e., areas identified to receive 2 feet or more of fill material) were cut flush with the ground and left in place. Stumps and their root mats remaining in perimeter berm locations that required bridge lift stabilization, were left in place. Depressions in the subgrade made by the removal of stumps or roots were filled with structural fill.

2.4 Rough Grading

Prior to performing grading work, ORSC surveyed each of the Landfill Parcels to establish pre-construction topography. The pre-construction topography was used to redesign the preparatory grades to incorporate any changes in the Landfill topography resulting from landfill settlement. Following the pre-construction surveys, a control grid was established for placement of fill and management of cut areas. The control grid had defined positions every 50 to 100 feet across the area of the proposed landfill cap.

Rough grading activities included grading necessary to establish the appropriate Landfill side slopes dimensions for the construction of channels reflected in the subgrade design, as well as establishing the locations of the main surface features (access roads, sediment basin, and drainage structures). Sideslopes varied from a minimum of four- (4) percent slope to a maximum of 3 horizontal to 1 vertical (3H: 1V). Structural fill used for rough grading was furnished by numerous sources. The Structural fill sources are described in the following section.

2.4.1 Material Sources – Rough Grading

On-site and imported materials were utilized for rough grading and stabilization of the site. Stockpiled construction and demolition (C&D) materials, recycled concrete, Lake Lucille and RAIA alternate fill material, and spoils from the on-site screening operations were placed in deep fill locations to reduce the volume of imported materials required. Rough grading materials were placed in deep fills (locations that would permit up to two feet of subgrade materials to underlie the low permeability barrier layer as a cushion). Some rough grading materials (C&D and recycled concrete) were also utilized to construct access roadways through soft or unstable areas of the site.

Other on-site materials consistent with the requirements for structural fill were used for rough grading of the site as well as construction of the Basin walls, perimeter berms and the soil component for the soil bentonite slurry wall construction. These materials included the TOWN stockpile and Ballfield materials (materials excavated from LFP #5 during wetland mitigation).

2.4.2 Installation – Rough Grading

Rough grading materials such as C&D, and the TOWN stockpile materials were on-site at the beginning of the Contract. Additional materials used for rough grading such as Waste Management Soils were imported and stockpiled. Earth moving equipment such as excavators and payloaders were used to load the various materials into articulated trucks (DJB's & 10-wheel dump trucks) for transport to and off-loading in approved locations. Materials were spread using bulldozers and compacted by means of tracking the materials followed by rolling with vibratory compaction equipment.

C&D and screen spoils were placed in lift thickness controlled by the relative nominal sizes of the materials placed. Generally, lift thicknesses were limited to between twelve and eighteen inch depths. Bulky materials such as concrete sections were arranged in the orientation providing the best fit and fixed in place using smaller diameter particles and soil materials to fill voids. Materials were tracked into place and rolled using vibratory compaction equipment to further interlock the various size particles. Whenever practical, granular soil layers were installed between the C&D materials to provide smaller particles to infiltrate the remaining void spaces. QA inspectors from WESTON continuously inspected and monitored the placement and densification of the rough grading materials.

2.4.3 Quality Assurance/Quality Control During Installation – Rough Grading

Quality assurance and quality control during construction of the rough-grading layer consisted of full-time observation by WESTON, as well as laboratory and field-testing when applicable. The thickness of material layers was monitored by means of measurements in the field and placement of marked grade stakes on a 100-foot by 100-foot grid.

The thickness of the rough grading layers was verified by hand digging test pits, as directed by WESTON, when appropriate. No test holes were dug without the QA Inspector present. After measurements were made, the holes were backfilled with the excavated soil, and compacted using of hand-held equipment.

All laboratory and field testing was performed by the approved independent geotechnical laboratory, Fairway Testing Laboratories, subcontracted by OGDEN. Fairway Testing Laboratories provided continuous quality control (QC), including field moisture and density tests during the compaction of each lift of soil in accordance with Table 2.1 below. WESTON performed periodic quality assurance (QA) testing to verify QC testing results.

Table 2-1
Quality Control
Field and Laboratory Minimum Testing Requirements for Structural Fill

Property	Test Method	Frequency
Particle Size Analysis w/ Hydrometer	ASTM D421/422	5,000 yd ³
USCS Classification	ASTM D8487	5,000 yd ³
Atterberg Limits	ASTM D4318	5,000 yd ³
Moisture Content (Laboratory)	ASTM D2216	5,000 yd ³
Standard Proctor Compaction	ASTM D698	5,000 yd ³
Field Density	ASTM D2922	10,000 ft ²
Moisture Content (Field)	ASTM D3017	10,000 ft ²
Lift Thickness	-	*
Environmental - Cleanliness	EPA 8020	10,000 yd ³

* lift thickness testing was performed as necessary to facilitate materials placement and testing

The rough grading soil was compacted to a minimum density of 95 percent of the maximum dry density with moisture content within +/-3 percent of the optimum moisture based on the Standard Proctor Test, as determined by ASTM D-698, where applicable. The moisture and density of the rough grading soils were measured in the field by a nuclear moisture/density-testing device at depths consistent with the lift thickness placed. Field density/moisture tests were performed at approximately a 100-foot grid interval on the rough grading soil. Lifts failing moisture/density testing were either scarified or had moisture added, re-compacted and were retested until passing results were achieved.

Refer to Volume 2 of 6, Appendix A1 for the structural fill moisture/density field testing results and locations to include all re-testing where applicable.

Refer to Volume 2 of 6, Appendix A2 for the structural fill geotechnical laboratory test results.

Refer to Volume 2 of 6, Appendix A3 for the structural fill chemical analysis laboratory test results

2.5 Subgrade Preparation

The work associated with the liner subgrade layer included furnishing, placing, grading, and compacting six (6) inches (minimum) of subgrade fill directly over the rough graded surface to provide a suitable surface for deployment of the geomembrane. All subgrade soils used were tested in accordance with the approved Technical Specifications.

2.5.1 Material Source - Subgrade

The material used for the subgrade layer was in general conformance with the Technical Specifications. All subgrade soil was tested and approved per the QA/QC requirements of the Specifications prior to being imported to the Clarkstown Landfill project.

The material used for the subgrade layer was imported from various borrow sites. All material was transported to and stockpiled or placed directly at the construction area on site by various trucking companies.

2.5.2 Installation - Subgrade

The subgrade fill was placed directly above the rough graded surface in one loose lift thickness not exceeding 12 inches and compacted to obtain six (6) inches minimum thickness. Low ground pressure (LGP) dozers were used to grade the subgrade. The thickness of the subgrade was monitored using surveying stakes at approximately 50 grid intervals that were marked six (6) inches above the approved rough graded surface. A smooth drum vibratory roller was used to proof roll and compact the subgrade layer to provide a smooth firm subgrade surface for placement of the geosynthetics.

2.5.3 Quality Assurance/Quality Control During Installation - Subgrade

ORSC retained the services of Fairway Testing Laboratories to perform field density and moisture testing on the subgrade layer. The subgrade was compacted to a minimum of 95 percent of maximum dry density with a moisture content within ± 3 percent of the optimum moisture based on the Standard Proctor Test, as determined by ASTM D-698. The subgrade soil layer moisture and density were measured in the field to a minimum 6-inch depth by a nuclear densometer. Both QC and QA personnel performed field density/moisture testing on subgrade materials at a frequency of 1 test per 10,000 square feet placed for each lift. Lifts failing moisture/density testing were either scarified or had moisture added, re-compacted and were retested until passing results were achieved. Refer to Volume 2 of 6, Appendix A1 for the structural fill moisture/density field testing results and locations to include all re-testing where applicable. Subgrade fill was not placed upon frozen or saturated surfaces of the rough graded landfill nor was mud, snow, ice or frozen earth incorporated in the material.

QA/QC testing was conducted on the subgrade structural fill material in accordance with the requirements outlined in Table 2-1 above. The QC Site Manager took all samples in the presence of WESTON's Geotechnical QA Inspector. Pre-construction samples were collected prior to delivery and construction samples were collected upon delivery at the specified frequencies. Refer to Volume 2 of 6, Appendix A2 for the structural fill geotechnical laboratory test reports and Appendix A3 for the structural fill chemical analysis laboratory test reports.

3.0 LANDFILL GAS MANAGEMENT

The municipal solid waste within the landfill creates a gaseous by-product commonly referred to as Landfill Gas (LFG), which is composed primarily of methane (CH_4) and carbon dioxide (CO_2), with lesser amounts of nitrogen (N_2) and oxygen (O_2). LFG is created as a result of aerobic and anaerobic biological activity during the natural decomposition process of compacted and covered municipal solid waste. The rate of LFG generation is dependent upon such factors as temperature, moisture content, composition of refuse, age of refuse, density of refuse, the presence of nutrients, pH level, and oxygen levels. LFG, due to the high concentration of methane gas, is a potentially explosive gas when found in concentrations greater than 5 percent of the total volume of air being measured. Five percent by volume of methane gas in air is known as the Lower Explosive Limit (LEL). Methane is a colorless, odorless, gas that is lighter than air in its pure form. LFG can be very odorous from trace components such as hydrogen sulfide (H_2S), and its density can vary depending on the concentrations of the other gas components, making it typically slightly heavier than air but in some cases slightly lighter than air.

LFG at the Clarkstown Landfill is controlled by means of an active LFG recovery system, which draws LFG from the Landfill under vacuum pressure. The LFG recovery system consists of 52 vertical extraction wells, two horizontal surface collector networks, and the transfer station collection and venting pipes, which are all connected to the LFG blower and flare facility.

Off-site LFG migration is monitored by a series of nine (9) LFG migration monitoring probes located along the eastern and northern property boundaries of the Landfill. One LFG migration monitoring probe, GM-7, was not installed due to lack of access to the Riverso property.

Migration to the west and south is inhibited by the natural water barriers at the Clarkstown Landfill. These natural water barriers are present along most of the perimeter, primarily along the north, west, and south boundaries. The Landfill is bounded to the north by a small unnamed creek, to the south by Muddy Brook, and to the west by wetlands that are part of the Hackensack River Wetlands. The east is bounded primarily by the Town of Clarkstown Transfer Station property and Route 303. In locations where natural barriers do not exist and where depths of trash were too shallow for vertical wells, horizontal Landfill Gas collection systems were constructed at the locations shown in plan view on Drawings 4101 and 4102, and in detail on Drawing 4105. Modifications were made to the proposed horizontal surface collector network in the vicinity of LFP 1 due to lack of access to the Riverso

The Transfer Station located adjacent to the landfill to the east was equipped with 17 LFG vent stacks, of which 12 had blowers to control and reduce any possible migration of LFG to the structure. The blowers were designed to withdraw LFG from perforated horizontal pipes placed beneath the Transfer Station slab and vent it at the roofline. The blowers, most of which were not operable at the start of the construction, were removed and the vent pipes were reconnected to a new manifold piping system that became part of the active LFG recovery blower/flare system. Shortly after start-up, it was determined that the composition of the LFG being recovered from the Transfer Station system contained lower levels of methane and higher levels of oxygen rendering it inappropriate for combustion at the flare. An alternative design to remove and dispose of the LFG from the Transfer Station system is currently being developed and reviewed and will be forwarded to the NYSDEC for approval.

3.1 Landfill Gas Extraction Well Installation

As part of the Clarkstown Landfill Remediation Contract, ORSC was responsible for the installation of fifty-two (52) vertical LFG extraction wells and two (2) horizontal LFG collection systems. ORSC subcontracted this portion of the work to Barbella Environmental Technologies (BET) who in turn subcontracted the drilling of the vertical extraction wells to Moretrench Corporation.

The vertical wells were drilled using a track mounted drill rig with an auger-type drill bit and telescoping Kelly bar, which was capable of drilling the 36 inch diameter well bores to the specified depths, as designed and noted on the gas extraction well schedule on Drawing 4104. The vertical LFG wells vary in depth from about 10 feet to 60 feet based on the known depths of in-place refuse at that particular location.

The depth of each well allowed for approximately 10 feet minimum vertical distance between the bottom of the well bore and the bottom of the landfill refuse. Continuous well bore depth monitoring and close observation of drilling spoil materials were performed to ensure that the well bore depths did not exceed the estimated depths of refuse and possibly penetrate and potentially compromise the integrity of the natural clay liner located at the bottom of the landfill. All well drilling spoils were promptly collected and removed on a daily basis and disposed of in the on-site disposal area #1. The 52 LFG wells consisted of a total of 1,867 vertical feet of 6 inch diameter Schedule 80 heavy-duty polyvinyl chloride (PVC) plastic pipe with about 925 feet or approximately 50 percent of the total vertical length being slotted.

The slotting pattern actually used was not as designed, but had a slightly greater percentage of open area per foot than the original slotting design. This change was reviewed, approved, and formally accepted. The slotted portion of the vertical well piping was installed in the center of the borehole and was surrounded by a clean sub-angular coarse gravel, identified as Tilcon ¾" (NYSDOT#2). Installed directly above this layer within the well borehole was a layer of bentonite pellets which was typically 3 feet in depth with the upper 2 feet of the bentonite pellets hydrated during installation with a bentonite slurry mixture to ensure a sufficient well bore seal. The remainder of the hole was back filled with clean on-site fill dirt and compacted as per the specifications.

2, hydrated slurry?

Special safety precautions were taken by the ORSC and Weston Health and Safety Officers during the drilling and back filling process to ensure that air quality in the breathing zone was acceptable and that all personnel working in the vicinity of the bore hole were properly secured with a safety harness and line at all times.

The quantity and locations of the vertical LFG wells were established using the total of the available landfilled acreage with a minimum solid waste depth of 20 feet and a minimum frequency of one well per acre, with a rough spacing of approximately 200 feet. All vertical LFG wells were installed in accordance with the construction plans/drawings and the technical specifications with the exception of minor field location and depth adjustments. In two areas of the landfill, the northeast and southeast corners, where minimum required depths of solid waste were not available, horizontal LFG well systems were utilized, as indicated on the approved plans, to ensure adequate and complete gas recovery.

3.2 LFG Horizontal Collection System

The horizontal LFG well system, also referred to as surface collectors, are a series of perforated 6 inch diameter high density polyethylene (HDPE) plastic pipes placed horizontally within 18" by 18" trenches surrounded by NYSDOT #1 gravel and 6-ounce non-woven geotextile. The trenches are spaced approximately 100 feet apart and are generally located directly beneath the geomembrane liner. The horizontal LFG well systems/surface collectors were installed in accordance with the construction plans/drawings and the technical specifications with the exception of a small section of the 'North' surface collector which was eliminated due to the inaccessibility of the Rivero property at the time of construction. Additionally, the surface collector network to the north of the ballfield was installed to the grades as indicated on the original plans, prior to the placement of additional fill materials (known as RAIA II). To control the possibility of any LFG above this surface collector network, four (4) passive vents were installed to vent any LFG that might be produced by the RAIA II material.

3.3 Landfill Gas Collection System

As part of the Landfill Remedial Construction Contract, the 52 vertical extraction wells and two horizontal collection systems were interconnected by a pipeline manifold system that consisted of approximately 17,000 linear feet of various diameter (2, 4, 6, 8, and 10 inch diameter) heavy-duty high density polyethylene (HDPE) plastic pipe. The main LFG collection system consists of a single looped ring main header pipe from which a series of 12 valved branched laterals (designated A through L) extend, connecting the central ring main to the 52 extraction wells, the 2 surface collector systems, and the wells/vents at the Transfer Station zone. The 12 branch laterals are individually controlled by what is referred to as 'Zone Valves' (designated A through L).

The central ring main header pipe itself is segmented into sections by four isolation valves, identified as "Header Valves" (designated I through IV). Each valve in the system is enclosed within a rectangular vault, the cover of which was installed flush with the final grade of the landfill. In addition, each 'Zone' or 'Header' Valve assembly is equipped with a valved sample port connection upstream of the valve within the vault to allow for monitoring of LFG quality, pressure, and temperature at each location.

This active LFG collection system transports the LFG from the wells under a slight vacuum to an on-site thermal incinerator (flare) at which point the LFG is ignited and destroyed at approximately 1500 degrees Fahrenheit.

The LFG collection system piping was placed directly above the drainage composite and PVC membrane liner on an additional layer of 12-inch wide drainage composite material (a "rub-sheet"). OGDEN requested and received approval to place the collection system piping in its designed location prior to placing the cover soil above and around it, as opposed to placing the cover soil and then excavating the piping trenches to within a few inches of the liner which could possibly result in unseen liner damage and thus compromise the integrity of the geomembrane liner system. The piping was surrounded and covered by the cover soil material, which was carefully placed over the collection system piping to a thickness of 24 inches. Topsoil was later placed above the cover soil to a depth of 6-inches. It should be noted that it was

- first successfully demonstrated that the HDPE piping could withstand, without any deformation or degradation, the dynamic loads of the cover soil placement and compaction process/equipment, before this alternative installation procedure was approved.

The entire LFG collection system piping was pressure tested, in segments, after cover soil placement to ensure that no damage occurred to the piping during soil placement operations. All LFG collection system piping was installed with a minimum slope of 2 percent typically in the direction of the LFG flow. The natural contours of the landfill were utilized as much as possible to provide a natural minimum slope of 2 percent and in most cases greater. In locations where no slope was available or where a 'reverse slope' condition occurred (piping with slope opposite of LFG flow direction), low point condensate traps, also referred to as "drip legs", were installed, which allow for gravity flow of condensate back into the landfill.

There are 12 condensate traps/drip legs at the Landfill installed at strategic locations, which are designed to remove a significant amount of in-line condensate before it reaches the blower/flare facility. Each condensate trap is located within a vault for access and/or maintenance and is equipped with a shut-off valve between it and the LFG collection system which can be accessed through a 12 inch diameter vertical pipe extending from the valve to the covered landfill surface. The condensate traps are shown in plan view on Drawings 4101 and 4102 and in detail on Drawing 4106. The majority of the remaining entrained in-line condensate in the LFG stream is removed at the condensate knockout tank located at the south end of the blower/flare compound.

The condensate knockout tank is a buried, vertical, cylindrical, double-walled high density polyethylene (HDPE) tank, with a 375 gallon capacity before pumps are activated, where the condensate is accumulated and periodically pumped through a buried 2 inch diameter HDPE force main pipeline to the condensate storage tank. The condensate storage tank is an above-ground, horizontal, cylindrical, heated and insulated, double-walled stainless steel tank, with a 5,000 gallon capacity, where the condensate is temporarily stored and released in a controlled manner by a timer-actuated motorized discharge valve into a nearby manhole where it enters the Rockland County sewage system.

3.4 Wellheads, Vaults and Valves

The Landfill Gas Collection System includes 52 LFG extraction wells. Each wellhead is secured within a vault installed flush at final grade. The wellheads came pre-fabricated from a shop where they were pre-assembled, pressure tested, and shipped to the site in one piece. The wellheads are constructed of 2 inch Schedule 80 heavy-duty polyvinyl chloride (PVC) plastic pipe with threaded connections and a movable/adjustable 6 inch by 2 inch slip joint fitting for easy vertical adjustment which is expected to be required in the future due to landfill settlement. The wellheads include a flow control valve, as well as a flexible hose for connecting the wellhead to the collection pipe, on an integrated orifice plate with pre-drilled and pre-installed quick-connect sampling ports. These ports allow monitoring devices for gas quality, flow rate, pressure, and temperature to be easily connected to the wells .

The LFG well vaults are constructed of a heavy-duty fiberglass composite material with a removable and lockable double lid. The rectangular vault interior dimensions are approximately 6 feet long by 3 feet wide by 30 inches deep with a 12 inch opening in the bottom of the vault for the well pipe penetration and an 8" opening at the lower portion of one end for the collection pipe penetration.

The LFG collection system control valve vaults are constructed of a heavy-duty fiberglass composite material with a removable and lockable double lid. The rectangular vault interior dimensions are approximately 4 feet long by 3 feet wide by 30 inches deep with two 12-inch openings at the lower portion of each end for the collection pipeline penetrations.

The condensate trap/drip leg vaults are constructed of a heavy-duty fiberglass composite material with a removable and lockable single lid. The rectangular vault interior dimensions are approximately 3 feet long by 2 feet wide by 30 inches deep with an offset 12 inch opening in the bottom of the vault for the condensate trap penetration.

The 52 valves in each wellhead assembly are 2-inch gate valves, which allow for maximum control of LFG flow rates and pressures. The valves were installed rotated 90 degrees from what is depicted on the plans, with the handles to the side to ensure that the handles did not interfere with the underside of the vault lid should settlement occur.

The 16 collection system control valves, referred to as 'Zone' or 'Header' valves are butterfly valves sized in accordance with the size of the existing collection system pipeline at each respective location. The valves are considered isolation and/or control valves and are typically left in the full open position. These valves are closed only to isolate specific areas of the collection system piping to facilitate vacuum distribution problems and/or leak detection and repair.

Submittal information pertaining to Sections 3.1 Landfill Gas Extraction Well Installation and 3.2 LFG Horizontal Collection System is provided in Volume 2 of 6, Appendix B1: LFG Extraction Wells and LFG Migration Monitoring Probes – Piping, Crushed Stone and Boring Logs. Appendix B2: LFG Collection System Piping Data contains submittal information pertaining to Section 3.3 Landfill Gas Collection System. Similarly, Appendix B3: Wellheads, Vaults and Valves contains submittal information pertaining to Section 3.4 Wellheads, Vaults, and Valves.

4.0 LANDFILL GAS BLOWER AND FLARE FACILITY

The blowers and flare stack were constructed in conformance with the contract drawings, except for minor modifications to the layout of the electrical control panels. The condensate tank interiors were QC and QA inspected on-site for corrosion protective coatings. Underground electrical grounding circuits were installed per plans. Alarms and safety shutdowns were installed and tested prior to flare start-up.

The Landfill Gas (LFG) Blower/Flare System consists of three systems which are: an enclosed ground flare system, a gas handling system, and a blower and flare control system. It is located within a 60 foot x 116 foot security-fenced and gated area, which contains all of the mechanical systems and control equipment for the handling, processing and combustion of the LFG. This portion of the work was installed in accordance with the technical specifications and construction drawings. The fabricator of the systems met all of the minimum required qualifications as set forth in the specifications. The blower/flare system meets the specified flow, temperature, pressure and performance requirements. Construction materials and workmanship were found to meet all requirements as noted in the technical specifications and construction drawings. The blower/flare system has gone through initial start-up and commissioning and has demonstrated successful continuous operation with only minor electrical malfunctions which were quickly identified and promptly corrected.

The main control panel with its built-in program logic computer 'PLC', is the heart of the system. It is equipped with status, alarm, and shutdown warning lights, which monitor a variety of system functions. Within the control panel is a continuous chart recorder, which displays and records flow rate, flare temperature, methane concentration and oxygen levels in the gas. Flow rate data is received from an annubar and transmitter located in the LFG main pipeline downstream from the blowers. LFG analysis is performed in the gas analytical cabinet (GAC) located adjacent to the control panel. Also located at the control panel is the flare stack temperature controller that monitors and controls the combustion temperature of the LFG by automatically adjusting the three air inlet louvers located at the base of the flare stack. The panel also has numerous display and setpoint switches, which display various real-time levels, allowing for easy setpoint adjustments. The control system can be operated in three basic modes, Auto, Manual, and Test. For normal continuous unmanned operation, the system will be set in the Auto mode.

The condensate knockout tank is the first vessel that the LFG passes through via the header pipe from the Landfill well field. This predominantly below-grade double-walled HDPE vessel removes a large quantity of condensate from the gas stream with a series of baffles. The accumulated condensate is then pumped through a 2 inch HDPE force main to the condensate storage tank located approximately 300 feet away (adjacent to Route 303). (See Section 3.3)

The LFG leaves the condensate knockout tank and is directed to the blowers via two gas streams. Individual demister vessels intercept additional moisture and particulates from the LFG streams before entering the blowers. A single manual control valve is located in the gas main before the demisters and one is also located before each blower, which allows for individual flow control through each blower. The LFG, which is under a vacuum before the blowers, is then under pressure after discharge from the blowers. The two LFG streams are again united shortly after discharge from the blowers and pass through a single 10-inch diameter pipeline to the flare.

Along the pipeline, which leads to the flare, is an automated hydraulic control valve, which has a spring-actuated fail-closed safety feature. This valve completely shuts down the flow of LFG to the flare for a variety of pre-programmed causes including a power failure. Downstream from this valve is the flame arrester, which is an essential safety device which consists of a series of aluminum baffles within a steel box. The flame arrester prohibits any flame from passing through it (i.e., "backing up" from the flare into the LFG pipeline).

The LFG passes into the flare through the burner manifold and through numerous burner tips where it is ignited and destroyed at approximately 1500 degrees F. The flare stack, which is approximately 8 feet in diameter and 30 feet in height, has a flame detector to continuously check the combustion chamber area to assure that a flame is detected while the blowers are in operation. It is equipped with three thermocouples which can detect and record the interior flare stack temperatures at any one of three different vertical locations. Three automated louvers are located near the base of the flare on three sides which allow for controlled and regulated inflow of air for mixture with the LFG at the point of combustion. The automated and continuously adjusting louver settings are controlled by the temperature controller located at the previously described main control panel. The combusted LFG finally exits the top of the stack at approximately 30 feet above ground level.

Throughout the first year of operation, visual observation of the flare stack showed no evidence of incomplete combustion. At no time was any visible smoke or particulate matter observed being emitted from the flare stack.

Compliance test methods for the landfill gas flare at the Landfill were originally proposed in the test program prepared by Roy F. Weston of New York, Inc. (WESTON) and as approved by the New York State Department of Environmental Conservation (NYSDEC) in February 1999. This original test compliance effort was field conducted on February 17 and 18, 1999, in accordance with the test methods as approved.

The original test program, performed in accordance with Environmental Protection Agency (EPA) Reference Method 25C, demonstrated that this test method did not have the necessary precision for compliance with the requirement for 98% destruction/removal efficiency for non-methane organic carbon (NMOC) emissions. The concentration of NMOC in the landfill gas, at the inlet to the flare, is on the order of 1,000 parts per million (ppm) as carbon, as measured by Method 25C. Due to the relatively low concentration of NMOC in the landfill gas and the ambient dilution air introduced into the flare, a NMOC concentration on the order of 1 ppm is required to demonstrate 98% destruction/removal efficiency. The limit of detection for Method 25C is on the order of 15 ppm NMOC as carbon. The high limit of detection prevents the demonstration of NMOC destruction/removal efficiency using Method 25C.

WESTON, with the approval from NYSDEC, conducted a supplemental flare stack test on October 28, 1999. This re-test combined EPA Reference Methods 25A and 18. The retest results proved to be within the acceptable levels. Please refer to Attachment 1 for the data/report and NYSDEC approval letter.

5.0 LEACHATE COLLECTION SYSTEM

The existing Leachate Collection System (LCS) was originally designed to collect the precipitation and flowing groundwater that, through exposure to the landfill refuse, became leachate. The mound of leachate within the landfill mass would flow outward toward the landfill perimeter to a gravel filled collection trench and into the existing collection chambers. From the chambers the leachate would be discharged to the Rockland County Sewer system.

Due to operating deficiencies and the presence of solid waste outside the boundaries of the existing LCS, the existing LCS was upgraded and refurbished under this Remediation Contract. The existing LCS was for the most part reconstructed to the lines and approximate grades indicated on the Drawings and Contract Specifications. The work included abandonment of existing chambers # 2 and #7 and construction of two new Leachate Collection Chambers (LCCs, referred to as 2N and 7N), construction of two new Leachate Collection Trench (LCT) loops, refurbishment of 5 existing chambers (LCCs 1, 3, 4, 5 and 6) and the construction of a new tank farm for the collection and storage of leachate.

5.1 Existing System

The existing LCS contained seven (7) LCCs located at points along the perimeter of the Landfill. The leachate flowed into each LCC, via gravity, through a network of perforated collection pipes within stone filled trenches. Each Collection Chamber had two (2) collection pipes penetrating its structure.

The leachate collected in LCC Nos. 2, 3 and 4 was pumped through individual force mains and discharged into the existing temporary leachate Holding Basin No. 1. The leachate collected in LCC Nos. 5, 6 and 7 was pumped through individual force mains and discharged into the existing temporary leachate Holding Basin No. 2. The leachate collected in Collection Chamber No. 1 was pumped through a dedicated force main into a manhole located adjacent to the garage and office building.

The leachate from temporary Holding Basin No. 1 and temporary Holding Basin No. 2 flowed via gravity through a series of manholes into the sewage Pump Station wet well. From the Pump Station, the leachate was pumped directly to Rockland County Sewer District No. 1.

5.2 System Upgrade and New Construction

The scope of work for upgrade of the existing LCS included the modification of the existing LCC Nos. 1, 3, 4, 5, and 6, the abandonment of LCC Nos. 2 and 7, and the abandonment of the existing holding basins (temporary Holding Basin No. 1 and No. 2). The existing collection piping system for LCC Nos. 1, 3, 4, 5 and 6 were to remain operable and in place. Construction also included the installation of two new chambers (LCC Nos. 2N and 7N) as well as the extension of the existing LCCs (1, 3, 4, 5 and 6) and installation of new valve pits, new pumps, and instrumentation for all seven LCC's to control the removal of leachate from the landfill.

- New leachate collection trench was installed to feed leachate to the new LCCs (2N and 7N) and new forcemain piping was installed to convey leachate from all of the LCCs to the leachate storage tank.

The upgrading of the LCS also included the construction of a leachate storage/equalization tank farm for the storage and metering of the leachate before discharge to Rockland Sewer District No. 1.

5.2.1 LCC Abandonment and Rebuilding

The abandonment of LCC Nos. 2 and 7 began with the removal of all equipment from the chambers. When both chambers were emptied of equipment, each was backfilled to the surface using on-site soil. Due to the preparatory grades in the vicinity of the abandoned chambers no demolition of the chamber itself was required.

Refurbishment of the LCCs included removal of pumps, block valves, check valves and flow meters from LCC Nos. 1, 3, 4, 5, and 6. Metering pits associated with each chamber were demolished and the remaining concrete disposed.

Each collection chamber was evacuated and plugged to permit entry into the chamber for cleaning and reconstruction. The chamber was cleaned of all grit and debris and the lower portion of a new pump rail assembly was installed in the bottom of the concrete structure. The plugs were then pulled allowing the chambers to refill with leachate. At a later date, the rail system installation was completed, the pumps were set and level sensors were installed.

Valve pits were installed adjacent to each of the chambers, connected to the chambers by a two inch drain and a three inch flexible Teflon and stainless steel hose. Each three inch hose was installed with a sag to promote ponding of leachate, creating a trap to prevent gas migration between the two chambers. Each valve pit was outfitted with the specified valves, sampling port and other equipment.

5.2.2 LCC and LCT Construction

Both Leachate Collection Trenches (LCTs) were constructed starting at the LCC. As indicated in the Technical Specifications, groundwater was encountered in each location requiring the use of pumps and discharge manifold systems to adequately dewater the excavations. At each of the two new LCCs (LCC Nos. 2N and 7N) an excavation was dug slightly beyond the invert elevation of the chamber, upon which the chamber was installed on a stone bedding, in accordance with the Contract drawings and Technical Specifications, including minor revisions. The chamber excavations and LCT placement were advanced with the assistance of a trench box.

Excavations for the perforated high-density polyethylene (HDPE) collection line piping were then dug in several stages. Two bench levels were excavated to allow the excavation sidewalls to be sloped at a safe angle for workers entering the trench. The bottom, or third level was excavated using vertical walls to four feet below the bottom of the second bench to accommodate the perforated pipe installation. Prior to installing the pipe, the excavation was draped with non-woven geotextile. Each panel of non-woven

- geotextile was overlapped a minimum of 18 inches as required in Section 06020 of the Technical Specifications. Aggregate materials were then placed in the bottom of the excavation as bedding for the HDPE piping. The aggregate was placed to assure that the proper line and grade had been established. The trench bottom and invert elevation of the piping were controlled by survey.

HDPE piping was butt-welded alongside the trench in lengths that could be easily managed by the laborers assisted by excavation equipment. Piping was installed on a bed of stone. Stone was then placed above the pipe to the bottom of the second bench. The stone trench was constructed above the piping alignment using two steel boxes in an alternating sequence. They were set end-to-end on top of the stone backfill and wrapped with the geotextile draped in the excavation. Backfill was then placed around the draped box and aggregate material placed in the boxes. One box was then pulled, being careful to avoid tearing the geotextile fabric, and placed at the opposite end of the second box. Using the two boxes, the cycle proceeded from one end of the trench to the other until the stone trench was completed. In deep trenches, where the stone trench was greater than the box height, multiple passes with the boxes were required. When completed, the fabric was draped over the top of the stone wall and backfill placed over the completed LCT.

5.3 QA/QC Material Requirements

Testing requirements for components of the leachate collection system were performed as set forth in Town of Clarkstown, Clarkstown Sanitary Landfill Remediation QA/QC Plan (Clarkstown QA/QC Plan) and the applicable sections of the Remediation of Clarkstown Sanitary Landfill and Landfill Capping Specifications, (Technical Specifications).

Did not perform all of these tests.

5.3.1 Coarse Aggregate Materials

Approved coarse aggregate materials satisfied the physical and engineering properties required in the specifications. The Contractor submitted certified laboratory test reports from the proposed borrow source(s) of all aggregate materials stating that said materials met or exceeded the quality and durability requirements for coarse aggregate. Coarse aggregate materials also met or exceeded requirements for physical and engineering properties specified, as determined using appropriate ASTM standards. Testing and gradation requirements for coarse aggregates are provided in Table 5-1 and 5-2 respectively. Test reports for the specified coarse aggregates are provided in Volume 2 of 6, Appendix C.

Table 5-1
Laboratory Testing Program for Each Proposed Aggregate Borrow Source

Property	ASTM Test Method	No. of Tests
Permeability <i>Note:</i> Samples were compacted to at least 90% relative density (D_r).	D 2434	2
Moisture Content	D 2216	2
Grain-size Distribution	D 422	2
Maximum and Minimum Density Determinations	D 4253, D 4254	2

Table 5-2
Leachate Collection Trench Backfill Aggregate
(AASHTO No. 57 Coarse Aggregate Material)

U.S. Standard Sieve Opening	Percent Finer
1.5 inch	100
1 inch	90-100
0.5 inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-5

5.3.2 Trench backfill

Material used to backfill the LCT was obtained from several sources. The materials removed during the excavation were segregated into solid waste and predominantly soil stockpiles. Soil materials were utilized to backfill the exterior or outside portion of the trench and solid waste materials were used to backfill the interior or landfill side of the trench. Solid waste and excavated soils were placed and compacted in thin (12 to 18 inch) lifts using the excavation equipment and a sheepfoot roller when applicable. Excavated solid waste and soils (containing varying degrees of solid waste) were not amenable to standardized testing. Visual

- observations such as the "feet" on the sheepsfoot roller walking up out of the layer were used to verify compactness.

Borrow source materials were used to backfill the upper portion of the trench. The borrow materials detailed in the Site Preparation section of this report were used as backfill. Testing requirements associated with structural fill were applied to the trench backfill procedure. Reference Section 2.0 for structural fill QA/QC information. Structural fill documentation is provided in Volume 2 of 6, Appendix A.

Handwritten note: "see Volume 2 of 6, Appendix A"

5.3.3 Geosynthetics

Geotextiles used in construction of the LCT stone wall met the material and testing requirements of Specification Section 06020. Geotextile data is provided in Volume 3 of 6, Appendix E4.

5.3.4 Pipe Materials

The leachate collection and force main piping was high-density polyethylene (HDPE). The pipe was manufactured in accordance with ASTM F714 and ASTM D 3261.

Pipe and fittings delivered to the work site were inspected by the Contractor and the Engineer prior to installation. When accepted by the Engineer for installation, such materials were marked. Non-accepted and damaged pipe and fittings were removed or repaired, if repairable, as directed by the Engineer.

All pipe and fittings were unloaded and handled with proper equipment, avoiding severe impact blows, especially during cold weather. Pipe was inspected before installation. If damage occurred during handling and placement and was deemed repairable, it was repaired as directed by the Engineer, in accordance with approved manufacturer's recommendation. If damage was not repairable, in the opinion of the Engineer, such pipe was rejected, removed, and replaced.

The HDPE pipe joints were electro-fusion butt welded, to provide a joint that, at a minimum, had the physical properties of the pipe. All welding was performed by an individual trained in accordance with the pipe manufacturer's recommendations. Information regarding the LCT and forcemain piping is provided in Volume 2 of 6, Appendix C.

6.0 SLURRY WALL INSTALLATION

The Plans and Technical Specifications provided criteria to construct two lengths of slurry wall at the landfill. The total length of the slurry wall as designed was 4,325 feet to be constructed at two separate locations. The North Slurry Wall was to be generally on an East-West line (in the vicinity of LFP 1) and have a total length of 1,475 feet. The South Slurry Wall was to surround the Ballfield at a length of 2,850 feet. The North Slurry Wall was to extend parallel to the north leachate collection trench to provide a groundwater flow barrier. The South Slurry Wall, extending parallel to the proposed south leachate collection trench and around Landfill Parcel 5 (LFP 5) was designed to have a two-fold effect. The primary intent was to inhibit the flow of leachate across the barrier. A secondary purpose was to contain water within LFP 5 (also referred to as the "Ballfield"), allowing the area to re-establish itself as a wetland environment.

Installation of the two slurry walls was initiated by the construction of two working platforms. The platforms were constructed along the intended slurry wall alignments. The slurry walls were to be constructed with vertical sidewalls with a minimum width of 36 inches and extend to the elevations shown on Drawing No. 2043. In accordance with the Specifications, a soil/bentonite (SB) slurry wall composition was selected by ORSC to achieve the hydraulic conductivity requirements, and the conditions necessary to construct the slurry wall.

The north and south slurry walls were adjusted during construction due to existing site conditions and the availability of the Riverso property (Parcel 106-A-17). At completion, the north slurry wall was constructed to a length of 957 feet, excluding the portion of the alignment beginning at the eastern edge of the Riverso Property and continuing westward. The north slurry wall alignment was also modified in the vicinity of the southern tip of Basin 8 to extend the wall directly south from the basin instead of including the two 90 degree turns indicated on the original plans. This was changed to facilitate construction. The south slurry wall was partially constructed to a length of approximately 410 feet before the failure of the wall. The construction of the south wall was eliminated due to stability concerns, which arose during the construction process and are the subject of Change Order 28.

Based on constructibility issues and stability concerns, the NYSDEC was petitioned and concurred with the Engineers proposal to eliminate the east and south legs of the south slurry wall surrounding LFP #5. On April 2, 1997 ORSC was directed to eliminate the east and south legs of the slurry wall due to platform instability. Additional stability issues became apparent when unforeseen subsurface conditions and constructibility concerns led to a similar elimination of the north and west legs of the south slurry wall sections.

Refer to Figure 6-1 which shows what portions of the slurry walls was constructed as compared to what was called for by the Contract Documents.

6.1 Slurry Wall Work Platform

Prior to the construction of the north slurry wall a level working platform was constructed along the slurry wall alignment. The platform provided a level working surface for the excavator that was required to dig a vertically straight trench.

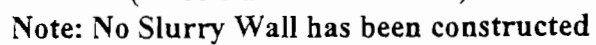
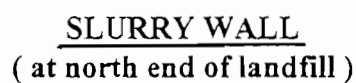


FIGURE 6-1

Construction of the working platforms for the south slurry wall began in November 1996 with the installation of bridge lift stabilization along the south and east legs of the south slurry wall alignment around LFP 5. The bridge lift construction in this area consisted of placing a woven geotextile across the 60-foot wide platform directly over the existing ground. The geotextile was then covered with stream fill aggregate to a minimum depth of six inches above the existing water level in the adjacent Muddy Brook stream. Soil from LFP 5 and the Town Stockpile was then used to construct the upper lifts of the working platform. During construction of the final lifts of the working platform around the Ballfield, a localized area of weakness was encountered near the northeast corner of the ballfield that precluded completion of the southern and eastern legs of the south slurry wall work platform. Due to the unforeseen subsurface conditions present and constructibility concerns, an evaluation of the site hydrology was performed. After review of constructibility of the south slurry wall at this location, the decision was made to eliminate the east and south legs of the south slurry wall around LFP 5. The decision to eliminate the east and south legs of the south slurry wall considered that the work platform and wall would be constructed directly through the wetland. Where the west and north legs of the south slurry wall would be constructed adjacent to the wetland, it was initially anticipated that the slurry wall could be constructed based on the following:

- Subsurface soils in the adjacent areas were presumed to have been preconsolidated through years of solid waste and cover soil placement.
- The borings used to define the alignment of the leachate collection trench and the remaining two legs of the south slurry wall provided a realistic profile of the subsurface conditions of the area confirmed during the construction of the leachate collection trench.

The work platform for the North slurry wall was constructed using screened TOWN material. The TOWN material required screening to be used as backfill for the slurry wall. As the slurry wall would be dug through the work platform, materials approved for use in the slurry wall were considered adequate for the platform construction, as well as adequate for use as a backfill mixing area. The north slurry wall platform was constructed in March 1997. The south slurry wall work platform west and north of LFP 5 was completed between June 23 and 25, 1997.

6.2 Slurry Wall Construction

Preparations for the North slurry wall construction began in March 1997 with the stockpiling of backfill material adjacent to the slurry wall alignment. Screening the TOWN stockpile to remove cobbles, boulders, and other objects greater than three inches in diameter produced the backfill material. The screening process continued until an adequate quantity of material was produced to construct both the north and south slurry walls. Backfill soil for the south slurry wall was stockpiled near the intersection of LFP Nos. 5,8, and 9. In May 1997 two slurry-mixing basins were constructed west of the transfer station and north of the proposed flare station.

The slurry walls were constructed in accordance with the Specification Section 02240 and referenced documents. The procedure began with the mixing of a bentonite slurry using water from an onsite fire hydrant and bentonite. Feeding the bentonite into a hopper and mixing box assembly, which combined the powdered bentonite with the water, mixed the slurry. The slurry mixture was then pumped to the southern slurry pond. A second pump was used to transfer the slurry to the northern pond.

During the mixing of the slurry and filling of the ponds, 4 inch diameter HDPE piping was installed from the slurry pond to the slurry wall location. The piping was butt-fusion welded. Piping was extended to the trench and additional lengths of piping staged with quick-connect fasteners to be either extended or disassembled as the work progressed. The soil component of the backfill was staged adjacent to the slurry wall alignment on the side opposite of the piping. Dry bentonite was then placed over the piles to supplement the slurry mixture that would be used to complete the backfill.

Excavation of the north slurry wall lead-in trench began on June 12, 1997. The purpose of the "lead-in" trench was to allow backfill to "sluice" into the trench reducing the possibility of air pockets forming in the backfill as a result of the material otherwise dropping through the slurry. In the case of the north trench, the lead-in trench was oriented approximately 90 degrees to station 0+00 allowing full depth to be achieved at that location. The south slurry wall trench used an in-line lead-in trench.

Once the trench excavation had reached full depth, via the "lead-in" trench, the excavation continued at the depth determined by the slurry wall subsurface investigation, as verified in the field. As shown on the subsurface profile in the Construction Drawings, the North slurry wall was extended to bedrock, varved clay, or an organic silt layer that was identified in the boring program. The southern slurry wall was designed to intercept either the dense glacial till strata or the overlying organic strata.

Slurry was pumped to the trench from the ponds as the excavation increased in depth initially, then on a periodic basis as the excavation continued. The slurry level in the trench fluctuated continuously as the excavation advanced. In general, as the excavation became longer the slurry level would drop. The level would be increased through the addition of slurry from the ponds, or the addition of backfill to the trench. The addition of backfill would increase the slurry level quickly. When the backfill could not be used to reestablish the slurry level, slurry would have to be pumped from the reserve pond at a slower pace.

Backfill was prepared adjacent to the slurry wall using a bulldozer to mix the soil component with the slurry. Slurry was either pumped directly from the ponds or "ladled", using a backhoe, from the trench to a mixing area prepared by the bulldozer. Mixing of the two components was achieved through the motion of the bulldozer, using both backblading and track motions. When complete, the materials slump was determined using a concrete slump cone. A slump of between two to six inches was considered acceptable. Once the backfill reached an appropriate slump, the bulldozer placed the material by backing it into the trench with the blade in its back-blade position. The reverse technique was used to prevent the blade from digging into the underlying soil and allowing dry subgrade material to create dry pockets in the backfill. Backfill was placed from the lead-in trench until it surfaced in the trench. Backfilling then advanced with the trench as the bulldozer backed slurry into the exposed backfill surface. The completion of the wall was accomplished by removing the slurry from the trench as backfill was placed.

Construction of the north slurry wall continued until June 23, 1997. Upon completion of the north slurry wall, the construction equipment was relocated and connections to the slurry ponds rerouted to the southern end of the site.

Following completion of the north slurry wall in June 1997, work began on the excavation for the south slurry wall. Despite the anticipated stability of the slurry wall alignment along the west and north sections of the south slurry wall, the initial construction sequence for the west leg of the south slurry wall lead to

cracking of the work platform and settlement of the east side of the slurry trench. As a result, WESTON and ORSC performed subsurface investigations to determine the mechanism responsible for the failure of the trench. Based on the investigations, both WESTON and ORSC agreed that the observed conditions were the result of a deep-seated failure of the slurry trench and concurred that an increase in the density of the slurry mixture as well as shifting the alignment to the west would allow the west leg of the north slurry wall construction to resume and the wall to be completed. ORSC returned to the excavation of the south slurry wall on September 8, 1997. On September 12, 1997 cracking in the north end of the trench was again noted. Work continued until September 16, 1997 with the west leg of the south slurry trench becoming increasingly wider. On September 17, 1997 WESTON issued a Stop Work Order for the remaining south slurry wall construction.

6.3 Slurry Wall Quality Assurance / Quality Control

Prior to construction of the Slurry Wall, the contractor completed a slurry wall mix design to determine the proper mix proportions for the slurry wall components consistent with obtaining a wall permeability of 1×10^{-7} cm/sec or less when evaluated in a laboratory permeability testing program using groundwater collected at the site as the permeant. The testing consisted of the following

- Gradation testing of the stockpiled material, including sieve, hydrometer, plasticity, and natural moisture content.
- Mix of water and landfill leachate
- Testing for hardness, pH, conductivity, and Total Dissolved Solids.
- Trench slurry characterization tests consisting of clay fraction, marsh funnel viscosity, apparent viscosity, yield point, gel strength, filtrate loss, and density.
- Slurry chemical compatibility tests between the trenching slurry and the site contaminated groundwater consisting of filter cake permeability, chemical desiccation cracking, and relative viscosity.
- Permeability testing of the trial backfill mixes.
- Five trial mixes prepared using a mixture of the soil borrow and various percentages of bentonite slurry, by weight.

Results for the preparatory and mix design testing are presented in Volume 2 of 6, Appendix D.

Throughout the installation of the slurry wall, adjustments were made to the slurry mixture to adjust density, viscosity, and unit weight. Each property of the slurry was established using field-testing performed by InQuip and observed by the Engineer. Adjustments such as adding fresh slurry to cut density or replacing wood infiltrated slurry with an uncontaminated batch was controlled by ORSC's slurry trench specialist subcontractor, InQuip.

Testing of the slurry periodically confirmed that the mixture density was not less than 18 pounds per barrel (42 gallons) of bentonite and water, with a slurry unit weight between 64 pcf and 94 pcf. A minimum apparent viscosity of 15 centipoise or 40 seconds reading through a Marsh Funnel Viscosimeter, and a maximum filtrate loss of 30 cubic centimeters in 30 minutes at 100 psi were also established prior to pumping the slurry to the trench and were maintained through the majority of the work.

Periodic slump testing was performed using the field-mixed backfill material. Samples were also collected for periodic permeability testing by an independent laboratory. The results of the Field-testing are summarized in Table 6-1 (North Slurry Wall) and Table 6-2 (South Slurry Wall). Permeability testing results are provided in Volume 2 of 6, Appendix D.

**Table 6-1
North Slurry Wall
Field Testing Results**

Date	Test No.	Marsh Funnel (>40 Seconds)	Filtrate Loss (<30 cc in 30 min. @100 psi)	Density (64 to 94 pcf)	Sand Content (%)	Temp. (Degrees F)	Backfill Slump (inches)
6/12/97	1	56	17.5	66	3	64	-
6/13/97	2	53	16	67.5	-	-	-
6/13/97	3	60	17	68	3.5	64	-
6/16/97	4	48	15.5	69	4	62	-
6/16/97	5	58	19.5	72.5	8	68	-
6/17/97	6	38	-	-	-	-	3.25
6/17/97	7	59	17	74	7	-	-
6/17/97	8	54	20.5	76	6	69	-
6/18/97	9	53	18.5	77	7	60	-
6/18/97	10	60	20	82	9.5	-	-
6/19/97	11	55	16	79	10	60	4.5
6/19/97	12	43	19	72	3.5	68	-
6/20/97	13	43	22.5	76	5	66	-

Table 6-2
South Slurry Wall
Field Testing Results

Date	Test No.	Marsh Funnel (>40 Seconds)	Filtrate Loss (<30 cc in 30 min. @100 psi)	Density (64 to 94 pcf)	Sand Content (%)	Temp. (Degrees F)	Backfill Slump (inches)
6/25/97	1	42	23	65	-	-	-
6/25/97	2	38	-	66	<0.5	-	-
6/25/97	3	47	21	68	1.5	-	-
6/26/97	4	44	21	69	5	70	5
6/26/97	5	42	23	66	2	-	-
6/27/97	6	50	19	69	4	65	-
6/30/97	7	45	18	66	2	64	-
6/30/97	8	80	16	73	8	72	-
6/30/97	9	57	20	73	-	-	-
9/8/97	10	50	14	65	1	-	-
9/8/97	11	58	-	69.5	-	-	-
9/8/97	12	-	-	69	-	-	-
9/10/97	13	58	14.5	76	4	-	-
9/10/97	14	60	14	65	-	-	-
9/10/97	15	60	14	75	10	-	-
9/10/97	16	80	19	85	20+	-	-
9/11/97	17	60	12.5	80	20	-	4.5
9/11/97	18	61	16	82	10	-	-
9/12/97	19	60	12.5	80	20	-	-
9/12/97	20	65	14	81	17	-	-
9/12/97	21	70	14	83	20	-	-
9/15/97	22	54	18.5	80	12	-	-

• 7.0 WETLANDS REMEDIATION

Wetlands remediation activities occurred in two areas at the site as part of this remediation Contract. The areas are referred to as the Pyramid property (LFP 2) and the Ballfield (LFP 5). Both areas required excavation of waste materials. The Ballfield required backfill with a mixture of clean soils and peat.

7.1 Pyramid Property Remediation

The Pyramid property is located in LFP 2 at the northwest corner of the Landfill. Approximately 11,000 cubic yards of excavated material was removed in accordance with the approved Plans and Specifications. Prior to commencement of the excavation, ORSC placed the required turbidity barrier in accordance with the erosion and sediment control plan. Construction and demolition debris material was then used to build a temporary road in the remediation area to allow for heavy equipment access. Backhoes and off-road trucks were used to remove the material from the remediation area to the depths indicated on the approved Plans and Specifications. The material removed was placed on the landfill in the waste disposal areas. No backfill was required as part of this remediation area work. Photographs showing the construction of this remediation area can be found in Section 14.0 of this report.

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7.2 Ballfield Remediation

The second wetland remediation area was the area referred to as the Ballfield (LFP 5). The Ballfield is located at the southeastern portion of the Landfill. Prior to working in this area, the contractor placed the required silt fence and turbidity barrier in accordance with the approved erosion and sediment control plans. The area was excavated by bulldozer in accordance with the approved plans and specifications to the depths indicated. The excavated material was loaded into off-road trucks by backhoe and hauled to the waste disposal areas where it was dumped and spread by bulldozer. The remediation area was then backfilled to the grades indicated on the Plans with a 50-50 mixture of clean soils and peat. The peat was obtained from the excavation required for the relocation of Muddy Brook (Muddy Brook is located on the southern perimeter of the landfill). After mixing, placement and compaction of the soils by bulldozer, the mitigation area was planted with a combination of wetland plants and grasses in accordance with the approved Plans and Specifications.

Material certifications for the plants and grass seed mixtures used as part of this remediation can be found in Volume 6 of 6, Appendix H3. Photographs of the construction area can be found in Section 14.0 of this report.

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8.0 LOW PERMEABILITY LAYER (GEOSYNTHETICS)

The original Contract Specifications and Drawings required OGDEN to install either Low Density Polyethylene Geomembrane (LDPE) or Polypropylene Geomembrane. OGDEN requested the substitution of Polyvinyl Chloride (PVC) geomembrane in place of the specified materials as the low permeability layer of the cap system. WESTON and the NYSDEC under Change Order No. 2 approved OGDEN's request. Refer to Attachment 2 for a copy of NYSDEC correspondence approving the PVC geomembrane substitution.

Three types of PVC geomembrane cover systems were installed, defined as follows:

- Type I Cover System - Consisting of a 6 ounces per square yard (oz/yd²) non-woven geotextile on the bottom, then 40 mil smooth PVC geomembrane and drainage net with 6 oz/yd² non-woven geotextile on top. The Type I cover system was used on slopes less than 15%.
- Type II Cover System - Consisting of a 6 oz/yd² non-woven geotextile on the bottom, then 40 mil embossed on both sides PVC geomembrane and drainage composite. The Type II cover system was used on slopes greater than 15%.
- Type III Cover System - Consisting of a 6 oz/yd² non-woven geotextile, a landfill gas collection net, 40 mil smooth PVC geomembrane, drainage net and another layer of 6 oz/yd² non-woven geotextile. The Type III cover system was used in LFP 1, 5 and 9.

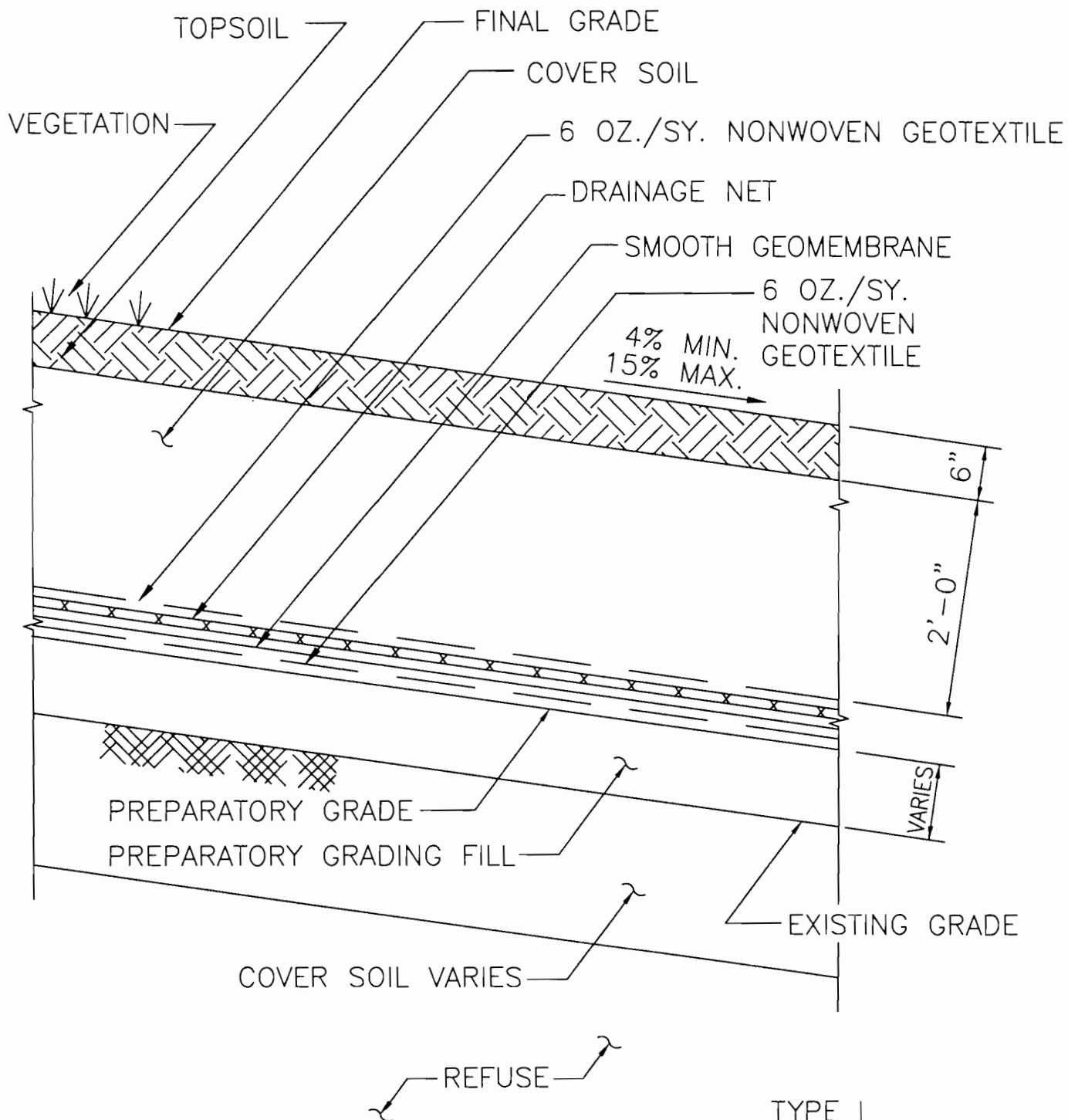
Please refer to Figures 8-1, 8-2, and 8-3, which illustrate the typical final cover cross-sections for the three types of cover systems.

8.1 PVC Geomembrane Manufacturer

The manufacturer of the PVC geomembrane is responsible for the production of the materials and for quality control during production including certification that its materials conform to the Contract Specifications. The manufacturer was required to submit certification that the PVC geomembrane was formulated and manufactured from 100% virgin raw material and that it was specifically compounded for use in hydraulic structures and only first quality phthalate and/or phosphate plasticizer was used. The PVC geomembrane used on this project is manufactured by Nan-Ya Plastics Corporation, America at their manufacturing plant in the State of Louisiana. Rocheux International, Inc. is the exclusive Flexible Membrane Liner (FML) material sales/technical organization for Nan-Ya Plastics Corporation.

Nan-Ya Plastics was required to submit written certification that each lot of material met or exceeded the Technical Specifications (Table 06010B-2) as well as those published by the National Sanitation Foundation's NSF Standard 54 (1993). Nan-Ya Plastics certificate of analysis reports can be found in Volume 3 of 6, Appendix E1.

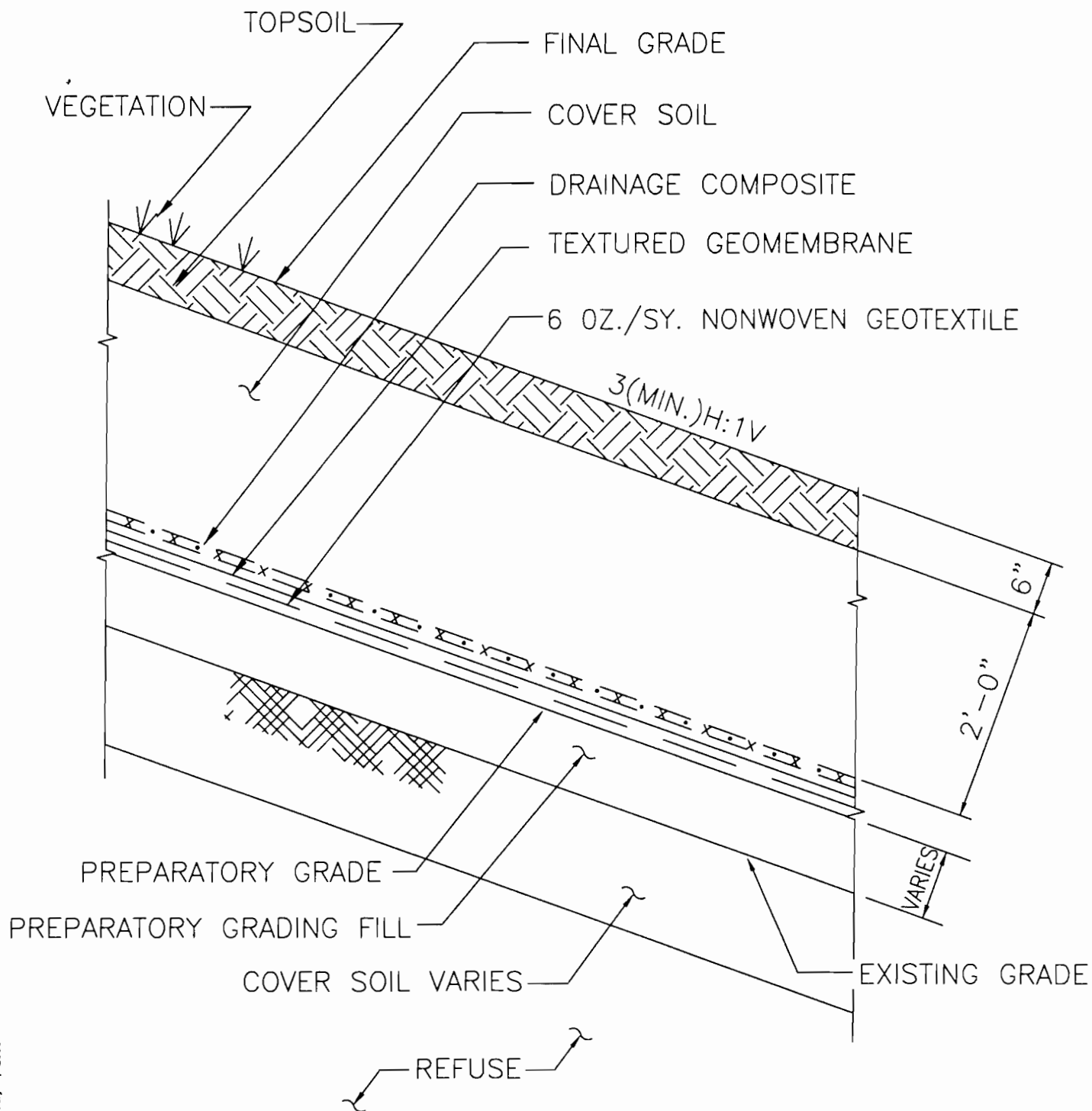
Also, multiaxial tension tests were performed on each type of PVC geomembrane (smooth and embossed) in accordance with ASTM D 5617. Refer to Volume 3 of 6, Appendix E1 for the multiaxial tension test results.



TYPE I
FINAL COVER SYSTEM
CROSS SECTION ON
LANDFILL TOP
CLARKSTOWN SANITARY LANDFILL

WESTON
MANAGERS DESIGNERS/CONSULTANTS
ROY F. WESTON OF NEW YORK, INC.

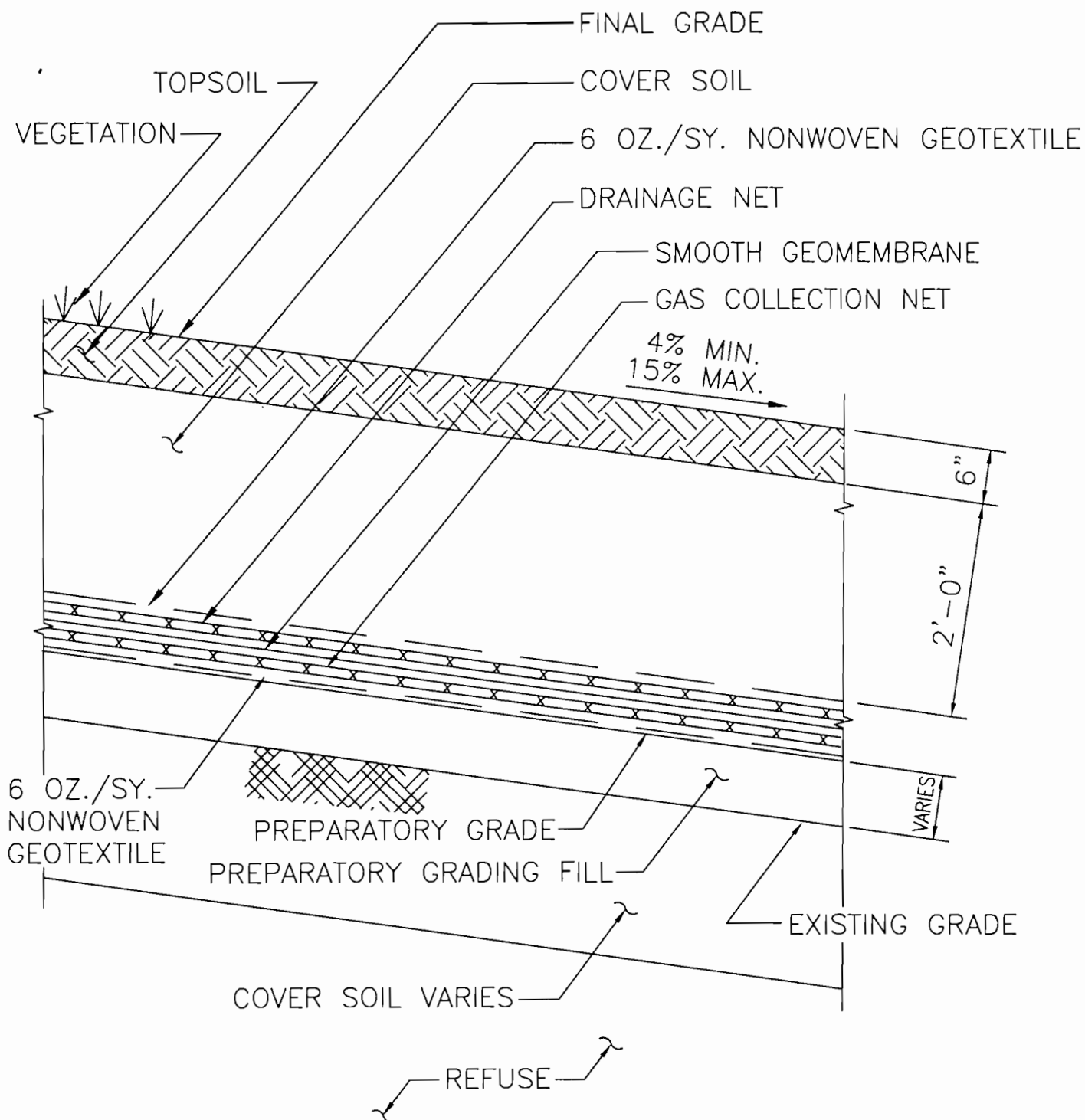
FIGURE 8-1



TYPE II
FINAL COVER SYSTEM
CROSS SECTION ON
LANDFILL SIDE SLOPES
CLARKSTOWN SANITARY LANDFILL



FIGURE 8-2



TYPE III
FINAL COVER SYSTEM
CROSS SECTION WITH
GAS COLLECTION LAYER
CLARKSTOWN SANITARY LANDFILL



FIGURE 8-3

8.2 PVC Geomembrane Fabricator

The PVC geomembrane fabricator for this project is Environmental Liners, Inc. (EL) of Cortez, Colorado. EL's responsibility was to take individually manufactured Nan-Ya Plastics rolls of PVC membrane (approximately six feet wide) and factory fabricate, by a factory controlled seaming process using thermal bonding machinery, the individual rolls into large panels. The large panels were custom designed and manufactured specifically for this project so as to minimize field seaming.

Prior to factory seaming, all roll goods were unwound and inspected on both sides for unmixed or poorly dispersed ingredients, thin spots, the presence of contaminants or foreign particles, pin holes, tears, punctures, blisters, and any other defects. All defects and impurities were removed or repaired before the membrane was fabricated into large panels. Thickness was measured according to ASTM D1593 at the center and at each edge of the beginning and end of each roll of material used in this Contract. A log was maintained listing the material type, tool number, lot number, and thickness measurements. Refer to Volume 3 of 6, Appendix E2 for EL's PVC Geomembrane Fabrication Reports and Material Thickness Measurement Logs.

EL used the dielectric seaming method to factory seam the PVC rolls. This is a thermal (or heat fusion) method that is unique to factory seaming of flexible thermoplastic geomembranes. EL factory fabricated seams at a minimum one-inch (1") overlap of adjacent panels.

The large panels were fabricated at lengths and widths for use specifically at the Landfill. Panels, which begin with an odd number, refer to smooth 40 mil PVC (i.e., 100 and 300 series). Panels which begin with an even number refer to embossed 40 mil PVC (i.e., 200 and 400 series).

EL performed non-destructive testing on 100% of factory seams. Upon discovery of any defective seam, the fabricator repaired the seam and determined and rectified the cause of the defect prior to continuation of the seaming process.

The factory seams were destructively tested for shear and peel strength by EL's in-house laboratory at a frequency of two samples per panel fabricated. The samples were taken from extra material at the beginning or end of panel seams such that the actual panel used at the Landfill was not damaged. EL tested the factory seams for shear strength per ASTM D3083. Because EL dielectric factory seams did not produce seams that could be peel tested per ASTM D413, a modified version that peels the seam longitudinally (the length of the seam) was performed. Refer to Volume 3 of 6, Appendix E3 for EL's factory seam destructive test results.

8.3 Geosynthetic Installer

The geosynthetics on this project were installed by the fabricator, EL. EL acted as subcontractor to OGDEN. EL was responsible for on-site management of the PVC geomembrane, including handling, storage, placement, and installation of the fabricated panels, geotextiles and drainage media in accordance with the approved PVC geomembrane panel layout.

8.4 Quality Assurance/Quality Control During PVC Geomembrane Installation

Quality Control (QC) during PVC geomembrane installation was performed by EL. WESTON performed Quality Assurance (QA) of all installation and field-testing. Refer to Volume 4 of 6, Appendix F1 for copies of the QA Geosynthetic Daily Inspection Reports.

The QC/QA program included at a minimum the following:

- Ambient air temperature and weather conditions were monitored and reported daily by WESTON field representatives. No field seaming was allowed when the temperatures were below 40 degrees F, or above 120 degrees F (measured twelve inches above the PVC geomembrane surface), or during rain or winds in excess of 20 mph.
- Visual inspection was performed on the subgrade prior to geomembrane panel placement. The surface of the subbase layer was proof rolled smooth, compacted prior to geotextile/geomembrane installation, and inspected by EL, OGDEN and WESTON QA/QC personnel. The subbase was free from any angular rocks, glass, roots, grass and vegetation. Any foreign materials or protrusions were removed and all cracks and voids found in the subbase soil were filled to provide a firm, clean, dry and smooth surface. EL, OGDEN and WESTON approved the subbase conditions prior to any PVC geotextile/geomembrane installation. No geomembrane was placed on unsuitable subgrade. EL, OGDEN and WESTON signed a Subbase Acceptance Form prior to the installation of each panel of PVC geomembrane indicating acceptance of subbase. Refer to Volume 4 of 6, Appendix F2 for copies of the executed Subbase Acceptance Forms.
- Geomembrane placement was controlled and monitored by WESTON and EL QA/QC personnel. Refer to Volume 4 of 6, Appendix F1 for the PVC Liner Panel Inspection Forms, which indicate the panel numbers, panel dimensions, and date deployed. The PVC Liner Panel Inspection Forms are attached to the QA Geosynthetic Daily Inspection Reports.
- All field seaming was inspected visually.
- Non-destructive seam testing was performed in the field on all field seams over their full length using air-lance testing.
- Destructive seam testing including peel and direct shear testing on the field seams at a rate of one sample per 500 linear feet of field seam length was performed by EL and the independent geosynthetic laboratories J&L, M & T-NAMOW/TCL JV, EMCOM, and NTH Consultants.

- Any imperfections in the installed panels were identified and repaired in accordance with the Technical Specifications.

8.4.1 PVC Geomembrane Placement

When the subbase and underlying geosynthetics were approved, the accordion-folded PVC geomembrane panels were brought to the intended location, unfolded (if accordion-folded in a box), and accurately spotted on top of the underlying geosynthetics.

The respective limits of smooth and embossed PVC geomembrane were determined as per the Contract Drawings and existing field conditions. Only embossed PVC geomembrane was used on slopes at or exceeding 15 percent.

In general, seams were oriented parallel to the line of maximum slope, (i.e., oriented along, not across the slope). Seams on slopes exceeding 15 percent were not permitted to be at more than 30 degrees from parallel with the direction of the slope. Cross-slope seams were kept to a minimum and in no case were within five feet of adjacent panel cross-slope seams.

The PVC geomembrane panels were deployed on the slopes using earth working equipment and laborers.

The PVC geomembrane panels were carefully placed at the proper location and each panel was overlapped a minimum of four (4) inches, as required for proper seaming. Each PVC geomembrane panel was inspected by WESTON and EL personnel for any defects as it was placed, and assigned its corresponding panel number. The PVC geomembrane panels were installed in a relaxed condition free of tension or stress.

found acceptable

8.4.2 PVC Geomembrane Trial Seams (Start-ups)

PVC geomembrane trial seams, also called qualifying seams or start-ups, are considered to be an important aspect of the QA/QC procedures. They are meant to serve as pre-qualifying experience for personnel, equipment and procedures for field fabricating seams on the geomembrane material under the same climatic conditions as the actual field production seams are made. The test strips were made on two narrow pieces of excess geomembrane varying in length from 3 to 10 feet.

The goal of the start-ups is to reproduce all aspects of the actual production field seaming activities intended to be performed in the immediately upcoming work sessions so as to determine equipment and operator proficiency. For the hot wedge welding of field seaming, WESTON required that start-ups be made every four (4) hours (at the beginning of the work shift and after the lunch break), whenever personnel or equipment changed, and when climatic conditions reflected wide changes in geomembrane temperature (based on changes in ambient air temperature).

The start-ups were destructively tested for peel and shear as soon as the seam cooled using a field tensiometer. Four test specimens were cut from the test strip using a 1.0-inch wide die cutter. Two

- specimens were tested for peel and two for shear. The specimens were tested in both peel and shear using a field tensiometer and recorded. If all specimens passed, the technician was approved to weld. If any of the test specimens failed, a new test strip was fabricated by varying the temperature, speed or pressure, as applicable. If additional specimens failed, the seaming apparatus and technician were not allowed to seam until the deficiencies were corrected and successful start-ups were achieved.

8.4.3 PVC Geomembrane Field Seaming and Joining

The field seaming of the deployed PVC geomembrane panels is a critical aspect of the successful functioning of the PVC geomembrane as the low permeability barrier of the final cover system. Both the solvent weld and hot wedge weld method were used to field seam the panels.

Prior to field seaming, the contact surfaces of panels to be seamed were wiped clean to remove all dirt, dust, moisture and other foreign materials. The lap joints were formed by lapping the edges of the panels a minimum of four inches (4").

EL utilized the hot wedge method (thermal fusion) and adhesive method to field seam the PVC geomembrane panels. Thermal welds were made using a hot wedge welder. In thermal fusion or melt bonding method, portions of the opposing surfaces of the PVC geomembrane are truly melted. This being the case, temperature, pressure, and seaming rate all play important roles. The hot wedge welder used on this project consists of an electrically heated resistance element in the shape of a wedge that traveled between the two sheets of PVC geomembranes to be seamed. As it melted the surface of the two sheets of PVC geomembrane being seamed, a shear flow occurred across the upper and lower surfaces of the wedge. Roller pressure was applied as the two sheets of PVC geomembrane converged at the tip of the wedge to form the final seam. Hot wedge units are controllable as far as temperature, amount of pressure applied, and travel rate. The hot wedge welders utilized to field weld the seams on this project were manufactured by Columbine International, Ltd. The Columbine hot wedge welders used on this project produced single uniform width seams that are made with a nominal 1-3/4 inch solid wedge.

On field seams where the hot wedge welder could not be used, such as seam repairs, butt-seams, penetrations, patching destructives, and tie-in areas, EL applied a welding adhesive to bond together the overlapping edges of the PVC. The seam areas were cleaned with methyl ethyl ketone (MEK) and welding cement was applied between the two geomembrane sheets to be joined. After a few seconds, which was required to soften the surface, pressure was applied to the upper surface by means of a smooth hand held roller, to make complete contact and bond the sheets together. A heat gun was used during the early and late hours of the day to eliminate "fishmouths". All adhesive weld field seams were a minimum of 2 inches wide with an overlap of 4 inches and were shingled in a downslope direction where appropriate.

Extreme care was used to avoid "fishmouths" in the field seams. Where "fishmouths" occurred, they were cut from the seam to dissipate them, then lapped and seamed together in the lapped area and patched. Any portion of the PVC geomembrane damaged during installation was removed or repaired using an additional piece of PVC geomembrane, as specified.

- All penetrations were "booted" with 40 mil PVC geomembrane in accordance with the Construction Drawings and Technical Specifications. All "boots" were air-lance tested. Any defects were identified and repaired.

During tie-in of the PVC geomembrane to the existing PVC geomembrane around the Transfer Station, extreme care was used so as not to damage the existing geomembrane. The 40 mil PVC geomembrane was connected to the existing PVC geomembrane around the Transfer Station area by exposing the existing PVC geomembrane and adhering to the existing geomembrane by means of hot wedge or adhesion method. Prior to any field seaming, the surfaces of the existing geomembranes and the PVC geomembrane were cleaned of excess sand and debris as required. Any damage found on the existing PVC geomembrane around the scales during the exposing process for tie-in was repaired accordingly. In addition, the tie-in field seams and repairs were non-destructively (air-lance) and destructively tested.

All allures completed in satisfaction with the design requirements

8.4.4 Non-Destructive Testing (NDT) of PVC Geomembrane Field Seams

The primary purpose of the non-destructive seam testing is to assure continuity along the entire seam length. Although it is obviously important to conduct destructive tests on the fabricated seams, such tests do not give adequate information on the continuity and completeness of the entire seam between sampling locations. Non-destructive testing was performed by EL and witnessed by WESTON to validate 100% of the seams.

On this project, all field seams were non-destructively tested over their full length by the air-lance method. The air lance method uses a jet of air, regulated at 50 to 60 pounds per square inch (psi) pressure, coming through an orifice of 3/16-inch diameter. The air stream was directed beneath the upper edge of the overlapped seam and was held within two inches of the edge of the seamed area in order to detect unbonded areas. When such an area was located, the air passes through the opening in the seam causing an inflation and "fluttering" in the localized area. A distinct change in sound emitted can be heard.

Any defects found during air-lance testing were identified, repaired and re-tested with the air-lance equipment by EL in accordance with the Technical Specifications. Repairs were inspected by WESTON. Refer to Volume 4 of 6, Appendix F1 for copies of the air-lance testing results (non-destructive testing). These forms were prepared by WESTON and include weather conditions, field seam number, field seam length tested and field seam test results and are attached to the QA Geosynthetic Daily Inspection Reports.

good example of what we want

8.4.5 Destructive Testing of PVC Geomembrane Field Seams

Samples from the production of field-fabricated geomembrane seams for destructive testing were taken at a minimum of one destructive test sample every 500 linear feet of field seam, as specified in the Technical Specifications. Destructive testing of the geomembrane seams is performed by actually cutting out (i.e., sampling) and removing a portion of the completed production field seam, and then further dividing the sample into specimens for testing in accordance with ASTM D 4437/3083 - Seam Shear Strength and ASTM D 4437/413 - Seam Peel Strength.

The "stratified" random sampling method was used by WESTON. This method takes each pre-selected interval (i.e., every 500-linear foot) and randomly selects a single sample location within this interval. Various factors were taken into consideration in selecting the sample location, such as, visual inspection of the seam, overall quality, and ensuring that all hot wedge welders in operation were represented.

The destructive samples were removed from the completed geomembrane field seam by EL. The location of the sample was determined and recorded by WESTON using the method described above.

The cutout destructive sample was approximately 12 inches wide by 48 inches long with the seam centered lengthwise. Two (2) 1-inch wide strips were cut from each end of the sample to be field-tested (total of four specimens) for shear strength and peel adhesion. To be acceptable, all four (4) specimens had to pass the required peel and shear requirements of 10 lb/in and 74 lb/in, respectively.

The remainder of the sample was cut into three parts, each 12-inches by 14-inches, and distributed as follows:

- One part to the Contractor (OGDEN) for archive storage.
- One part was retained by WESTON for archive storage.
- One part to the Independent QA geosynthetic laboratory (J&L, M&T-NAMOWTCL, EMCON) for testing.

The sample part sent to the Independent QA geosynthetic Laboratory was then cut into 10 specimens at 1-inch wide (5 specimens tested for peel and 5 specimens tested for shear). To be acceptable, four of five specimens per sample had to pass both the shear strength and peel adhesion test values of 74 lb./in and 10 lb./in, respectively.

The following procedure was implemented whenever a typical destructive sample, DS-XX, failed laboratory testing:

1. The seam with the failed destructive sample was traced outward to intermediate points (at least 10 feet from the location of the failed test in each direction) and a 12 inch by 12 inch sample was taken for testing using the field tensiometer.
2. If the additional samples in each direction failed, the process was repeated until a passing sample was obtained. Each passing sample was confirmed by a second consecutive passing sample that was obtained minimum of 10 feet from the location of the initial passing sample. All failing destructive were flanked by two (2) consecutive passing field tests.

3. When two (2) consecutive passing field tests in each direction were obtained, the entire failed seam was cap-stripped between each second consecutive passing sample of the original failed sample and a new destructive sample, identified as DS-XX-R, was cut from the cap-strip seam.
4. If the new, DS-XX-R destructive sample failed, the procedure was repeated, until the final seam was bounded by two passing test results.

The sample cutouts in the geomembrane resulting from the destructive seam sample were repaired by patching the sampled field seam with identical geomembrane material the same day. The patch extended a minimum of six inches beyond the repair area in all directions. All destructive patches were air-lanced.

After completion of the PVC geomembrane installation, including all testing (destructive and non-destructive) and prior to placement of the upper geosynthetics (i.e., drainage net and geotextile or drainage composite), EL and WESTON performed the final walk-through inspection. No PVC geomembrane was covered by OGDEN until WESTON and EL completed the final walk-through inspection.

Refer to Volume 4 of 6, Appendix F3 for the Field Seams Destructive Test Results. A total of one hundred and eighty four (184) destructive tests were analyzed for peel and shear in accordance to ASTM D4437/3083/413.

Upon completion of the liner installation, EL was required to submit a Workmanship Warranty certifying that the installation was properly performed and in compliance with all Construction Plans and Specifications. An "As-Built" detailed liner panel drawing was also submitted and is included in Volume 6 of 6, Appendix K1.

is this included in Volume 6?

8.4.5.1 M & T Laboratory Geomembrane Testing Issues

M&T-NAMOWTCL (M&T) was the Independent QA geosynthetic laboratory to test the sample as per ASTM methods as required by the Contract.

On June 11, June 29 and July 01, 1998, WESTON representatives visited M&T laboratory to observe the PVC geomembrane destructive testing procedures for peel and shear. During these visits to M&T, WESTON representatives observed that the M&T testing procedures employed for PVC geomembrane destructive testing did not conform with ASTM test methods D4437-88. As a result, WESTON immediately halted submission of further PVC geomembrane destructive samples to M&T. Destructive Sample, DS-161, was the last field destructive sent to M&T. WESTON retained the services of EMCON to test all future field destructive samples (i.e. DS-162 through DS-184). EMCON is an accredited geosynthetic-testing laboratory in the "Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP)".

In response to WESTON's request that M&T prove all prior testing of geomembrane field seams was performed in accordance with ASTM standards, M&T obtained the services of an independent qualified geosynthetic consultant to verify and validate all passing destructive test results as reported by M&T. The

selected and approved consultant is NTH Consultants, Ltd. (NTH). NTH is an accredited geosynthetic-testing laboratory in the "Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAILAP)".

To validate M&T's passing destructive test results (i.e., DS-2R, DS-5R, DS-8, DS-9, DS-10R, DS-11R, DS-15, DS-28 and DS-33 through DS-161), the corresponding archive portion retained by WESTON of the destructive field seam samples were sent to NTH for peel and shear strength testing in accordance with ASTM D4437. A total of 136 destructive seam archive samples were tested by NTH. Of these, 30 samples were found to be below the specified value of 74 ppi for shear strength (i.e., 4 of the 5 specimens meeting this requirement), but not less than 65 ppi. The National Sanitation Standard 54 (1993) requirements for peel and shear strength of seams are 10 ppi and 74 ppi, respectively, for 40 mil PVC.

WESTON obtained the services of TRI/Environmental Inc. (TRI) to evaluate the NTH test results. TRI sent a letter to WESTON dated 16 December 1998, that included their analysis. This TRI letter was forwarded to NYSDEC under WESTON transmittal letter dated 29 April 1999. NYSDEC raised several issues in its letter, dated 04 May 1999, which required additional discussion and analysis by WESTON.

To address the NYSDEC issues, WESTON commissioned an independent evaluation of the field-constructed seams and the measured shear strength of the seams in question. The independent evaluation was performed by Mr. J.P. Giroud of GeoSyntec Consultants (GeoSyntec).

GeoSyntec prepared a document entitled, "Cover Geomembrane Evaluation for the Clarkstown Municipal Sanitary Landfill Remediation," dated 28 October 1999, in which many issues raised by NYSDEC are discussed. The GeoSyntec Report was forwarded to NYSDEC with WESTON's correspondence dated 08 November 1999.

Refer to Attachment 3 for a copy of WESTON's correspondence "Response to NYSDEC Letter of 04 May 1999, Regarding the Field Constructed PVC Geomembrane Seams" to NYSDEC, dated 08 November 1999. Also included in Attachment 3 is the NYSDEC correspondence, dated February 16, 2000, which finds WESTON's response, evaluation and certification of the field seams satisfactory.

8.5 Geotextiles

The non-woven geotextiles used in the Type I, Type II and Type III cap systems were all manufactured by Amoco Fabrics & Fibers Company (Amoco) and referred to as Amoco 4506. The Amoco 4506 geotextile was also used in the construction of the leachate collection system. Amoco 4506 is a 100% polypropylene, non-woven, needle-punched fabric conforming to the specified properties of Table 06020-1 included in the Technical Specifications.

The woven geotextiles used in the gravel road and bridge-lift and aggregate stream fill construction were also manufactured by Amoco and are referred to as Amoco 2002 and 2006, respectively.

All geotextiles delivered to the site were tested by the manufacturer prior to shipment to ensure that the physical and mechanical properties of the delivered geotextiles were in accordance with the required

- material properties, test methods, values and units presented in Table 06020-1 included in the Technical Specifications. Refer to Volume 3 of 6, Appendix E4 for copies of Amoco 2002, 2006 and 4506 geotextiles certified test reports.

The geotextiles were installed by EL/OGDEN at the locations shown on the Contract Drawings. All bedding geotextile seams within drainage channels and geotextile seams within the final cover system drainage layer consist of adjacent panels sewn securely together.

The geotextiles were sewn together using 100% polyester - 12/4 ply natural white lubricated thread to stitch the adjoining geotextiles. All geotextile seams required to be sewn used the "prayer" seam type. This type of seam consists of a two-thread double thread locked stitch with a density of three (3) stitches per inch. A single row of stitching was used with a minimum seam allowance (distance from the geotextile roll edge to stitch line) of 1.5 inches.

The geotextile seams on the slopes were oriented with the slope. End-of-roll seams were offset a minimum of five (5) feet between adjacent roll ends. Where seaming of the geotextiles was not required (e.g., gravel roads and drainage outlets), adjacent panels of geotextiles were overlapped a minimum of 18 inches with the upgradient panel on top. The woven geotextiles used for bridge-lift and aggregate stream fill construction were installed in accordance with the Section 02200 of the Technical Specifications.

so they were all installed in accordance with the design documents?

8.6 Drainage Net and Drainage Composite

Drainage Net - The drainage net, used in the Type I and Type III cover systems, consists of a high-density polyethylene (HDPE) drainage net having the minimum physical properties specified in Table 06030-1 of the Technical Specifications.

Drainage Composite - The drainage composite, used in the Type II cover system (i.e., slopes exceeding 15%), consists of three layers, utilizing two 6-oz/yd² non-woven geotextiles, one on the bottom and one on the top of a HDPE drainage net. The drainage composite is manufactured by heat bonding the layers of geotextiles to the HDPE drainage net on both sides. The 6-oz/yd² non-woven geotextiles used for the drainage composite manufacture conforms with the required material properties, test methods and values presented in Table 06020-1.

The drainage net was tested by the manufacturer prior to shipment to ensure that the physical and mechanical properties of the installed drainage net are in accordance with the required minimum values presented in Table 06030-1 of the Technical Specifications. Refer to Volume 3 of 6, Appendix E5 for copies of the manufacturer's certified test results. *check*

The drainage net and composite within the final cover system were installed after the underlying geomembrane was installed and accepted (except for the Type III cover system which the drainage net was also installed below the geomembrane to function as the landfill gas collection layer). Prior to installing the drainage net/composite, the underlying geosynthetics were cleaned and free of dirt, dust, or any other objectionable materials, which could inhibit the ability of the drainage net to transmit water. During placement, the drainage net and composite were inspected by WESTON on both sides for

- Plant Testing of Geotextile Used in Drainage Composite -

The nonwoven geotextiles used for drainage composite manufacture shall conform to Section 06020 of these Specifications. Properties tested, test methods, required values and test frequency shall be as set forth in Section 06020.

- Field Testing Of Drainage Net and Composite -

Samples of drainage net and composite shall be obtained by the Contractor in the field for possible testing at an approved testing laboratory at a frequency of one (1) sample (at least 4 ft by 4 ft) for every 85,000 ft² of material installed at the site. If testing is deemed necessary by the Engineer, said samples shall be tested to determine density, carbon content, and thickness for the net (including that used for drainage composite) and/or transmissivity, according to the methods listed in Table 06030-1. The samples selected shall have the location (grid coordinates), roll, lot, and manufacturer clearly marked on or attached to the sample. All samples not submitted for testing shall be submitted to the Engineer.

1.02.3 Laboratory Testing

- A. Unless otherwise indicated, testing shall be performed by the manufacturer or an Engineer-approved independent geosynthetics testing laboratory.

1.02.4 Visual Inspection Before and During Installation

- A. The Contractor shall inspect all material rolls delivered to the site. Damaged rolls shall be identified by the Contractor and staged for either return to the manufacturer or repaired in accordance with the manufacturer's recommendations. Return or repair will be at the Engineer's discretion.
- B. During placement of the drainage net and drainage composite, the Contractor shall carry out visual inspections of the material surface. Any faulty areas relating to net integrity (e.g., rib warping or crushing), continuity, overlapping/joining technique, and panel placement/orientation shall be repaired by the Contractor using preapproved techniques. Such repairs shall be reported to the Engineer by means of a Daily Quality Control (QC) log. At any point in the Work, if the Daily QC log has not been submitted, the Engineer has the right to stop Work at the cost of the Contractor until the Daily QC log is submitted.

1.03 SUBMITTALS

1.03.1 Certified Test Reports

- A. Certified test reports within the requirements of standards and testing methods specified herein shall be submitted to the Engineer for approval at least three (3) weeks prior to material delivery. Results of at least one (1) transmissivity test shall also be provided to the Engineer for approval prior to delivery of the first shipment of material. The material manufacturer and Contractor must satisfy the Engineer

key - TRI tested

DC 4205 - T = 650

these passed except for ply adhesion
(number under
spec 15)

Tenser

Tested against 13050

passed except for ply adhesion

TR 600 passed suitable for numerous retests

4105 does not ~~seem to pass~~ for water permeability
some tests not by results
spec 6

1305 some tests not by spec

TRI tested

DC 4205 - T = 600

?? ply - spec number

ETI tested transmissivity according to spec
30105

- imperfections, damage, or defects. All necessary precautions were taken to prevent damage to the underlying layers of geosynthetics. Field personnel were prohibited from using sharp tools, cigarettes, solvents, or any materials which could cause damage to the drainage net\drainage composite, or underlying geosynthetics.

The drainage net and drainage composite were installed as indicated on the Contract Drawings and rolled downslope (machine direction parallel to slope). Adjacent rolls were overlapped a minimum of 4 inches and secured by heavy-duty nylon braid ties approximately every five (5) feet along the roll length. Cross-slope seams or end-of-roll seams were overlapped a minimum of 6 inches and offset a minimum of 5 feet between adjacent roll ends and securely fastened together with heavy-duty nylon ties at a maximum of 1-foot intervals. The drainage net/composite was kept temporarily in place by use of sandbags.

Transmissivity tests were performed on both the drainage net and drainage composite produced for this project prior to installation of the respective net materials. Results of the transmissivity tests are included in Volume 4 of 6, Appendix F4.

9.0 LINER PROTECTION LAYER (Cover Soil)

The liner protection layer, or cover soil layer, is placed over the geosynthetics to protect its integrity from frost action, root penetration, burrowing animals and other damage. A minimum twenty-four (24) inch thickness of compacted cover soil was placed directly on top of the low permeability barrier layer (PVC geomembrane). The liner protection layer in the vicinity of the dike to channel transitions consisted of a 12-inch thick cover soil layer with a 12-inch layer of stone rip-rap. At some areas of the new compost area (LFP 1) only 10-inches of cover soil was used. The additional cover soil thickness in LFP 1 area (to 24-inches) was made up of pavement layers.

9.1 Material Source – Cover Soil

The cover soil used for the liner protection layer construction was environmentally clean earthen soil free of any organic material and in general conformance with the Technical Specifications. The liner protection soil used on the project was tested and approved per the QA/QC requirements of the Specifications prior to being imported for use at the Clarkstown Landfill project. An exception to this is approximately 10,000 cubic yards of Highland Sand & Gravel material that was placed on the North Slope of the landfill in LFP 3. This material was placed shortly before ORSC screening operation was established and it contains some oversize material and organic matter. Approximately 280,000 cubic yards of material were used as cover soil.

The cover soil was imported from various borrow sites. WESTON inspected most of the proposed borrow sites prior to general acceptance and procurement. All cover soil materials were trucked in and stockpiled on-site by various trucking companies.

9.2 Installation – Cover Soil

Extreme care was used in the placement of the cover soil over the PVC composite liner. Cover soil was installed in two (2) lifts with each lift having a thickness of not less than 12 inches after compaction for a minimum total thickness of 24 inches. Exceptions to this are in the new paved compost area (LFP 1) and an area on the North Slope of LFP 3. Some of the compost area cover soil was only 10-inches thick (as indicated on the Contract Drawings) with the remaining 24-inch thickness made up by the pavement layers (i.e., 12-inch crushed stone subbase, 6-inch asphalt binder course and 2-inch asphalt top course). The material placed in LFP 3 (discussed in Section 9.1) was also installed to depths exceeding 12-inches compacted. Grade stakes were used on a 100-foot by 100-foot (approximately) grid to ensure that each 12-inch lift was achieved.

Most cover soil was stockpiled, and then mechanically screened and then moved with earthmoving equipment such as excavators and payloads into articulated trucks (DJB's & 10-wheel dump trucks) for transport to and placement onto approved locations. Temporary roads with a minimum thickness of 24 inches were first built with low ground pressure (LGP) bulldozers to avoid undue stress on the underlying geosynthetics by the earthmoving equipment. The articulated trucks utilized these temporary roads to transport and deposit the cover soil, while the LGP bulldozer spread the material onto the geosynthetics. Soil placement was restricted to proceed from the bottom of the slope to the top with tracked low ground

- pressure (LGP) bulldozers. A smooth drum vibratory roller was used to proof roll the liner protection layer to provide a smooth firm compacted surface.

Laborers were assigned to every LGP bulldozer to remove any remaining rocks, stones, or other objectionable material to ensure that the lower six inches of the liner protection layer was reasonably free of stones (i.e., maximum particle size of two (2) inches). With the exception of the area in LFP 3 noted above, prior to placement of the first six inches of cover soil, the cover soil material was screened using a mechanical screener to remove any particle larger than four- (4) inches. QA inspectors from WESTON continuously inspected and monitored the quality of the liner protection layer soil and the integrity of the low permeability layer.

Send the material to be inspected with test sheet

9.3 Quality Assurance/Quality Control During Installation – Cover Soil

Quality assurance and quality control during construction of the liner protection layer consisted of full-time observation and laboratory and field-testing. The minimum thickness of 24 inches of compacted cover soil was monitored by means of placing marked grade stakes on a 100-foot by 100-foot grid (approximately).

The thickness of the liner protection layer was also verified by hand digging several test pits, as directed by WESTON. No test holes were dug without the QA Inspector present. After measurements were made, the holes were backfilled with the excavated or imported cover soil, and hand tamped. During digging and backfilling of test holes, OGDEN exercised extreme care not to damage the underlying geosynthetic materials.

All laboratory and field testing was performed by the approved independent geotechnical laboratory, Fairway Testing Laboratories, employed by OGDEN. Fairway Testing Laboratories provided continuous quality control (QC), including field moisture and density tests during the compaction of each lift of cover material in accordance with Table 9.1 below. Periodic quality assurance (QA) inspection and testing was performed by WESTON to verify the QC testing.

Table 9-1
Quality Control - Field and Laboratory Minimum Testing Requirements for Cover Soil

Property	Test Method	Frequency
Particle Size Analysis w/ Hydrometer	ASTM D421/422	2,500 yd ³
Atterberg Limits	ASTM D4318	1,000 yd ³
Moisture Content (Laboratory)	ASTM D2216	1,000 yd ³
Standard Proctor Compaction	ASTM D698	1,000 yd ³
Consolidated – Undrained Triaxial	ASTM D4767	10,000 yd ³
Field Density	ASTM D2922	10,000 ft ²
Moisture Content (Field)	ASTM D3017	10,000 ft ²
Lift Thickness	-	10,000 ft ²
Environmental - Cleanliness	EPA 8020	10,000 yd ³

The cover soil was compacted to a minimum density of 90 percent of maximum dry density with moisture content within ± 3 percent of the optimum moisture based on the Standard Proctor Test, as determined by ASTM D-698. The moisture and density of the liner protection soil were measured in the field to a 12-inch depth by a nuclear densometer. Field density/moisture on the cover soil were performed at approximately a 100-foot grid interval.

Refer to Volume 5 of 6, Appendix G1 for the cover soil moisture/density field testing results and locations.

Refer to Volume 5 of 6, Appendix G2 for the cover soil geotechnical laboratory test results.

Refer to Volume 5 of 6, Appendix G3 for the cover soil chemical analysis laboratory test results.

↑
penet
line
5

10.0 TOPSOIL AND SEEDING

The final step in the landfill final cover system was the construction of a 6-inch thick layer (minimum) of topsoil to sustain a well-established vegetative cover, which will protect the cap from erosion. Topsoil and seeding were placed in conjunction with the final cover system on top of the barrier protection layer (cover soil layer).

10.1 Material Source - Topsoil

The material used for the topsoil layer construction was in general conformance with the Technical Specifications. All topsoil used on the project was tested and approved per the QA/QC requirement of the Specifications prior to use at the Clarkstown Landfill project.

not good enough
used in some areas
not described in summary

Overall, topsoil was a fertile and a friable surface soil of good and uniform quality. Moreover, the topsoil did not contain subsoil materials. Topsoil was free of refuse, hard clods, woody vegetation, stiff clay, construction debris, boulders, stones larger than two inches, hydrocarbons, petroleum materials or chemicals toxic to plants, other miscellaneous or otherwise unstable or undesirable materials, and other deleterious inclusions.

Topsoil had a minimum organic content of five (5) percent by weight as determined by the method described in ASTM D 2974. Topsoil had a pH value within a range of 5.5 to 7.6 as required by NYSDOT.

The topsoil used on this project was a mixture of peat and sand that were imported from various local borrow sites. All material was trucked in, stockpiled, and then mixed to meet the specifications.

10.2 Installation - Topsoil

The topsoil was spread over the prepared and approved liner protection layer in sufficient quantity to obtain a minimum compacted layer of six (6) inches. No topsoil was permitted to be spread until the liner protection layer and the topsoil were approved by WESTON.

Prior to placement of topsoil, the subgrade surface for the topsoil (i.e., finished cover soil layer) had to be approved by the Engineer. Stockpiled topsoil materials were placed in Engineer-approved areas only. The stockpiled materials were placed and graded for proper drainage and were not placed near the edge of side slopes. Topsoil material delivered to the site was visually and continuously inspected by the Engineer during placement to check that it was consistently the same as the materials previously delivered to the site.

Topsoil work within the limits of the final cover system was executed in conformance with the lines and grades shown on the Drawings. For all work within the limit of the final cover system, slopes had a minimum of 4 percent and a maximum of 33 percent. Topsoil was placed so that the surface was free draining. Runoff and other water were conveyed in ditches and channels to the site perimeter storm water management system.

- After screening, mixing and stockpiling the delivered material, it was then moved with earthmoving equipment such as excavators and wheel loaders into articulated trucks for transport to and placement at a desired location. Topsoil was evenly placed with a LGP bulldozer to a minimum thickness of six (6) inches within the limit of final cover system and limits of disturbance. Grade stakes were used on an approximately 100-foot by 100-foot grid to ensure that a six (6) inch lift was achieved. The topsoil was pushed in an upslope direction on slopes steeper than 10%. Irregularities in the surface resulting from topsoil placement or other operations were corrected so as to prevent the formation of depressions where water would pond. Topsoil was not placed when the subgrade surface was frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to the proposed seeding program. In addition, mud, snow, ice or frozen earth were not permitted to be incorporated in the topsoil.

10.3 Quality Assurance/Quality Control During Installation - Topsoil

Quality control during the topsoil layer construction consisted of full-time observation, and laboratory and field-testing. The minimum thickness of 6 inches of topsoil was monitored by means of placing grade stakes on an approximately 100-foot by 100-foot grid. In addition, OGDEN was required to verify the thickness by hand digging test pits, in the presence of WESTON QA inspectors.

As the construction progressed, QA/QC conformance sampling and testing was conducted per the Specifications (generally every 10,000 cubic yards for QC and every 25,000 cubic yards for QA). Refer to Volume 6 of 6, Appendix H1 for the topsoil analytical laboratory test results.

The chemical analyses of the topsoil (EPA Method 8020) were performed at the specified frequency of no less than one test for every 10,000 cubic yards of topsoil material delivered to the site. Refer to Volume 6 of 6, Appendix H2 for the topsoil chemical analysis laboratory test reports.

Did the, all pass

10.4 Seeding

Seed mixture and application rates conformed to Table 02932-1 of Section 02931 of the Technical Specifications. OGDEN submitted a certificate attesting that the seed mixture is composed of the specified varieties and proportions in the Technical Specifications. Refer to Volume 6 of 6, Appendix H3 for a copy of the seed mixture certificate of compliance.

Seed mixed prior to delivery was approved on the basis of a certification by the vendor stating the minimum percentage of germination and variety of each kind of seed, and the quantity of each kind of seed in the mixture.

Areas to be seeded were scarified sufficiently to break up the surface crust immediately before seeding except where the ground was loose and subject to rolling or sliding. Rocks, debris and all other objects which were detrimental to mowing were removed.

Seed was placed by a Brillion drill seeder and a 3,000-gallon hydroseeder. When the Brillion drill seeder was used, the seed was not to be planted any deeper than one-quarter (¼) inch. After seeding, seedbeds were

- raked lightly and rolled with an empty steel hand roller. Any unplanted areas observed after growth of the grass were re-seeded. The seed was also applied by hydroseeding prior to and in a separate operation from mulching. However, covering and firming were still required even though the seed was applied by the hydroseeding method.

Fertilizer was applied to the areas of permanent seeding. Permanent seeding was provided at a minimum of 600 pounds of 5-10-10 or equivalent per acre in accordance with the project specifications. Temporary seeding did not require soil amendments. Lime was provided at ninety-two (92) pounds per 1,000 ft², two (2) tons per acre, on all areas which received permanent seeding.

All seeded areas were mulched. Seeded areas received two (2) tons of straw mulch per acre, machine or hand spread evenly and uniformly such that, at least, ninety-five (95) percent of the surface was covered. Mulching was completed within twenty-four (24) hours after seeding. Cowd Virgin Wood Fibre Mulch was used in the hydroseeding mixture.

For drill seeding, the rate of application of mulch was a minimum of two (2) tons per acre. For hydroseeding, the rate of application of mulch was a minimum of 1,500 pounds per acre. Mulch stabilizer was applied at the rate of the manufacturer's recommendations.

this is in conference with the design docs?

11.0 DRAINAGE CONTROL STRUCTURES

The drainage system was designed to accomplish the following:

- To remove stormwater runoff from the landfill surface during storm events in order to prevent ponding of water on the landfill
- To provide sediment control prior to discharge of collected stormwater to the surrounding wetlands
- To control the effects of erosion on the landfill cap
- To collect precipitation infiltrating through the cover soil to the drainage layer above the PVC geomembrane liner

The final cover system design for this project provides the required site drainage using a series of lined side slope diversion dikes, constructed of structural fill and lined with either erosion control mat or grass. These structures direct surface runoff to lined drainage channels before directing it off site to neighboring wetlands through the use of concrete and HDPE pipe culverts and rip-rap lined outlets. Several gravel access roads also serve to direct runoff to the drainage channels while providing for site access. Two sedimentation basins (#3 and #8) have been left on site. Basin #3 drains the west side of the main Landfill area and discharges into the surrounding wetlands. Basin #8 which was originally intended for use as a temporary storm water sediment basin, was left in place to accommodate a future planned use by the TOWN for surface control of runoff from the paved compost facility located adjacent to the landfill.

Prior to the commencement of construction, ORSC placed silt fence, turbidity barrier, and hay bales in accordance with the plans and the Contractor's approved erosion and sediment control plan (Refer to Section 2.2 of this report).

were also done in accordance with the design documents - see Section 1

11.1 Side Slopes

etc

The side slopes of the landfill were constructed using structural fill to be less than or equal to thirty-three (33) percent (3H: 1V) and steeper than or equal to four (4) percent in accordance with 6 NYCRR Part 360 Regulations. The "crown" or top of the landfill is primarily at a four-percent slope. The remaining sideslopes (slopes between the "crown" and the landfill perimeter) range in slope between 4 percent and thirty-three (33) percent.

After setting survey grade stakes, the contractor used off-road trucks to haul and bulldozers to spread and compact the structural fill to grade in approximate one foot compacted lifts in accordance with the specifications. A smooth drum vibratory roller was used to compact the structural fill prior to both QA and QC testing.

Most of the structural fill used for construction of the side slopes was tested for quality control and quality assurance in accordance with the structural fill testing requirements outlined in Section 2. Test results for this material appear in Volume 2 of 6, Appendix A.

11.2 Diversion Dikes/Drainage Channels

The diversion dikes were constructed using structural fill to have a minimum of four (4) percent slope along the centerline (vertex) of the "vee" shaped channel (bedslope) and are a minimum of two feet in depth. The diversion dikes were constructed in accordance with Table 1 of Contract Drawing No. 2025 and are lined with either turf reinforcement mat or grass vegetation depending on the hydraulic characteristics of the anticipated flow. The turf reinforcement mat was manufactured by Excelsior to meet the material requirements of the Technical Specifications.

After setting grade stakes, the Contractor used off-road trucks to haul and low ground pressure (LGP) bulldozers, backhoes and a grade-all for fill placement, and a roller for compaction of the structural fill used for the diversion dikes. The turf reinforcement mat was placed by hand.

The drainage channels that carry the storm water down the sideslopes of the landfill were constructed in accordance with Table 2 of Contract Drawing No. 2024. Drainage channels are lined with fine rip-rap or turf reinforcement mat, depending on the hydraulic characteristics of its anticipated flow. Diversion dike/drainage channel transitions are lined with light rip-rap. The rip-rap used for the drainage channels was manufactured by Tilcon of NY to meet the material requirements of the Technical Specifications.

After setting grade stakes, the Contractor used off road trucks to haul and bulldozers and backhoes to place and compact the structural fill used in construction of the drainage channels. The backhoe was used to excavate the channel to design depth. The stone used to line the channels was placed using a Gradall 4000.

Structural fill QA/QC testing was conducted in accordance with the testing requirements outlined in Section 2. Test results for the structural fill appear in Volume 2 of 6, Appendix A. Material certifications for the turf reinforcement mat appear in Volume 6 of 6, Appendix I1. Material certifications and test results for the rip-rap used to line the channels appear in Volume 6 of 6, Appendix I2.

11.3 Drainage Pipes/Headwalls

Twelve (12) culverts were constructed as specified in the Technical Specifications and as shown on Contract Drawing No. 2026, Table 2, to carry runoff from the drainage channels away from the landfill. These twelve culverts are referred to as PC-1 through PC-12. The technical specifications allowed for the use of both corrugated metal pipe (CMP) and high-density polyethylene drainage pipes. The CMP were manufactured by Lane Enterprises, Inc. to meet the material requirements of the Specifications. The HDPE pipes were manufactured by Chevron Chemical Company to meet the material requirements of the Specifications. The concrete headwalls were manufactured by The Fort Miller Co., Inc. to meet the material requirements of the Specifications.

The drainage pipe/headwall work consisted of excavation, installation of pipe bedding material, placement of the pipe and headwalls and backfilling to grade with the specified backfill materials. A 245B Excavator and Gradall 4000 were used for this construction.

- Material certifications for the piping materials and headwalls appear in Volume 6 of 6, Appendix I3.

11.4 Granular Drainage System

The granular drainage system was constructed where the drainage composite layer above the PVC liner "daylights" to the surface of the topsoil layer of the cap. Its function is to allow for the release of water from the drainage composite layer of the cap to prevent the build-up of water in the cover soil layer. The stone envelope at the termination of the drainage composite prevents this water from eroding the cap as it is being released.

The placement of the granular drainage system consisted of grading the cover soil beneath the PVC geomembrane cover systems by LGP D4 Dozer or Gradall; hand placement of a "rub-sheet" layer of PVC geomembrane, drainage composite and geotextile; and placement of the stone on top of the "rub-sheet" layer of the cover system by backhoe and by hand labor to obtain the required drainage grades.

QA/QC testing for the geosynthetics was conducted in accordance with the requirements outlined in Section 8. Refer to Volume 3 of 6, Appendix E which contains the test results and materials certifications for the geosynthetics used for the granular drainage system. Material certifications and test results for the stone are contained in Volume 6 of 6, Appendix I4.

did this construction meet spec. fields

11.5 Perimeter Drainage System

The Perimeter Drainage System was constructed in accordance with the approved drawings where the cover system terminates near sections of the slurry wall. Its function is to allow the water that filters through the cover soil to drain to the perimeter of the slurry wall. The Perimeter Drainage System consisted of a trench filled with stone and a series of 4" diameter corrugated perforated polyethylene tubing to collect and transmit the water to 4" diameter solid PVC outlet pipes.

what about other areas

A backhoe was used to excavate the trench and to backfill the stone during construction of the Perimeter Drainage System. The geotextile and drainage pipes were placed by hand.

QA/QC testing requirements for the geotextile are outlined in Section 8. Test results and material certifications for the geotextile are found in Volume 3 of 6, Appendix E4. Test results and material certifications for the stone are found in Volume 6 of 6, Appendix I4.

*St. H. water
what
perimeter / granular
drainage pipe
should be better*

12.0 ADDITIONAL SITE WORK

Four areas of work, specified by the Clarkstown Landfill Remediation Plans and Specifications, are presented in this section to complete the coverage of Quality Control and Quality Assurance aspects of the field work. The work covered by this section includes Cast-In-Place Concrete, Asphaltic Pavement, Gravel Roadways, and Fencing and Gates. Each of the following sections presents a summary of the materials used, Installation practices and Quality Control / Quality Assurance procedures used.

12.1 Cast-In-Place Concrete

Cast-In-Place concrete was installed in the concrete-filled pipe piles beneath the Landfill Gas Blower Building, Flare Stack, and Condensate & Leachate Tank Farms. Cast-in-place concrete was also used to construct the foundations and containment basins for the above structures, a concrete travel-way for the movement of heavy equipment, as well as the concrete curb and gutter in the vicinity of the compost area.

All Cast-In-Place concrete was placed in accordance with American Concrete Institute (ACI) 301 guidance document, the Technical Specifications and the Project Drawings. Revisions were made to the dimensions and reinforcing steel requirements for the travel-way, based on constructibility issues encountered in the field. Rebar (#4 bars, 12-inches on-center both ways) was used in lieu of wire mesh. The pad was also installed at a thickness of 9-inches.

Prior to construction of the above-referenced structures the contractor commissioned an independent laboratory to provide and evaluate a mix design for the concrete to be placed. The results of the mix design are provided in Volume 6 of 6, Appendix J1.

During construction of the individual structures, Field QC testing was performed by Fairway testing and witnessed by the Engineer's field representative. The field verification consisted of slump testing (ASTM C-143), air entrainment (ASTM C231), and concrete sampling (ASTM C172) for the purpose of creating test cylinder sets. Concrete compression testing was performed for each set of cylinders in accordance with ASTM C31. Reports prepared for field testing of the concrete and reports prepared for laboratory analysis of the concrete are provided in Volume 6 of 6, Appendix J1.

12.2 Asphaltic Pavement

The Contractor replaced existing bituminous pavement and installed new bituminous pavement as shown on the Contract Drawing Nos. 2021, 2022 and 2034 and as required in the Specifications. The work included furnishing, stockpiling and placing materials, saw cutting and removing existing pavement, and replacement of existing road components necessary for repairing asphalt pavement or constructing new asphalt pavement as shown on the Drawings or as directed by the Engineer.

Prior to beginning the work, the contractor provided Certificates of Compliance that the materials met the following specifications:

- Asphaltic paving material for binder course - Type 3, as specified in NYSDOT Standard Specifications, Table 401-1.
- Asphaltic paving material for top course - Type 8, as specified in NYSDOT Standard Specifications, Table 401-1.

All asphaltic paving materials were installed in accordance with the applicable requirements of NYSDOT Standard Specifications, Section 403, and as shown on the Drawings. Certificates of Compliance are provided in Volume 6 of 6, Appendix J2.

12.3 Gravel Roadways

The work to be performed under this section included requirements for establishing gravel roads where indicated in the Contract Specifications and Drawings, including the preparation of subgrade and base courses as required. Gravel roadway installation included purchase, delivery, and installation of geotextile and purchase, delivery, and installation of surface aggregate.

Aggregates provided for access road construction were crushed stone which met NYSDOT standard specification, "Section 304 - Subbase Course." The crushed stone consisted of clean, durable, angular fragments of rock. The woven geotextile used as a stabilizing and barrier layer beneath the gravel surface layer met the material properties specified in Specification Section 06020.

Prior to the installation of gravel roadways, subgrade preparation was performed in accordance with Section 02200. The subgrade was established at the proper elevations in accordance with permanent roadway alignments and grade established in the Contract Drawings. Temporary surface drainage was established to prevent damming and ponding of water until permanent drainage channels, culverts and finish grading has been completed.

After subgrade elevations were achieved, woven geotextiles were installed in accordance with Section 06020 and the Manufacturer's recommendations. In general, the fabric was unrolled in the direction of the roadway. Aggregate was end-dumped on the fabric and spread in two six-inch lifts using a lightweight (less than 5 psi contact pressure) tracked bulldozer. A spreader box, attached to the front (blade) of a low ground pressure bulldozer was used for a portion of the roadway construction, but was abandoned due to poor production rates. After placement of the full depth of aggregate the roadway was compacted with two to three passes of a 10-ton smooth drum vibratory roller.

Gravel used in road construction was tested by an approved geotechnical laboratory prior to installation. The testing certified the aggregate on the basis of particle size analysis and compliance with Magnesium Sulfate Testing (NYSDOT 207). Testing results are provided in Volume 6 of 6, Appendix J3.

12.4 Fencing & Gates

Work under this section included furnishing and installing chain link fencing in locations shown on the Drawings and as provided in the Contract Specifications. The chain link fencing was installed in accordance with the plans and specifications, except as noted. The chain link fencing consisted of galvanized fence fabric conforming to the requirements of Section 710-02 "Galvanized Steel Fence Fabric" of the NYSDOT Standard Specifications, whereas the specifications called for 9-gauge aluminum meeting the requirements of Section 710-01. Line posts, terminal posts, top and bottom braces, and fittings were provided in accordance with Section 710-10.03 of the NYSDOT Standard Specifications, as originally specified.

Line and terminal posts were installed in accordance with the Specifications and Drawings. Posts installed over capping materials utilized oversized footings (3 feet in diameter) to avoid damage to the liner system and provide adequate overturning resistance. Fence layouts for the leachate collection chambers were revised to maintain access to the chambers while avoiding relocated roadways and code restrictions resulting from revisions in the electrical panel orientations. The fence installed around the blower/flare facility was installed at a height of 6-feet instead of the 10 feet height that appears on the design drawings due to a discrepancy between the plans and specifications. Refer to As-built Drawing No. 4107.

Gates located in the Scale and Transfer Station area were reinstalled in kind with the exception of one additional gate that was installed near Leachate Collection Chamber No. 1 to secure the Landfill. The remaining gates were installed as shown in the Specifications and Drawings.

Submittals providing fence compliance documentation for materials installed are presented in Volume 6 of 6, Appendix J4.

13.0 DESIGN MODIFICATIONS

The final cover of the Clarkstown Landfill was constructed in general conformance with the NYSDEC-approved Plans and Specifications. However, Variations from the design were made and were coordinated with NYSDEC, TOWN, and ORSC before officially ordering the modifications in the field. Executed Contract Change Orders document the discussions, development, and timing of these changes.

The design modifications which were implemented during construction, were as follows:

CHANGE ORDER #1

Tree removal for trees blown over from a storm after clearing and grubbing had been completed. ✓

CHANGE ORDER #2

Substitution of Polyvinyl Chloride for specified LDPE as the geomembrane layer. ✓

CHANGE ORDER #3

Installation of bentonite well seals in dewatering wells along the south leachate collection line. ✓

CHANGE ORDER #4

Substitution of Gray Iron for use as Trench Grates for the drainage channel near the compost area. ✓

CHANGE ORDER #5

Additional efforts to screen backfill supplied by the TOWN for use as slurry wall backfill. ✓

CHANGE ORDER #6

For reinforcement required to stabilize the slurry wall work platform around the Ballfield. ✓

CHANGE ORDER #7

Reduction of south slurry wall from 16,500 square yards to 9,300 square yards and resulting increase in the unit price to \$75.08 per square yard from \$50.00 per square yard, primarily to reflect fixed costs to be recovered under the total amount of slurry wall constructed. ✓

CHANGE ORDER #8

Changed conditions encountered at north leachate trench installation resulted in additional work and costs. ✓

CHANGE ORDER #9

Changed conditions encountered at south leachate trench installation resulted in additional work and costs. ✓

CHANGE ORDER #10

Cost adjustment for expenses from delay in obtaining a permit to discharge clean groundwater prior to installation of the south leachate collection trench. ✓

• **CHANGE ORDER #11**

Placement of approximately 92,470 cubic yards (loose) of Lake Lucille dredge spoils, sandy material, choking material, and recycled concrete for use as structural fill. ✓

CHANGE ORDER #12

Placement of approximately 60,000 cubic yards of RAI A construction and demolition debris for use as structural fill. ✓

CHANGE ORDER #13

Slurry wall repairs to stabilize the northern portion, approximately station 1+90 to 4+20, excavation from station 0+00 to 1+90 to a 3:1 slope, stabilization of southern area with 75 tons of cement and geogrid, and stabilization of slurry ponds with 150 tons of cement. ✓

CHANGE ORDER #14 – NOT USED ✓

CHANGE ORDER #15 – NOT USED ✓

CHANGE ORDER #16

Installation of an additional 14,500 square yards of woven geotextile, primarily due to an increase in the use of bridge lift stabilization around the landfill perimeter in soft subgrade areas. ✓

CHANGE ORDER #17

Installation of an additional 325 linear feet of 4-inch diameter high density polyethylene (HDPE) piping for the landfill gas collection system. *the bid is 325' x 4"* (X)

CHANGE ORDER #18 – NOT USED

CHANGE ORDER #19 ✓

Installation of an additional 150 tons of light riprap as aprons for sediment basins required as a result of the project redesign.

CHANGE ORDER #20 ✓

Additional materials for the extension and relocation of power feeder and control wiring cables between Leachate Collection Chambers #2 and #3 required as a result of the Riverso property access issue.

CHANGE ORDER #21 ✓

The project redesign modifying perimeter berm construction and deleting the Riverso property from the project also resulted in modification of sediment basin construction, including the deletion of Sediment Basin #7 and changes in basin outlet construction from pipes to spillways.

CHANGE ORDER #22S ✓

Placement of structural fill materials significantly overran original bid estimates primarily as a result of unforeseen settlement of the waste mass and landfill cap materials. (Structural fill overrun 100% to 115%)

CHANGE ORDER #22R

Placement of structural fill materials significantly overran original bid estimates primarily as a result of unforeseen settlement of the waste mass and landfill cap materials. (Structural fill overrun above 115%)

CHANGE ORDER #23

Placement of approximately 39,000 cubic yards of RAIA and Practice Tee materials for use as structural fill.

CHANGE ORDER #24

For additional gravel road in the vicinity of the new compost area.

CHANGE ORDER #25

For modifications to the Town's weigh station such as improvements to the existing scales.

CHANGE ORDER #26

This change order included the costs for the additional drainage structures, passive landfill gas vents and additional cover soil required to accommodate the revised slopes due to placement of the RAIA material in Change Order # 23.

CHANGE ORDER #27

Following review of field data showing berm instability, and to accommodate required design changes related to this instability, major grade modifications were provided to the Contractor in a set of 57 Revised Drawings in March of 1997. The Contractor requested equitable adjustments to the contract for additional labor, equipment, and costs associated with this change.

CHANGE ORDER #28

The north slurry wall was only partially installed as indicated on the plans and specifications, as noted herein and in CO #28 documents. Minor revisions were made to the proposed alignment due to constructability concerns in the vicinity of Basin 8. Also, the section of the wall beginning at the eastern edge of the Rivero property and continuing westward was not installed due to lack of access to the parcel.

After encountering subsurface instabilities in the northeast corner of the ballfield area while installing the work platform, the southern and eastern legs of the south slurry wall were deleted from the project. Furthermore, after encountering a subsurface failure in the peat layer of the west and north legs of the south slurry wall, it was eliminated from the project.

CHANGE ORDER #29

A storm in excess of the predicted once in a hundred year severity produced almost 5 inches of rain in a two hour period at the landfill. The storm which constituted an Act of God under the contract terms caused damage to landfill surfaces and structures, including a leachate collection chamber which required extensive repairs.

CHANGE ORDER #30

While excavating an access road at the site, the Contractor severed telephone and electrical lines servicing the transfer station at the landfill.

• **CHANGE ORDER #31** ✓

The Contractor was directed to place NYSDOT #2 stone, as provided for under bid item 5D, under the Waste Disposal Areas to ensure adequate drainage.

CHANGE ORDER #32 ✓

Modification of design elevations and slopes from the redesign resulted in changes to the amounts of permanent seeding and straw mulch required at various areas of the Landfill that had previously called for wetland plant mixtures.

CHANGE ORDER #33 ✓

Differential settlement of the Landfill resulted in damage to a rigid flange connection to the condensate knockout tank. Repairs were made to the tank and connection.

CHANGE ORDER #34 ✓

Schedule delays prevented the Contractor from meeting the projected completion date in November of 1997. Work progressed through an additional winter season and in place materials were damaged by winter weather and subsequently replaced and repaired.

CHANGE ORDER #35 ✓

Plan Drawings show liner locations extending from the Transfer Station. In connecting to this existing liner the Contractor found that actual liner location differed from the Plan Drawings. Additional work was required to locate the existing PVC liner at the transfer station.

CHANGE ORDER #36 ✓

For costs associated with increasing the thickness of the concrete travelway and modifying the reinforcement from 6x6, 12 gauge wire mesh to # 4 rebar, 12-inches on center.

CHANGE ORDER #37 ✓

The Contract Specifications required the replacement of 8-foot tall fence on areas of the Landfill, including areas around the Transfer Station property. The Contract did not, however, provide for payment for installation of 8 foot fence under a bid line item as it did for 6 foot fence installation. The required 8-foot tall fence was installed in the areas specified by the Contract and the TOWN agreed to payment for such increase in fence installed.

CHANGE ORDER #38 ✓

For costs associated with "fine" riprap placed in the channels and was washed out requiring replacement with larger stone ("light" rip-rap).

CHANGE ORDER #39 ✓

Delays resulting from several sources, including the project redesign, storm damage, and the structural fill overrun prevented the Contractor from meeting its originally projected completion date. Additional time on site, including an additional winter shutdown resulted in increased work, overhead, and other expenses.

CHANGE ORDER #40

Dispute over methods of calculating payments for placement of RAIA materials resulting in \$11,861 in deductions of the Contractor's pay requests. The Contractor claimed for these disputed amounts and as part of the settlement agreement the Town paid those costs.

LANDFILL GAS EXTRACTION WELLS AND COLLECTION SYSTEM

- Landfill settlement resulted in changes to wellhead elevations and minor damage to wellheads that has required repairs, including boot and collars adjustment.
- Relocation of drip leg 2 was required after RAIA II fill materials were placed in LFP 8. Refer to Volume 6 of 6, Appendix K2, Sheet 4 of 6 for the location of drip leg 2, as installed.
- Wellhead specification requirements did not match valve vault clearances. To obtain adequate clearance below the valve vault lid, portions of the wellhead assembly were rotated 90%.
- Well and header pipe locations were modified to meet existing field requirements, as identified in the attached as-built plan drawings.
- Perforation patterns for slotted extraction well pipe were modified.
- Differential settlement of the landfill altered well elevations, as identified in attached plan drawings.
- Other modifications, including Passive Gas Vents in RAIA II material (LFP #8), Surface Collection Monitoring Point, and LFG Monitoring Wells (elimination/relocation) were required by field conditions and are reflected in attached as-built drawings. One gas monitoring probe, GM#7, was not installed due to Riverso.

LEACHATE COLLECTION SYSTEM

- Greater than expected amounts of differential landfill settlement required field modifications including changes to leachate chamber invert elevations, collection pipe invert elevations and associated changes in collection pipe slope.
- A portion of the proposed collection line near leachate chamber 2, from the eastern edge of the Riverso property and continuing westward, was not installed due to lack of access to the Riverso property.

SLURRY WALL INSTALLATION

In addition to Change Orders executed that affected slurry wall construction, other modifications to original slurry wall design were implemented, as follows,

- After placing material to create a work platform for slurry wall construction, subsurface instability caused the south slurry wall to be deleted from the project. Recovery of the work platform has been considered a

high risk to the Contractor's personnel and equipment because of the unforeseen instability of the area and the platform has been abandoned in place.

- After encountering subsurface instability in the area of the Ballfield, the south slurry wall alignment on the north and west sides of the Ballfield was moved closer to the Landfill mass by 5 feet and away from the Ballfield wetlands in an attempt to complete the installation of the wall.
- When south slurry wall construction resumed in September 1997 following the first failure in June 1997, further spreading of the slurry trench resulted in an ever expanding trench width. A subsequent investigation by both the Contractor and Engineer found the cause of the spreading to be a weakness in the peat layer. The remainder of the wall was deleted from the project and the remaining open trench and partially installed wall were solidified with a concrete additive to stabilize the area.
- A portion of the proposed slurry wall (north) from the eastern edge of the Rivero property and continuing westward, was not installed due to lack of access to the property.

WETLANDS MITIGATION & RESTORATION

Several modifications to the wetlands mitigation and restoration plan have been implemented,

- As referenced above, the south slurry wall work platform installed in the Ballfield has been abandoned in place due to safety concerns for personnel and equipment arising from the unexpected instability of soils in the area.
- Sediment Basin #8, which was originally planned to be removed, is now proposed by the Town to remain in place to serve as a runoff basin for the compost area.

GEOMEMBRANE INSTALLATION

- Lack of access to the Rivero property and changes to the south slurry wall construction resulted in changes to geomembrane installation locations. Actual location is depicted in the As-Built Geomembrane Panel Layout included in Appendix K1.
- An issue regarding the destructive test results by the QA laboratory (M&T) arose during construction and has been addressed extensively in Project correspondence (M&T geomembrane testing issue) and in Section 8 of this report.

LINER PROTECTION LAYER (Cover Soil)

- Following changes made in slopes and elevations from the project redesign, locations of transitions from diversion dikes to channels were altered. This relocation of the points where dikes met channels prevented the Contractor from adjusting preparation grade elevations below the modified transitions so that final construction left reduced amounts of cover in these areas as compared to original design requirements. The liner protection layer at the dike to channel transitions consists of approximately 12-inch thick cover soil layer, geotextile on top of the cover soil, and 12-inch thick rip-rap stone.

LFG BLOWER/FLARE FACILITY

- A 10 inch diameter automated valve at the inlet header pipe of the blower skid replaced two 3 inch diameter vacuum relief valves.
- The Contract requires a 'demonstration of compliance' and the Contractor provided a certificate of destruction efficiencies and emission rates to meet this requirement. The NYSDEC requires stack emission testing to establish compliance. Under separate agreement to the Town of Clarkstown, WESTON conducted the required stack testing in February and October of 1999.
- Following repeated unexplained shutdowns of the flare, the Contractor installed a surge protection and an un-interruptible power supply to the flare panel.
- Flare downtime resulted in LFG migrating to the transfer station, particularly below the transfer station concrete slab floor. To address the conditions, WESTON undertook an extensive monitoring and mitigation program with the Town which including ventilating under the slab, testing and monitoring for gas concentrations and the recommended installation of permanent methane monitoring equipment at the transfer station building.
- The LFG line runs from the blower building to the flare. Both the blower building and the flare pad are supported by piles driven into the landfill mass. A support for the LFG line between the blower building and flare was set on a concrete base and was not supported by piles. This support experienced settlement as the Landfill settled. Because, the blower building and flare do not settle and the pipe support did, modifications to the support were made to remove a clamp that had dragged down the pipe and replaced it with a saddle that only supports it.
- Additional work to heat trace demister drains at the blower building were added to prevent freezing of the line.

ADDITIONAL SITE WORK

- An upgraded electrical panel was installed in the Maintenance Facility. The new transformer was also relocated to the roof of the office at the Town's garage to decrease the potential impacts with flooding.
- Additional wetland planting for restoration and stabilization of the failed south slurry wall area due to revising the platform location.
- The use of geotextile for reinforcement of the slurry wall work platform due to stability concerns, as described in Change Order 6 of this Section.
- Disposal of slurry at the landfill due to the abandonment of the slurry wall construction.

RIVERSO PROPERTY

- Lack of access to the Riverso parcel in the northern side of the landfill required design modifications, including rerouting of 480 volt service, revision to the installed length of the north slurry wall, modification of the leachate collection and LFG collection systems (including gas probe GM #7 and the

14.0 CONSTRUCTION PHOTOGRAPHY

Developed
signs at 2.1.1
photos??

Photographs of construction progress were taken for the duration of the work. These photographs follow this section. Table 14.1 provides a description of each photograph.

Table 14.1
Construction Photography Log

PHOTO NO.	VIEW	DESCRIPTION
1	NORTH	EROSION & SEDIMENTATION CONTROLS IN PLACE DURING CLEARING & GRUBBING
2	NORTH	CHIPPING IN PROGRESS
3	WEST	WASTE DISPOSAL AREA 1 SHOWING ROUGH GRADING WITH EXCAVATED MATERIAL FROM PYRAMID PROPERTY REMEDIATION EFFORT
4	SOUTH	LANDFILL SURFACE AFTER FINE GRADING OPERATIONS PRIOR TO APPLICATION OF LOW PERMEABILITY LAYER (40 MIL PVC)
5	SOUTH	LANDFILL SURFACE AFTER APPLICATION OF LOW PERMEABILITY LAYER (40 MIL PVC) & GEOCOMPOSITE
6	NORTH	GAS EXTRACTION WELL INSTALLATION BEING PERFORMED BY MORETRENCH OF AMERICA
7	SOUTH	HORIZONTAL LANDFILL GAS COLLECTION SYSTEM PRIOR TO TRENCH BACKFILL
8	NORTH	FINAL TIE IN OF 10 INCH LANDFILL GAS COLLECTION MANIFOLD
9	WEST	INSTALLATION OF LEACHATE COLLECTION CHAMBER 2N WITH BACKFILLING OF NEW LEACHATE COLLECTION LINE IN PROGRESS
10	WEST	EXCAVATION OF SLURRY WALL BEGINS WITH A LEAD IN TRENCH
11	WEST	WETLAND REMEDIATION – PYRAMID PROPERTY EXCAVATION
12	SOUTH	WETLAND REMEDIATION – BALLFIELD EXCAVATION
13	SOUTH	WETLAND REMEDIATION – BALLFIELD RESTORED
14	SOUTH	INSTALLATION OF GEOCOMPOSITE
15	NORTH	INSTALLATION OF 1 ST LIFT BARRIER PROTECTION LAYER
16	WEST	GRADING OF 2 ND LIFT BARRIER PROTECTION LAYER, QC TESTING IN PROGRESS
17	WEST	SAME AREA AS PREVIOUS PHOTO AFTER THE INSTALLATION OF TOPSOIL
18	SOUTH	COMPLETED DIVERSION DIKES AND CHANNEL WEST SLOPE
19	WEST	INSTALLATION OF HEADWALL #13 & #14 AT PIPE CULVERT #7
20	EAST	FLARE STATION COMPOUND PRIOR TO ENCLOSURE
21	EAST	FLARE STATION COMPOUND COMPLETED WITH SECURITY FENCING AND PROTECTIVE JERSEY BARRIER
22	WEST	CONCRETE TRAVELWAY – CAST IN PLACE CONCRETE
23	WEST	PAVING OPERATIONS AT THE FUTURE COMPOST AREA
24	SOUTH	INSTALLATION OF GRAVEL ROADWAY
25	EAST	Design Modifications at the Outbound Transfer Station Scale



PHOTO NO. 1

PHOTO NO. 2



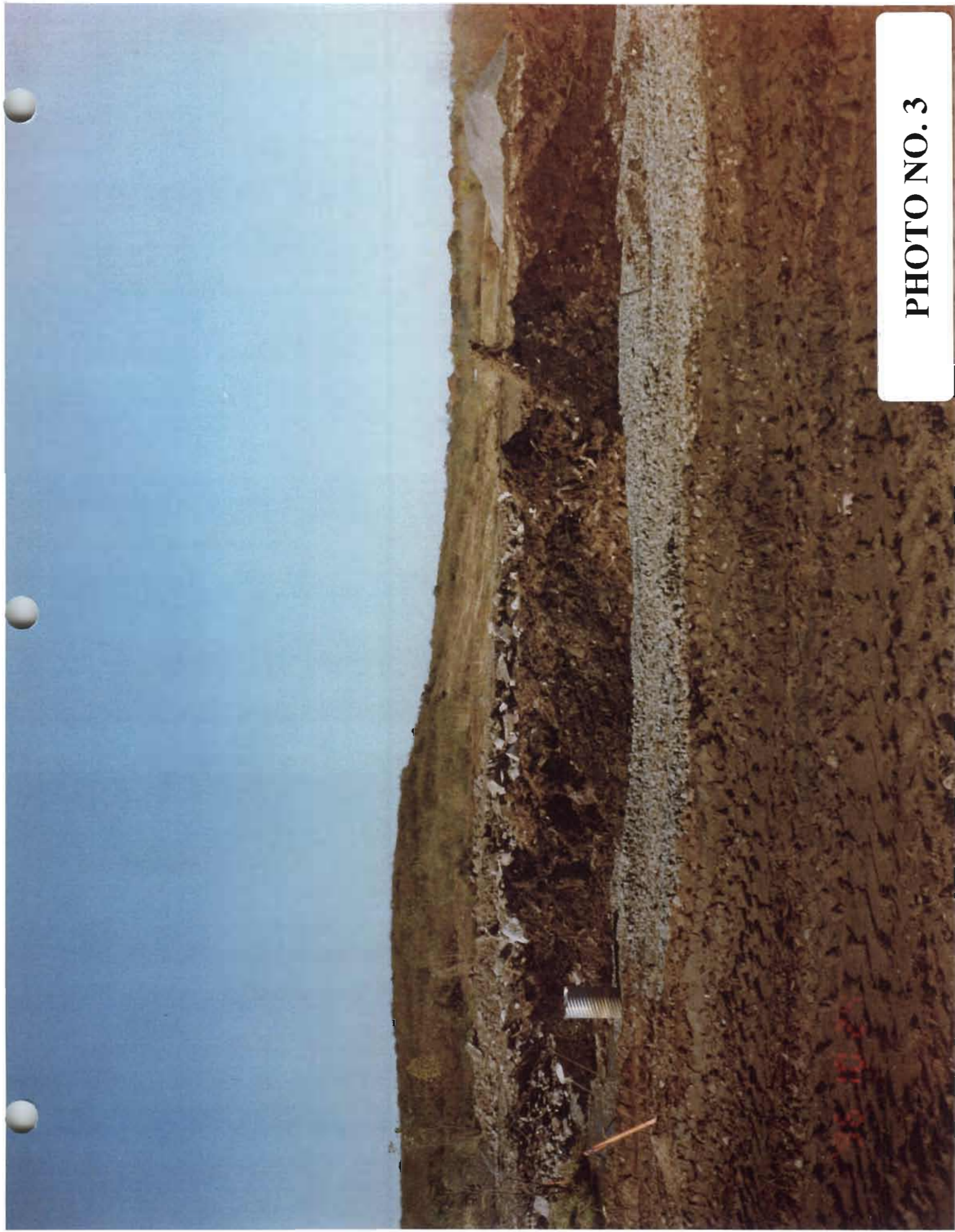


PHOTO NO. 3

15.10.21

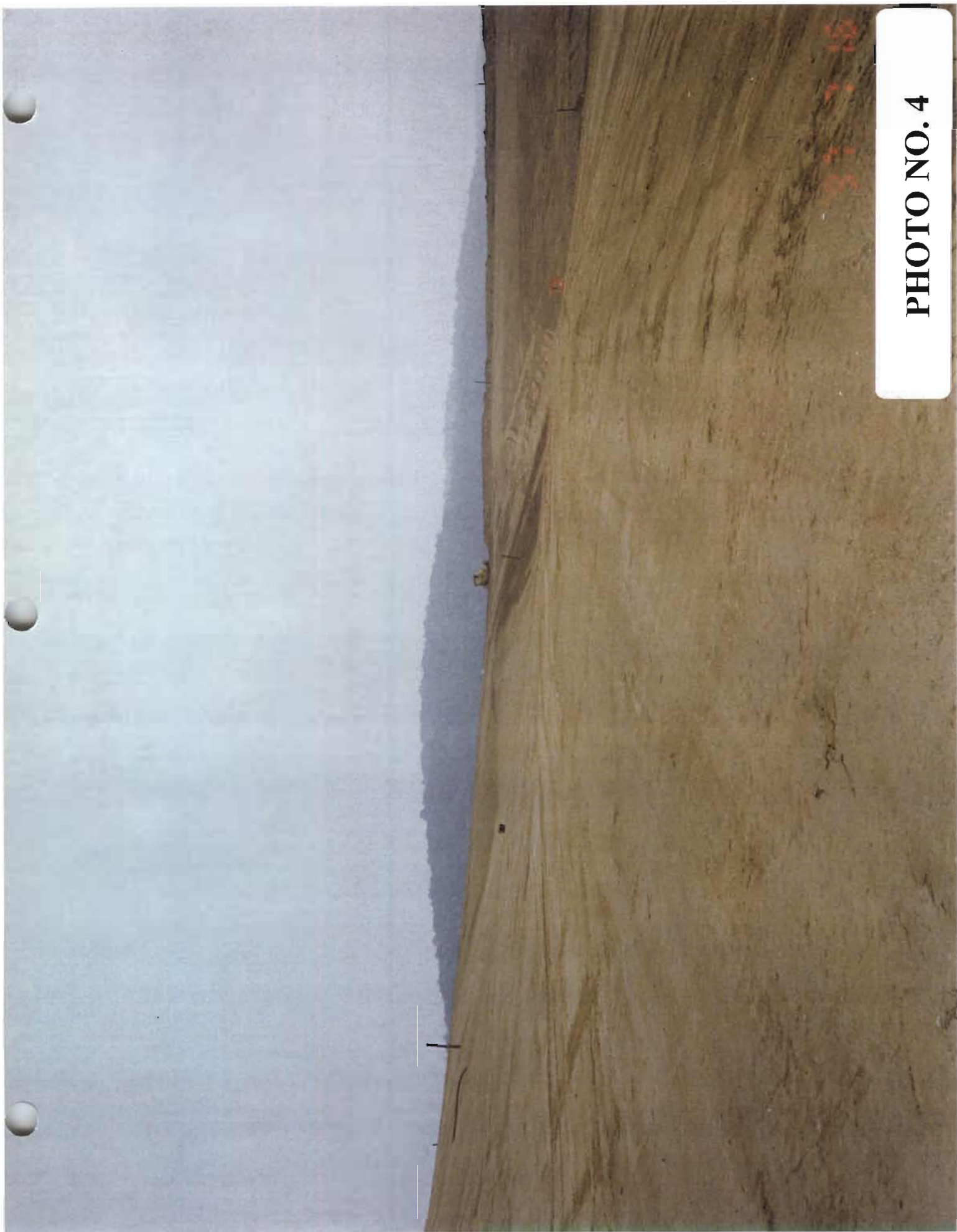


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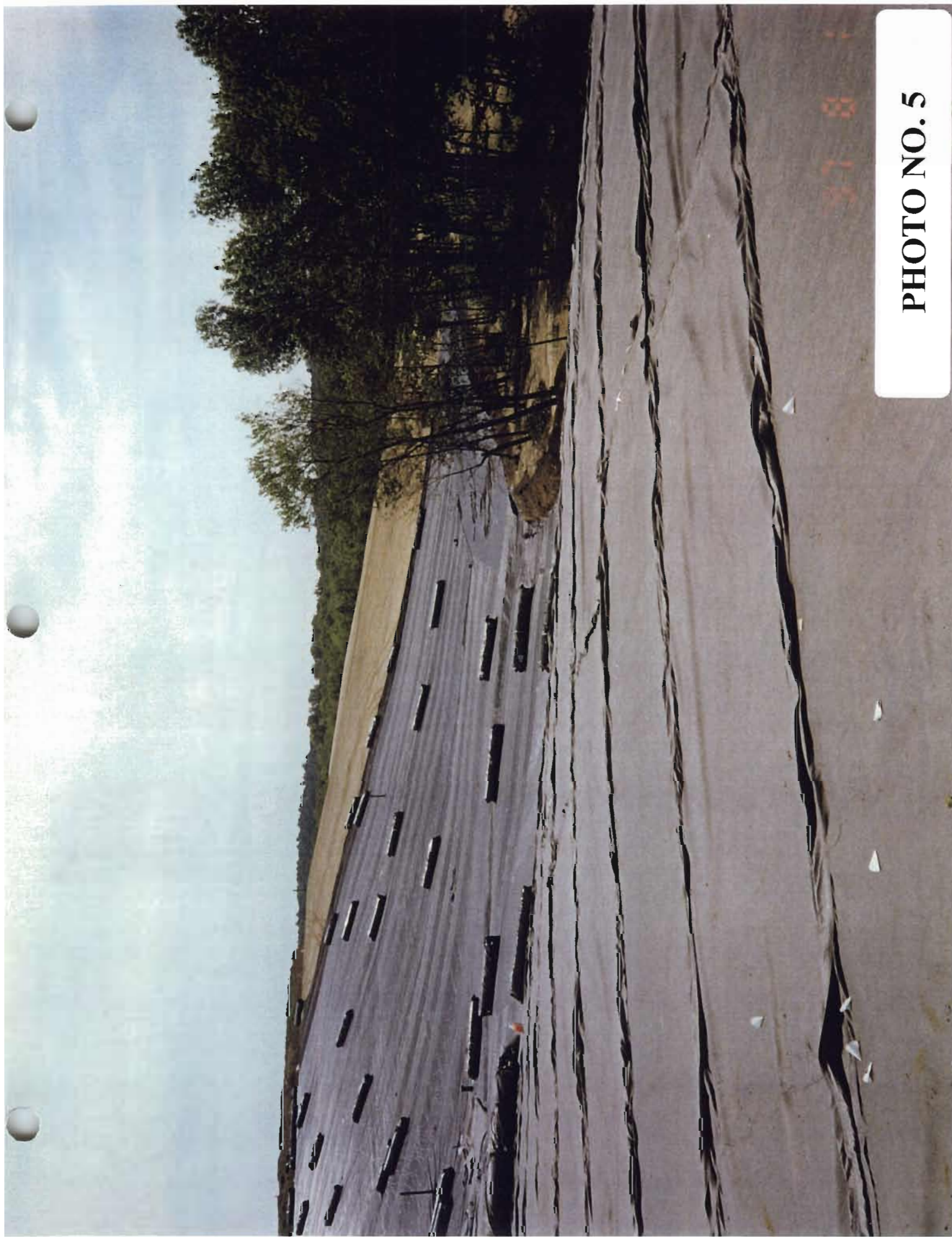


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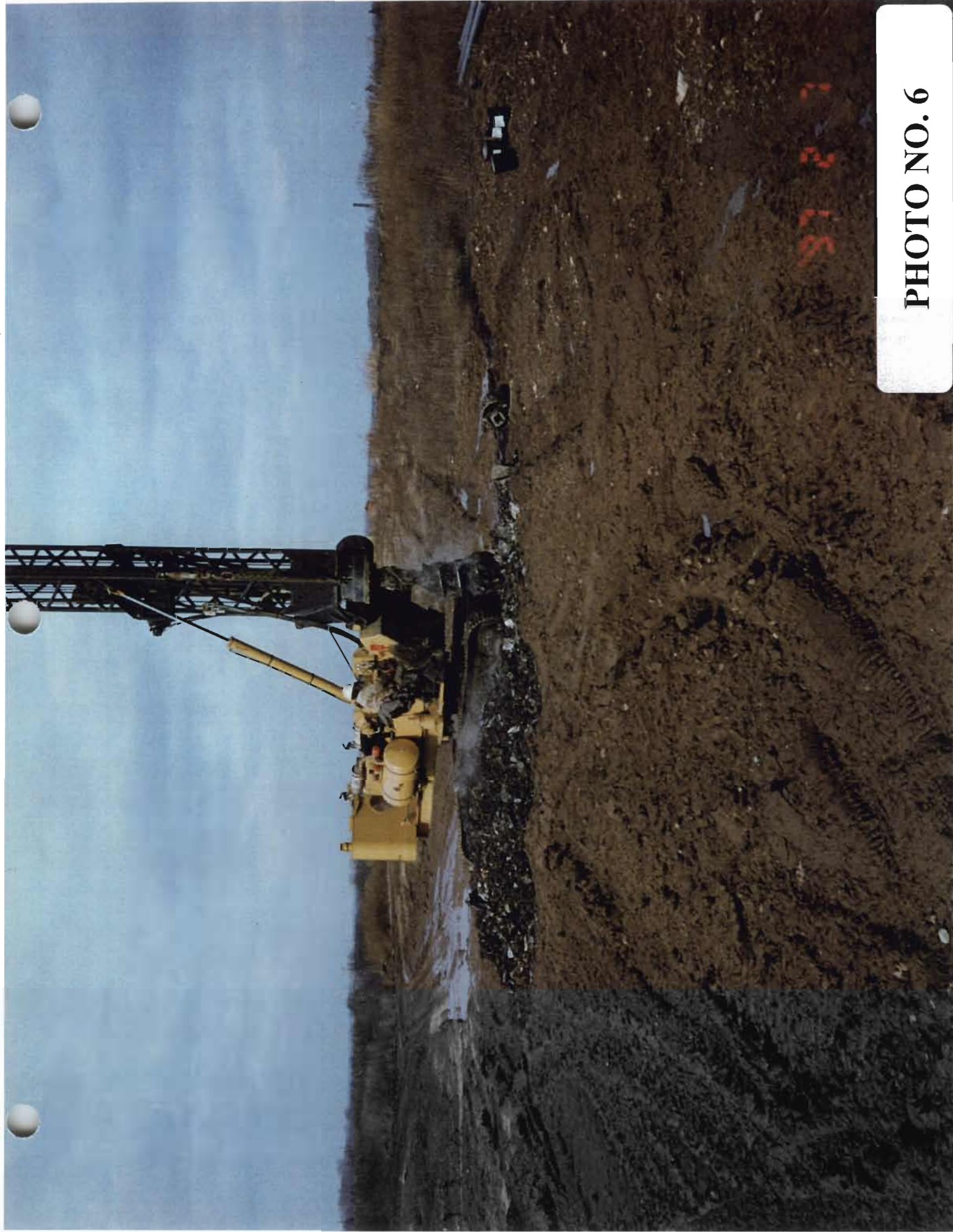


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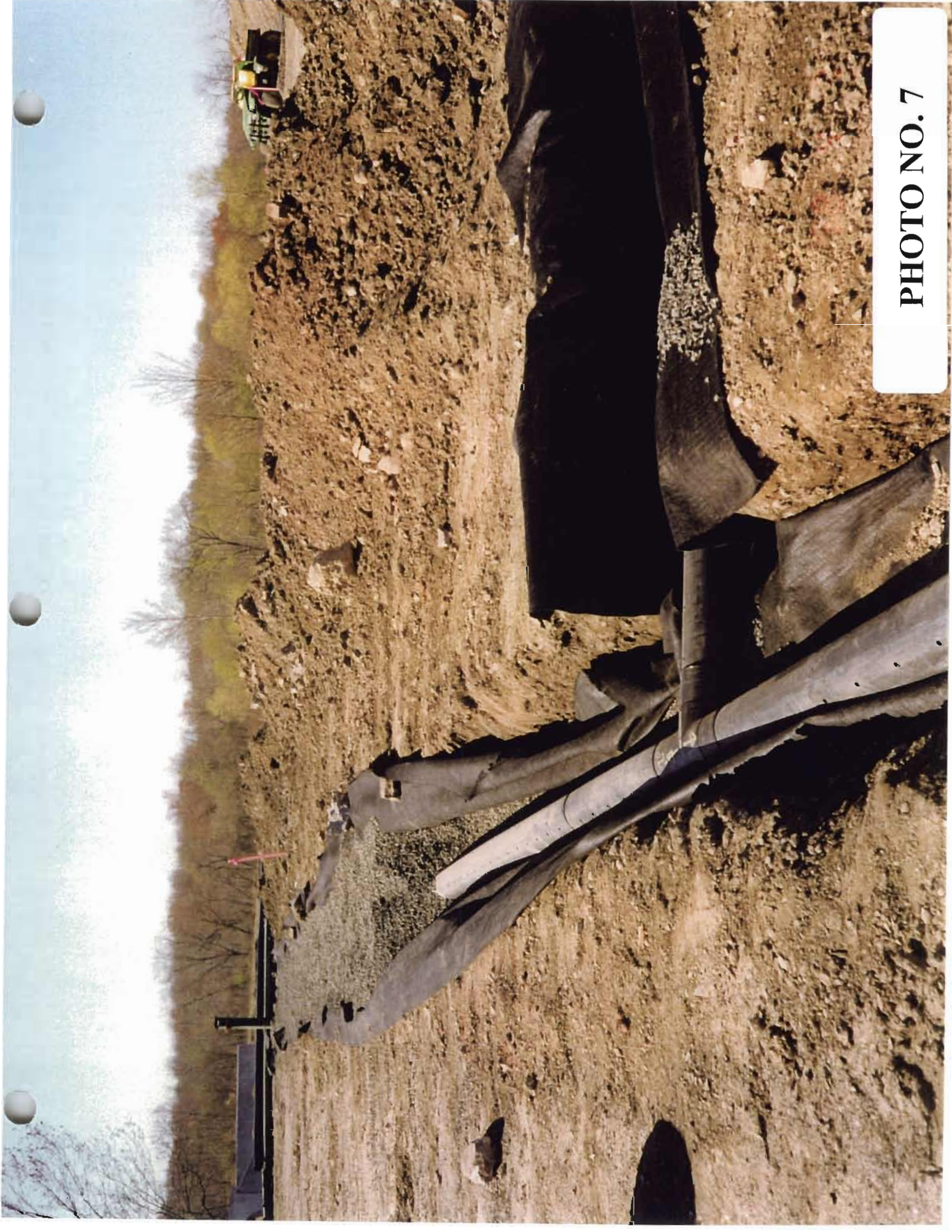


PHOTO NO. 7



PHOTO NO. 8



PHOTO NO. 9



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PHOTO NO. 10



PHOTO NO. 11



PHOTO NO. 12

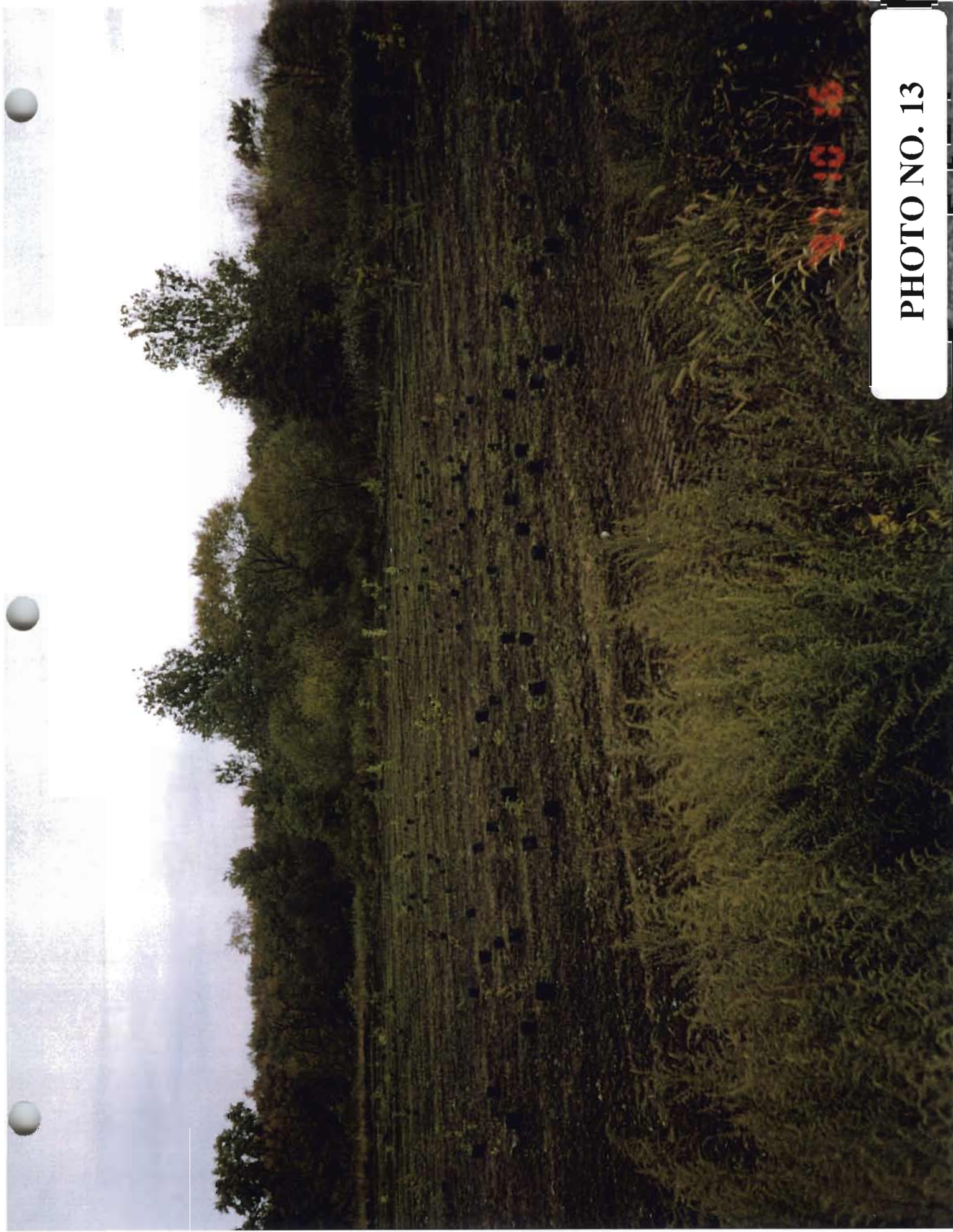


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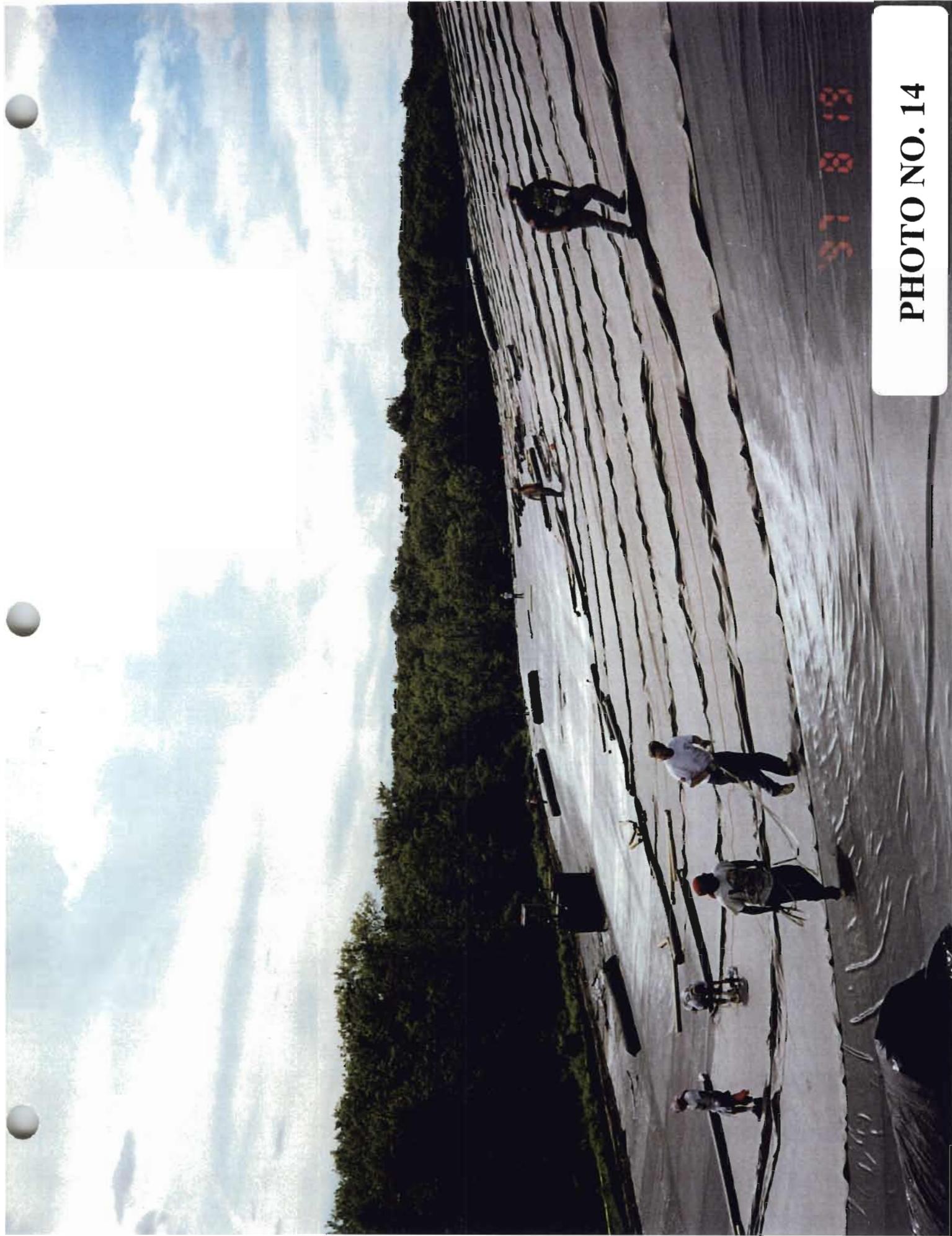


PHOTO NO. 14



PHOTO NO. 15



PHOTO NO. 16

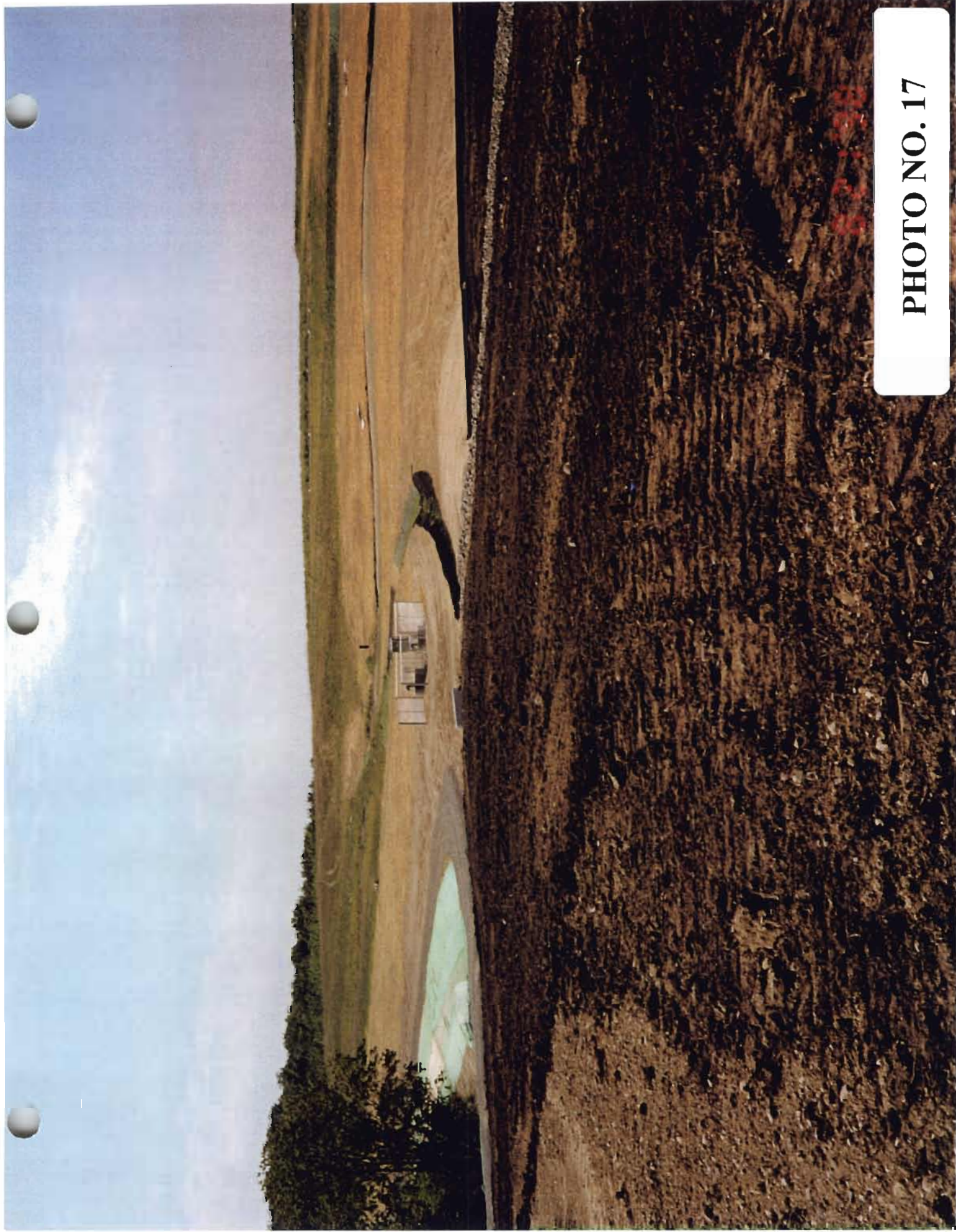
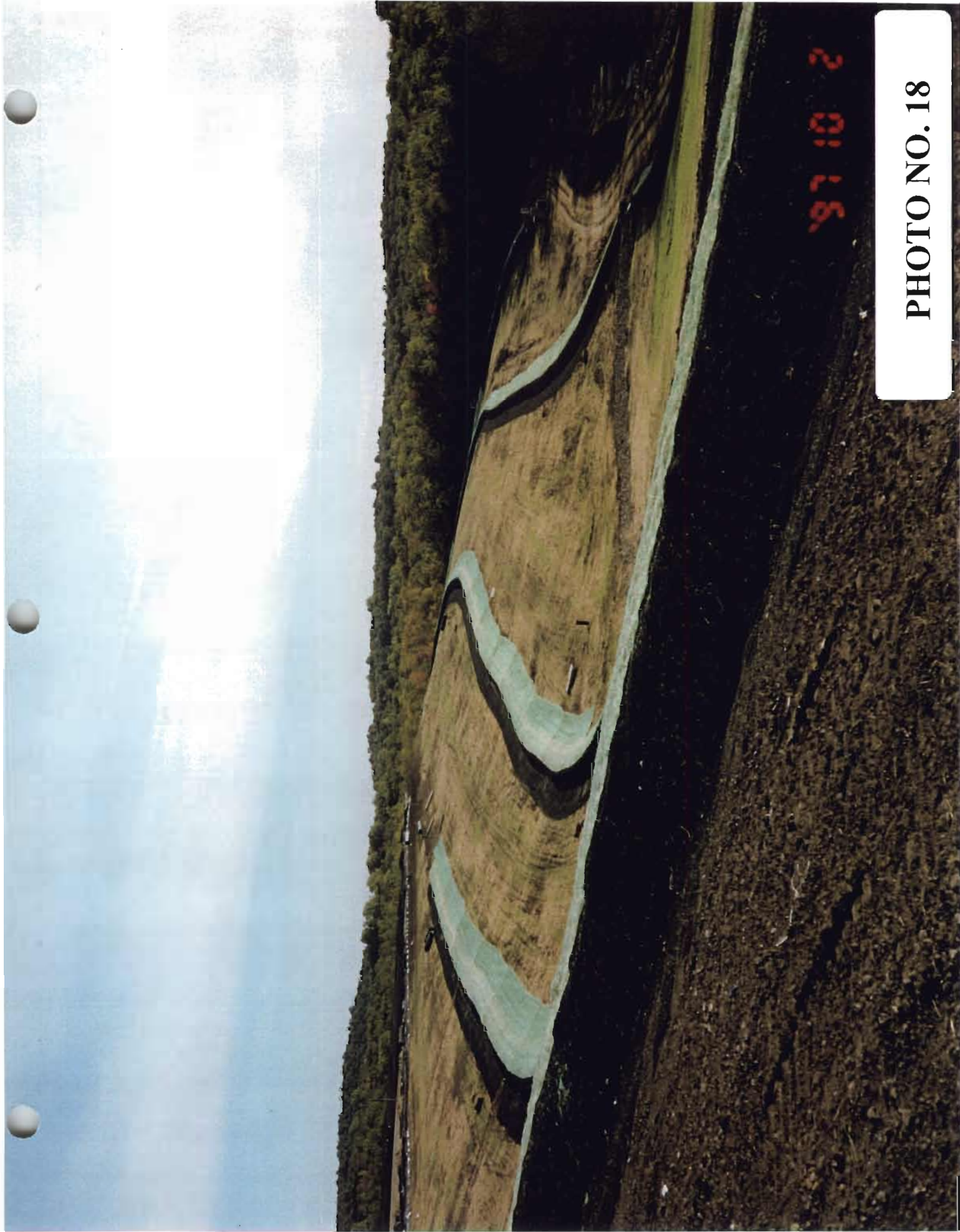


PHOTO NO. 17



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PHOTO NO. 18



PHOTO NO. 19

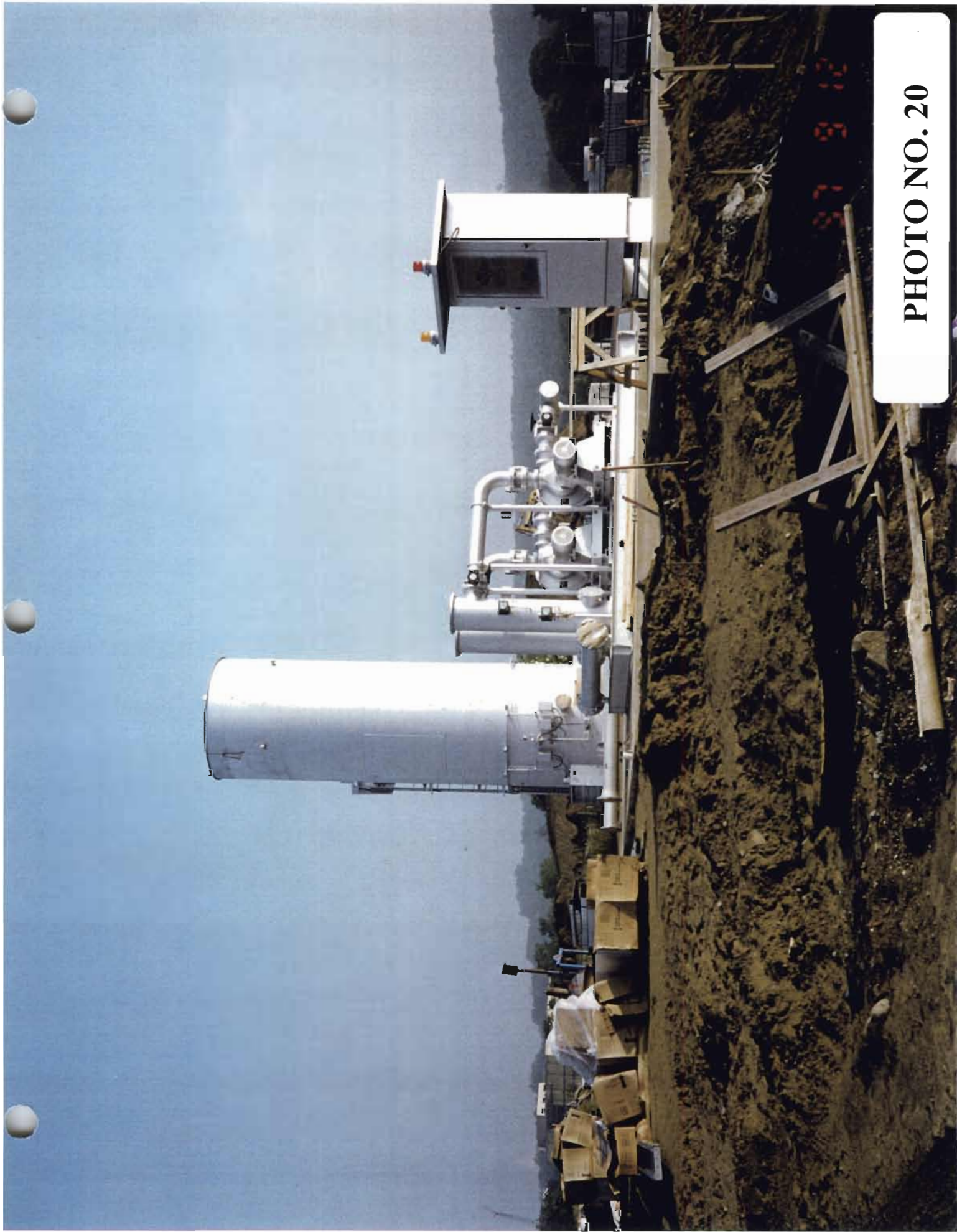


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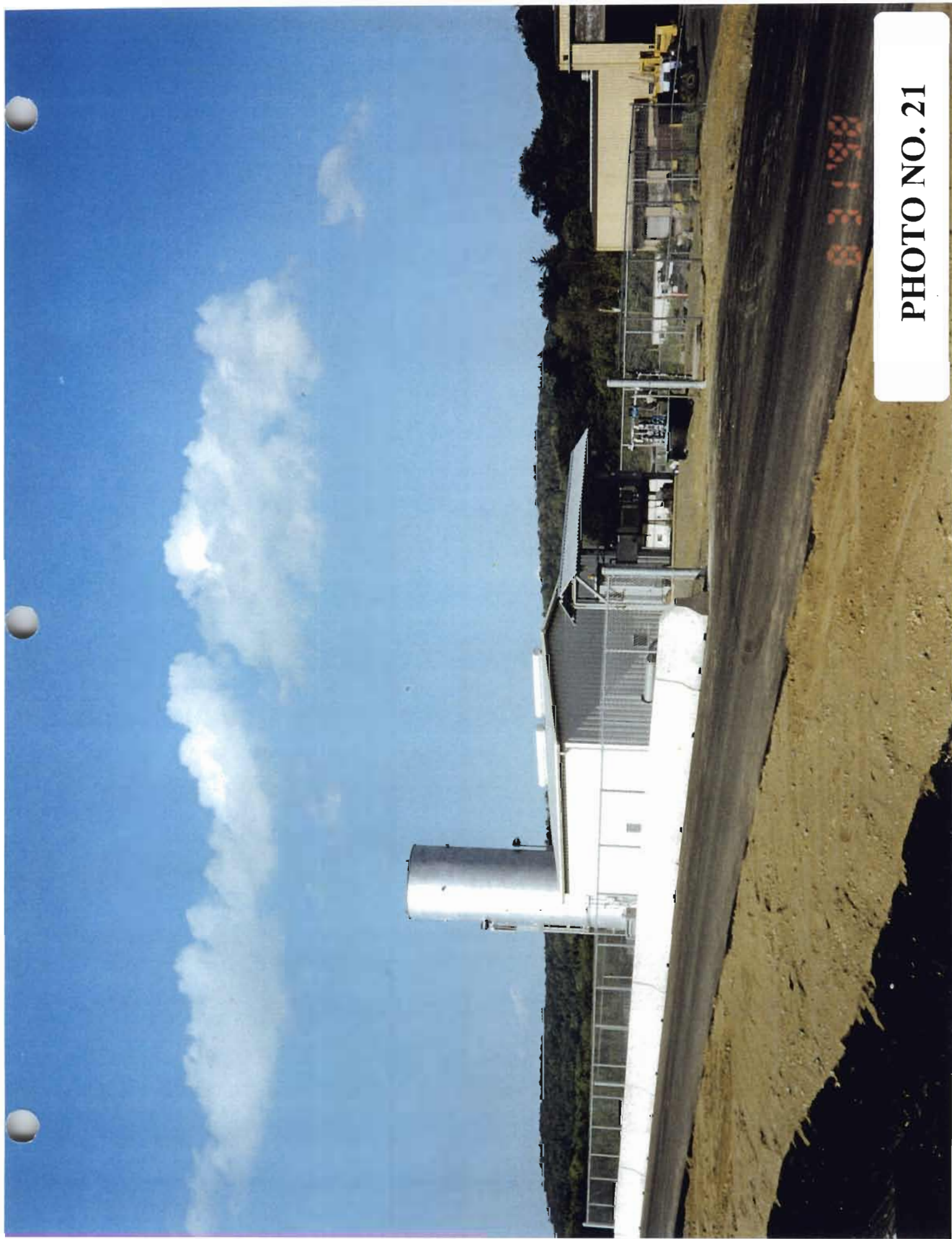


PHOTO NO. 21



PHOTO NO. 22

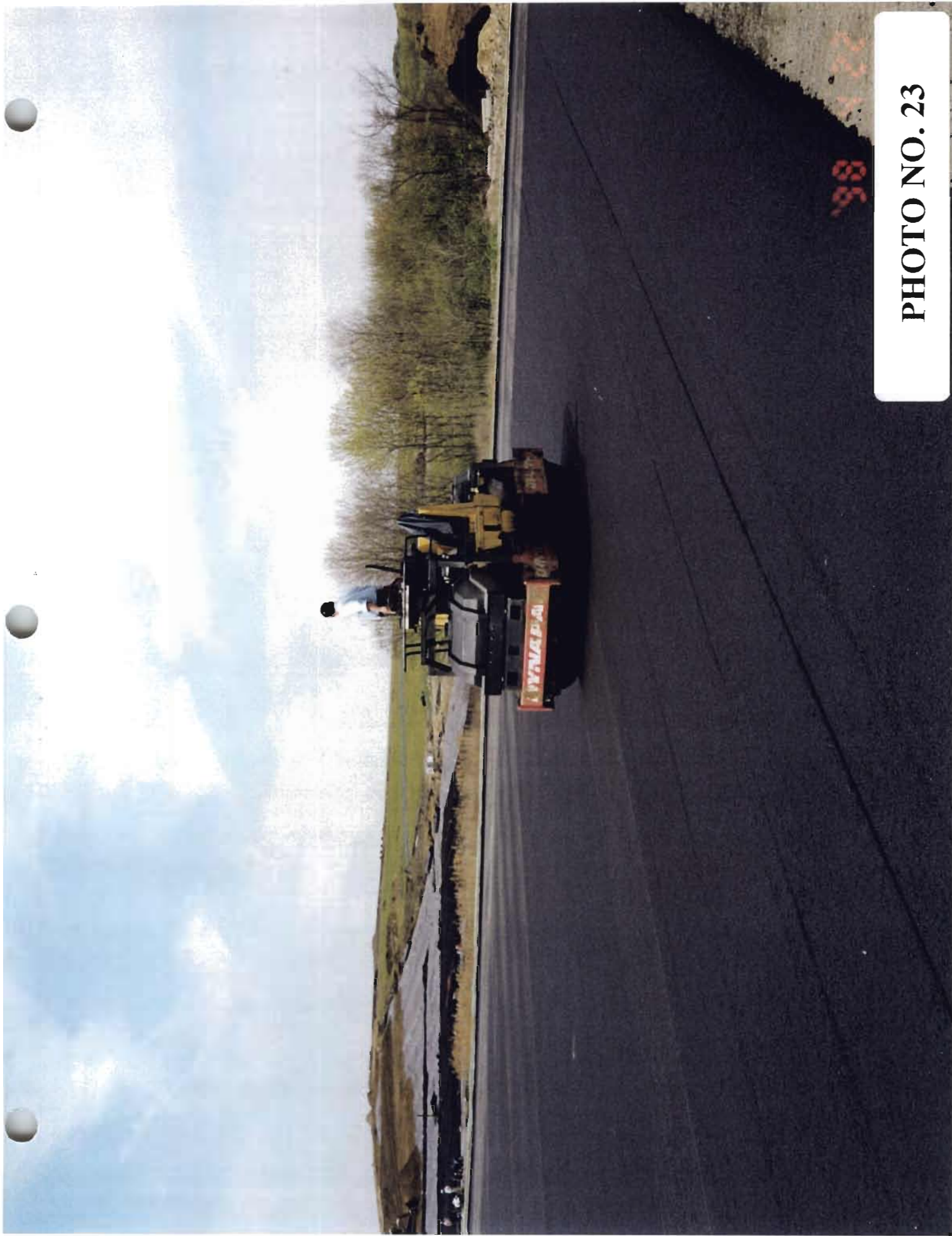


PHOTO NO. 23



PHOTO NO. 24

PHOTO NO. 25

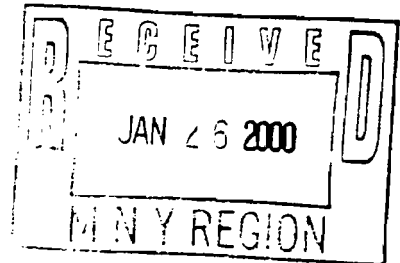


New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Construction Services, Room 267
50 Wolf Road, Albany, New York 12233-7010
Phone: (518) 457-9280 • FAX: (518) 457-7743
Website: www.dec.state.ny.us



JAN 21 2000

Mr. Paul O'Connor
Roy F. Weston
130 W. 30th Street
12th Floor
New York, New York 10001



Dear Mr. O'Connor:

Re: Site No. 3-44-001
Clarkstown Landfill
Flare Retest

The Division of Environmental Remediation staff has received and reviewed the Clarkstown Landfill NMOC Emission Test Report, Clarkstown Landfill Gas Flare System, dated November 1999 and the Clarkstown Landfill Source Emissions Test Report, Clarkstown Landfill Gas Flare System, dated November 1999.

Based upon that review, and the resulting discussions and emails between Department and Roy F. Weston staff, we are satisfied that the flare is operating satisfactorily. As these reports will become part of the forth coming closure report and operations manual, we do not require any additional copies or the placing of these reports in the local document repository. We also anticipate operating parameters for the flare will be established in these documents to ensure its continued satisfactory operation in the future.

As always, the Department appreciates your efforts and patience, as well as those of your colleagues, in completing this multifarious portion of the overall remediation project. We are looking forward to working with you to complete the remaining portions of this project in the near future. If we may be of further assistance, please feel free to contact myself or the assigned project manager at (518) 457-9285.

Sincerely,

Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

cc: N. Nowak - Roy F. Weston
T. Leonard - Roy F. Weston
L. Kalarickal - Town of Clarkstown
G. Brickwood - Town of Clarkstown
G. Price - Rockland County Department of Health
A. Klauss - NYSDEC, Region 3
R. Pergadia - NYSDEC, Region 3
A. Fuchs - NYSDEC, Region 3





DEPARTMENT OF ENVIRONMENTAL CONTROL

10 MAPLE AVENUE, NEW CITY, NEW YORK 10956

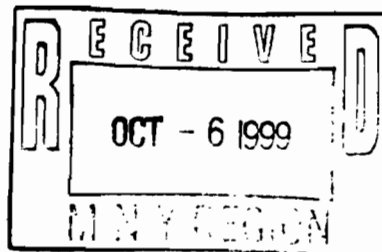
October 1, 1999

DENNIS M. LETSON, P.E.
FIRST DEPUTY DIRECTOR

K. LUKE KALARICKAL, P.E., L.S.
DIRECTOR

GERALD F. BRICKWOOD
DEPUTY DIRECTOR

Mr. John Helmeset, P.E.
NYS Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Construction Services, Room 267
50 Wolf Road
Albany, New York 12233-7010



Re: Clarkstown Landfill - Site No. 3-44-001
Landfill Gas Flare
Emissions Testing - Supplement to Testing Completed in February 1999

Dear Mr. Helmeset:

Attached please find a letter from Roy F. Weston of New York, Inc. (WESTON), regarding additional proposed landfill flare emission testing at the Town of Clarkstown's (TOWN) - Clarkstown Landfill. The emissions testing proposed herein will be used to supplement the testing that was completed by WESTON in February 1999.

As you are aware, based on our previous discussions, the emission testing that was completed in February 1999 did not demonstrate that the flare was meeting the necessary 98 percent destruction/removal efficiency (DE) for non-methane organic compounds (NMOCs). All other parts of the emission testing met the required standards.

The reason why the 98% DE for NMOCs was not met may be based in the fact that the concentration of NMOC in the landfill gas is relatively low and that ambient dilution air is being introduced into the flare, thus resulting in a NMOC concentration at the flare exhaust on the order of 1 part per million (ppm). The method used, EPA Method 25C, does not have the necessary precision to demonstrate compliance due to the method's high detection limit (DL), which is on the order of 15 ppm NMOC as carbon.

Therefore, in order to obtain a passing result on all parts of the emissions testing at the Clarkstown Landfill flare, the TOWN and WESTON propose to use an alternate performance requirement. This proposal is due to the NMOC concentration in the landfill gas being below the DL (i.e. 15 ppm of NMOC as carbon) for Method 25C. The alternate method being proposed is a combination of EPA Methods 25C and 18 and is explained further in the attached WESTON letter.

Mr. John Helmeset

October 1, 1999

Page 2

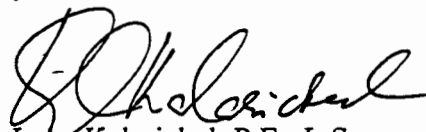
Please note that the method being proposed was used successfully and approved by NYS DEC at another landfill in New York State, namely the Edgemere Landfill in Queens, New York, which is of similar size, waste composition, and age, and used a similar type of landfill flare.

Please review the proposed alternate performance requirement for determining the DE for NMOC due to the relatively low concentrations of NMOCs in the landfill gas. The low concentration of NMOC in the landfill gas results in a concentration of NMOCs in the flare outlet emissions below the DL for EPA Method 25C.

WESTON has tentatively scheduled to perform the testing as described in the attached letter during the week of October 25, 1999, once given approval from NYS DEC to proceed. NYS DEC is invited to attend the testing, and the TOWN will notify NYS DEC of exact day, when scheduled.

Please call me at 914 639-2111 if you require any additional information.

Very truly yours,



K. Luke Kalarickal, P.E., L.S.

Director

KLK:rm
Enclosures

cc: G. Brickwood, Clarkstown DEC
R. Knizek, NYS DEC
S. Nowak, P. O'Connor, WESTON
P. McQuiston, Ogden Environmental and Energy Services



Roy F. Weston of New York, Inc.
130 West 30th Street
New York, New York 10001
212-502-7800 • Fax 212-502-7801

October 1, 1999

K. Luke Kalarickal, P.E., L.S.
Director
Department of Environmental Control
Town of Clarkstown
10 Maple Avenue
New City, New York 10956

RE: Clarkstown Landfill - Site No. 3-44-001
- **Gas Flare Emission Compliance Testing**
- **Revised Compliance Test Method for NMOC**
WESTON W.O. No. : 03228.018.001.3006.05

Dear Mr. Kalarickal:

Compliance test methods for the landfill gas flare at the Clarkstown Landfill were originally proposed in the test program prepared by Roy F. Weston of New York, Inc. (WESTON) and as approved by the New York State Department of Environmental Conservation (NYSDEC) in February 1999. This original test compliance effort was field conducted on February 17 and 18, 1999, in accordance with the test methods as approved.

The original test program, performed in accordance with Environmental Protection Agency (EPA) Reference Method 25C, demonstrated that this method did not have the necessary precision for compliance with the requirement for 98% destruction/removal efficiency for non-methane organic carbon (NMOC) emissions. The concentration of NMOC in the landfill gas, at the inlet to the flare, is on the order of 1,000 parts per million (ppm) as carbon as measured by Method 25C. Due to the relatively low concentration of NMOC in the landfill gas and the ambient dilution air introduced into the flare, a NMOC concentration on the order of 1 ppm is required to demonstrate 98% destruction/removal efficiency. The limit of detection for Method 25C is on the order of 15 ppm NMOC as carbon. The high limit of detection prevents the demonstration of NMOC destruction/removal efficiency using Method 25C.

A similar landfill in terms of size, waste composition, age, and type of facility is the Edgemere Landfill. It is located in Queens, New York and was subject to similar requirements for Landfill Gas Flare Emission Compliance Testing. That testing program used alternate methods, namely a combination of EPA Methods 25A and 18. These methods were combined to measure NMOC concentration at the flare outlet. WESTON is proposing to use this alternate emission performance test method to demonstrate the compliance of the Clarkstown Landfill flare.





Mr. Luke Kalarickal, P.E., L.S.

Town of Clarkstown

October 1, 1999

Page 2 of 3

Revised Compliance Test Method

Based upon the test program successfully utilized at a similar area landfill in New York State, WESTON proposes to conduct the Clarkstown Landfill tests combining EPA Reference Methods 25A and 18. The NMOC concentration will be demonstrated by measuring total hydrocarbon (THC) concentrations at the sampling locations at the flare outlet using Reference Method 25A. The flame ionization analyzer (FIA) will be calibrated with propane standards in the zero to 100-ppm range. Simultaneous with the Method 25A test runs, an integrated bag sample will be collected according to Reference Method 3. The integrated bag sample will be analyzed for methane content according to Reference Method 18. After the methane analysis, the integrated bag will be analyzed for oxygen (and carbon dioxide) according to Reference Method 3.

As stated in the original test protocol, a determination of moisture content and the volumetric flow rate at the flare outlet will be conducted according to Reference Methods 1, 2 and 4 during each test run.

The determination of NMOC as hexane at 3% oxygen will require the following calculations.

- The average THC concentration measured with the FIA as propane on a wet basis will be corrected to a dry basis using the measured moisture content.
- The dry THC concentration will be converted to a methane concentration basis by multiplying by a factor of three.
- The NMOC concentration (as methane) will be determined by subtracting the methane concentration measured by Reference Method 18 from the dry THC as methane concentration.
- The NMOC concentration (as hexane) will be determined by dividing the NMOC concentration (as methane) by a factor of six.
- The NMOC concentration will be corrected to 3% oxygen from the flare outlet concentration measured by Reference Method 3.

To demonstrate compliance, the Clarkstown Landfill gas flare will have an average NMOC emission concentration less than 20 ppm as hexane at 3% oxygen over the course of three (3) one-hour test runs.

The volumetric flow rate will be calculated to verify the flare is operating at the design levels, a nominal 1.2-mmBtu/hr heat input with a nominal 11,000 dscfm volumetric flow.

No sampling or analysis will be conducted on the landfill gas at the inlet to the flare.



Mr. Luke Kalarickal, P.E., L.S.

Town of Clarkstown

October 1, 1999

Page 3 of 3

The volatile organic compounds, particulate, nitrogen oxides, sulfur dioxide and reduced sulfur compound emission measurements conducted at the flare outlet during the February 17, 1999 test will not be repeated.

WESTON recommends that this letter be forwarded to NYSDEC along with a cover letter from the Town of Clarkstown that asks NYSDEC for review of the proposed landfill flare testing. WESTON is available to discuss the test procedures with NYSDEC, if necessary, and is prepared to perform the testing as soon as we receive approval from NYSDEC and the Town of Clarkstown. The testing has been tentatively scheduled to be performed during the week of October 25, 1999. NYSDEC is welcome to attend the testing when performed.

If you have any questions or desire additional information, please contact me at (212) 502-7800.

Very truly yours,

ROY F. WESTON OF NEW YORK, INC.

A handwritten signature in black ink, appearing to read "Neil C. Nowak for".

Neil C. Nowak, PE
Project Manager

cc: G. Brickwood - Town of Clarkstown
P. O'Connor, P. Clarke, T. Leonard, File - WESTON

**CLARKSTOWN LANDFILL
NMOC EMISSIONS TEST REPORT
CLARKSTOWN LANDFILL GAS FLARE SYSTEM**

Prepared for:

**DEPARTMENT OF ENVIRONMENTAL CONTROL
TOWN OF CLARKSTOWN
10 MAPLE AVENUE
NEW YORK, NEW YORK 10956**

A handwritten signature in black ink, appearing to read "Paul A. Clarke", is written over a horizontal line.

Paul A. Clarke
Technical Manager

Prepared by:

ROY F. WESTON, INC.
Raritan Plaza III Suite 2B
101 Fieldcrest Avenue
Edison, New Jersey 08837

NOVEMBER 1999

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INTRODUCTION

The Clarkstown Landfill Gas Flare was identified as part of a Remedial Investigation/Feasibility Study conducted by Roy F. Weston Inc., (WESTON) for the Town of Clarkstown pursuant to a Consent Order Agreement between the Town and the New York State Department of Environmental Conservation (NYSDEC). The Clarkstown Landfill has been listed by the NYSDEC as a Class 2 Inactive Hazardous Waste Site. The landfill gas collection and flare system installation are part of the Clarkstown Landfill Inactive Hazardous Disposal Site Remediation plan which also includes capping of the landfill, leachate collection and landfill gas extraction.

WESTON was retained to conduct a source emission testing and analysis program on the Clarkstown Landfill Gas (LFG) flare system.

The object of the test program was to determine target pollutant emission concentrations, mass rates and destruction and removal efficiencies (DRE's) with regards to the Federal New Source Performance Standards (NSPS) (40 CFR Part 60) landfill flare performance requirements and requirements outlined by the NYSDEC.

Testing procedures conformed to the specifications of the U.S. Environmental Protection Agency (EPA) and NYSDEC. All test program sampling and analysis procedures were conducted as specified in the emission test protocol approved by NYSDEC during the initial compliance test conducted on February 17 and 18, 1999. During this test program the landfill flare met the emission limits specified under the above referenced requirements with the exception of non-methane organic compounds (NMOC). A retest of the flare was conducted on October 28, 1999 using an alternate NMOC sampling and analytical method. No NMOC emissions were detected in the flare exhaust samples collected during the retest.

This report presents the results of the retest that demonstrated compliance with the NMOC emission requirements. Section 2 summarizes the emission test results. A description of the

Sampling locations is provided in Section 3. Sampling and analytical procedures are provided in Sections 4 and 5, respectively.

Process operations data, raw test data, analytical results, sample calculations, equipment calibration records and a list of WESTON project participants are provided in Appendices A through F, respectively.

2 SUMMARY OF RESULTS

WESTON Emission Testing personnel performed an emission test program on the Clarkstown LFG system on October 28, 1999 to demonstrate that the non-methane organic compound concentration in the flare exhaust was less than 20 part per million as hexane corrected to three percent oxygen ($<20 \text{ ppm C}_6\text{H}_{14} @ 3\% \text{ O}_2$).

Table 2-1 presents a summary of the results measured during this test program. No NMOC were detected in the exhaust from the flare. The limit of detection (LOD) and limit of quantification (LOQ) for the Method 18 analysis was 0.24 and 0.8 ppm as hexane respectively. When the larger LOQ value was used as the NMOC concentration, the resultant NMOC concentration as hexane corrected to three percent oxygen was 2.1 ppm ($2.1 \text{ ppm C}_6\text{H}_{14} @ 3\% \text{ O}_2$). The use of the LOQ is extremely conservative, since in the event of a non-detect result, the EPA reporting guidelines recommend using one half the LOD for emission calculations. This would yield an emission concentration of 0.32 ppm $\text{C}_6\text{H}_{14} @ 3\% \text{ O}_2$. The flare is meeting the NMOC emission requirements.

Testing procedures conformed to the specifications of the U.S. Environmental Protection Agency (EPA). All test program sampling and analysis procedures were conducted as specified in EPA Method 18 (40 CFR 60, Appendix A) or as specified by NYSDEC in and confirmed in a letter from WESTON to Mr. John Helmeset of NYSDEC on October 25, 1999.

The volumetric flow rate of the landfill gas flare exhaust was determined at the start and end of the test period. The initial volumetric flow rate was 12296 dry standard cubic feet per minute (dscfm), and the final flow rate was 12056 dscfm. This parameter did not impact the measurement of NMOC concentrations, but is useful as an indication of stable flare operations during the test period. The average flow rate for the test period was also used to compare flare operations during the October 28, 1999 test with the flare operations during the February 17-18, 1999 test. The average volumetric flow rate during the October test was 12,200 dscfm, and the average volumetric flow rates were 10,300 and 10,900 respectively on February 17th and 18th.

Table 2-1

Clarkstown Landfill Gas Flare
Clarkstown, NY

Summary of Non-methane Organic Emission Concentrations

Run	NMOC (ppm as hexane)	CH ₄ (ppm)	NMOC (lb/hr)
Run 1	<0.8	14.1	<2.1
Run 2	<0.8	14.23	<2.1
Run 3	<0.8	14.26	<2.2

¹ All samples were non-detect for NMOC. Reported value (0.8 ppm as hexane) is the limit of quantification, equal to 10 times the standards deviation of 19 separate methane standard injections.

Note: The average flare exhaust flow rate during the test period was 12,000 dscfm (12,000 acfm).

3 DESCRIPTION OF TEST LOCATIONS

Emission testing was performed at the landfill flare gas outlet. The following section presents a description of the sample location. The drawings are not to scale.

3.1 LANDFILL GAS FLARE OUTLET

The LFG flare outlet is a round stack oriented vertical with a 113 inch inside diameter. The stack height is 32 feet 8 inches tall. Four (4) four inch ID sample ports are located 90° apart approximately 25 feet (2.5 stack diameters) from the nearest upstream flow disturbance, the LFG flare inlet. The stack outlet, which is the nearest downstream disturbance is approximately 9 feet (~1 stack diameter) downstream of the sample ports. Only the north and west facing sample ports were accessed by a boom lift for this test program.

A schematic of the sample point and orifice flare location is presented in Figure 3-1.

CLARKSTOWN LANDFILL GAS FLARE CLARKSTOWN, NEW YORK

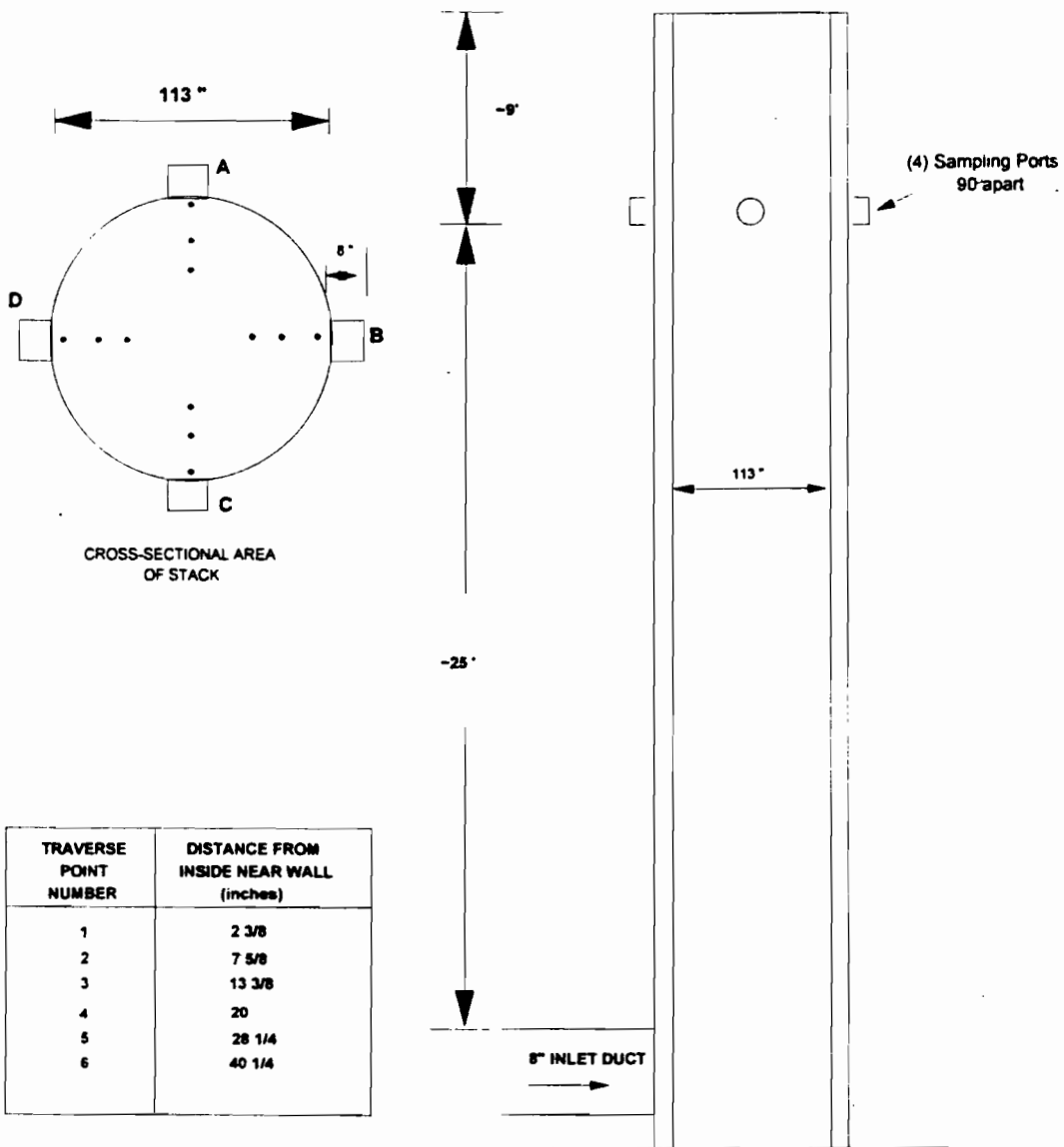


FIGURE 3-1
LANDFILL GAS FLARE OULET
PORT AND TRAVERSE POINT LOCATIONS

DESCRIPTION OF SAMPLING EQUIPMENT

This section describes the sampling equipment utilized for the emission test program. The equipment conforms to EPA source testing requirements.

4.1 GAS VOLUMETRIC FLOW RATE AND COMPOSITION – EPA METHODS 1,2 AND 3

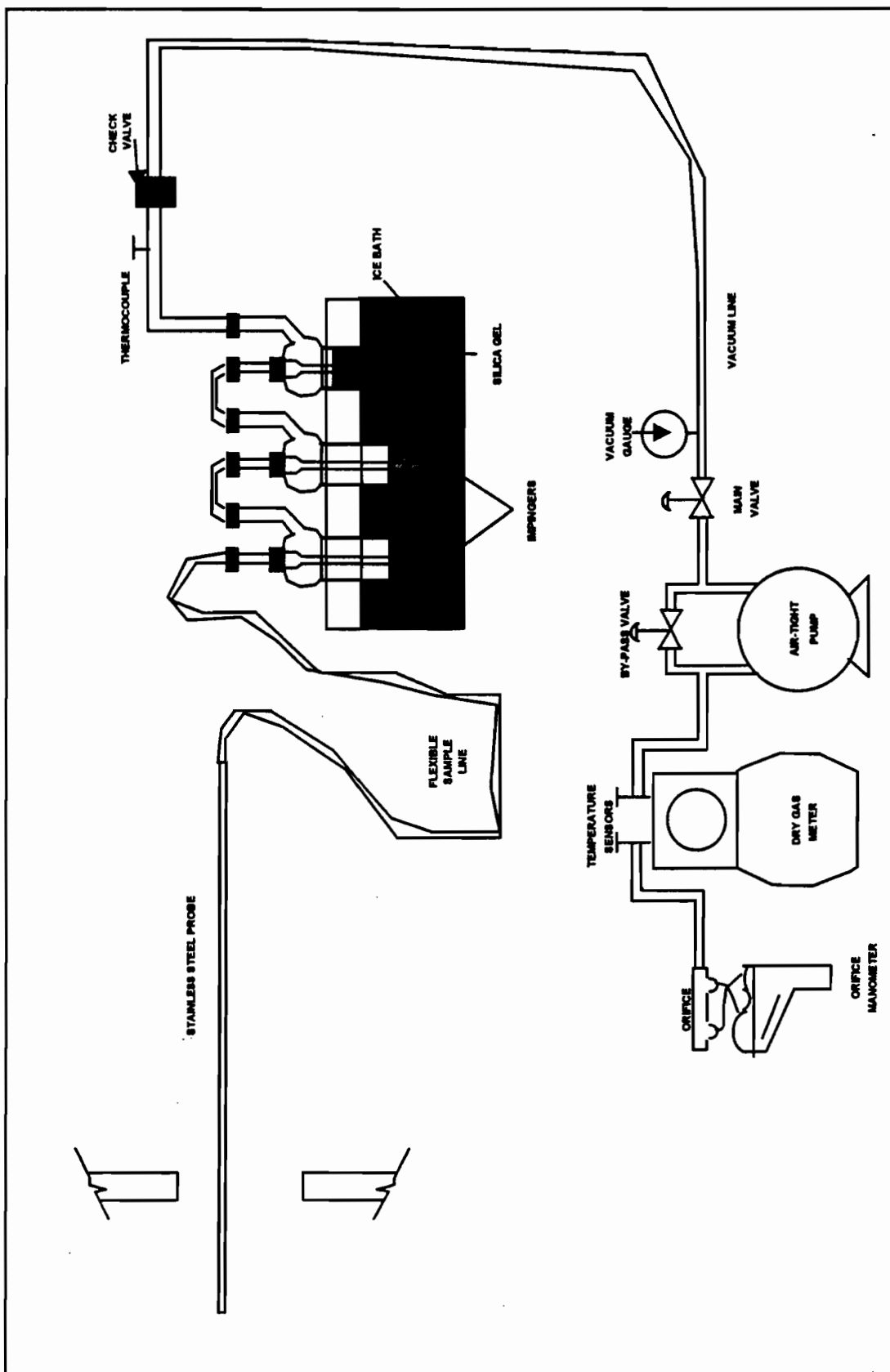
The gas velocity at the LFG flare outlet stack was measured using EPA Methods 1 and 2. Stack geometry measurements and traverse point distances were measured and calculated according to EPA Method 1 procedures. LFG flare outlet stack velocity measurements were performed utilizing an "S-type" pitot tube and an inclined micro-manometer. Flue gas temperatures were measured with a calibrated digital temperature readout equipped with chromel-alumel (K-type) thermocouple.

 The oxygen and carbon dioxide content of the stack gas was measured according to EPA Method 3 procedures. After the Method 18 sample bag had been analyzed, the oxygen concentration was determined by Orsat analysis.

4.2 GAS STREAM MOISTURE CONTENT – EPA METHOD 4

The sampling train utilized to perform the gas stream moisture sampling was an EPA Method 4 train. An unheated stainless steel probe was connected to a series of four impingers by a flexible line. The first and second impingers each contained 100 ml of distilled water; the third impinger was dry; and the fourth impinger contained 300 grams of dry preweighed silica gel. The second impinger was a standard Greensburg-Smith type, the first, third and fourth were of a modified design. All impingers were maintained in a crushed ice bath. A meter box control console with a leakless vacuum pump, a calibrated dry gas meter, a calibrated orifice, an electronic temperature readout, vacuum gauge, and dual inclined manometer were connected to the final impinger via an umbilical cord to complete the train.

 A diagram of the EPA Method 4 moisture sampling train is presented in Figure 4-1.



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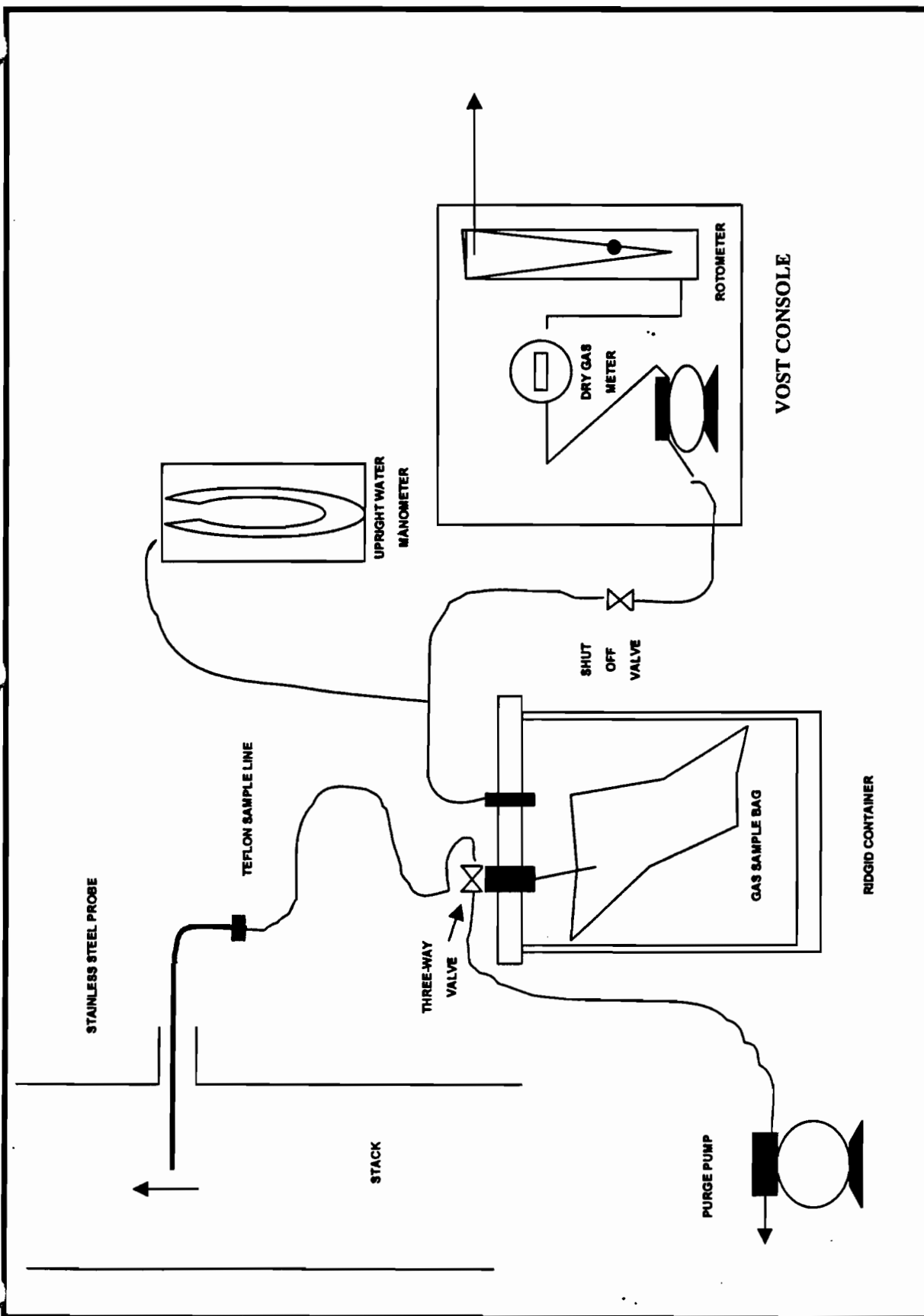
FIGURE 4-1 EPA METHOD 4 MOISTURE SAMPLING TRAIN

4.3 NON-METHANE ORGANIC COMPOUNDS - EPA METHOD 18

The test train utilized for measuring non-methane volatile organics at the LFG flare outlet stack was a lung sampling system utilizing the procedures outlined in EPA Method 18.

An unheated 6-foot effective length of thick wall stainless steel (3/8" OD - 1/8" ID) tubing was used as a sample probe. This probe was clamped into position on the sample port before the start of sampling and was allowed to condition by pulling sample gas through the probe for at least one hour. An additional 12 inches of the tubing extended outside the port in a vertical orientation to cool the sample prior to entering the 20-foot length of 1/4" OD thick wall Teflon tubing used as a sample line. During sampling the tubing connected directly to the common side of a three-way valve on the lung. One side of the valve connected to the inlet side of the lung, and the other was available to purge the probe and sample lines before each test run. An evacuated 25-liter Tedlar bag was connected to the sample inlet inside the lung. The lung was evacuated using a VOST type meter box. An upright manometer monitored the lung vacuum during leak check and during sampling. A shut off valve was placed between the lung and the control box. A diagram of the lung sampling system is shown in Figure 4-2.

Prior to the start of the sampling, the probe and sample line were conditioned by drawing sample in excess of one liter per minute for more than one hour. This allowed any organic residue to be driven off the probe and sample line. After the conditioning period, the probe was removed, allowed to cool and capped. A leak check was conducted by attaching the VOST box directly to the purge side of the three-way valve. After the probe and sample line passed the leak check, the probe was reattached to the port and positioned to sample from the centroid of the stack. The probe and sample line remained in this position until the end of the test program, when they were removed, allowed to cool and subjected to a final leak check. Period inspections of the probe position (during velocity traverses) showed that there was very little change (on the order of 4 inches of droop) in the probe position during the test period.



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FIGURE 4 - 2 EPA METHOD 18 SAMPLING TRAIN

5 DESCRIPTION OF SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical methods performed in this program conformed to EPA Reference Methods (40, CFR60, Appendix A).

5.1 PRELIMINARY DETERMINATIONS

The test data obtained at the LFG flare outlet during the February, 1999 test program was sufficient for the purposes of this test program. Other than conditioning the Method 18 sampling probe and line, no other pretest activities were required.

5.2 FORMAL TESTS

Three test repetitions were performed for NMOC during the test program. Intended test duration for each repetition was one hour. However, a misunderstanding of the Tedlar bag volume (22.5 vs. 30 liters) caused a shorter sampling period during run 1. The constant sampling rate was set at one half liter per minute to acquire the 30 liter sample over the sampling period. The bag reached maximum capacity in 45 minutes and the run was halted. The two remaining bags were collected at 0.3 liters per minute over the full hour.

The first velocity traverse was conducted prior to the collection of the first sample, and the second velocity traverse was conducted after the collection of the third sample. Moisture measurements were conducted with the first and third bag sample collections.

5.3 METHOD 18 BAG SAMPLING PROCEDURES

The EPA Method 18 samples were collected directly into virgin Tedlar bags using a lung system described above. The sample line and probe were leak checked separately at the start and end of the sampling period. The lung was leak checked at the start of each sampling period after the clean bag was positioned by turning the three-way valve away from the sample position. This closed the inlet to the bag (and prevented inadvertent sample collection during the leak check procedure) and allowed the sampling probe and sample line to be purged through a pump

connected to the opposite side of the three way valve. The VOST console pump was used to draw a vacuum (as evidenced on the upright manometer) in the lung, and the valve between the lung was closed to isolate the lung when the desired vacuum was reached. The lung leak check was performed by watching the level of the manometer for 60 seconds. A successful leak check held the desired vacuum level with less than 0.1" H₂O change in vacuum.

AT the start of a test run, the three-way valve was turned to the sample position and the shutoff valve between the VOST console and the lung was opened. The sample was drawn into the bag at a constant rate by adjusting the rate of lung evacuation using the VOST console. At the end of the test run, the three-way valve was turned to the purge position, the lung vacuum was stabilized at the highest vacuum observed during the sample collection, and the shutoff valve was closed to perform a post test leak check. The post test leak check is not required by method but was added to the sampling routine as a result of the overfilling of the bag during Run 1. As a result of the full bag, the lung vacuum reached a level that was significantly higher than the value used for the pretest leak check.

The bag was removed from the lung and transferred to the onsite laboratory for analysis.

5.4 NON-METHANE ORGANIC COMPOUND ANALYTICAL PROCEDURES – EPA METHOD 18

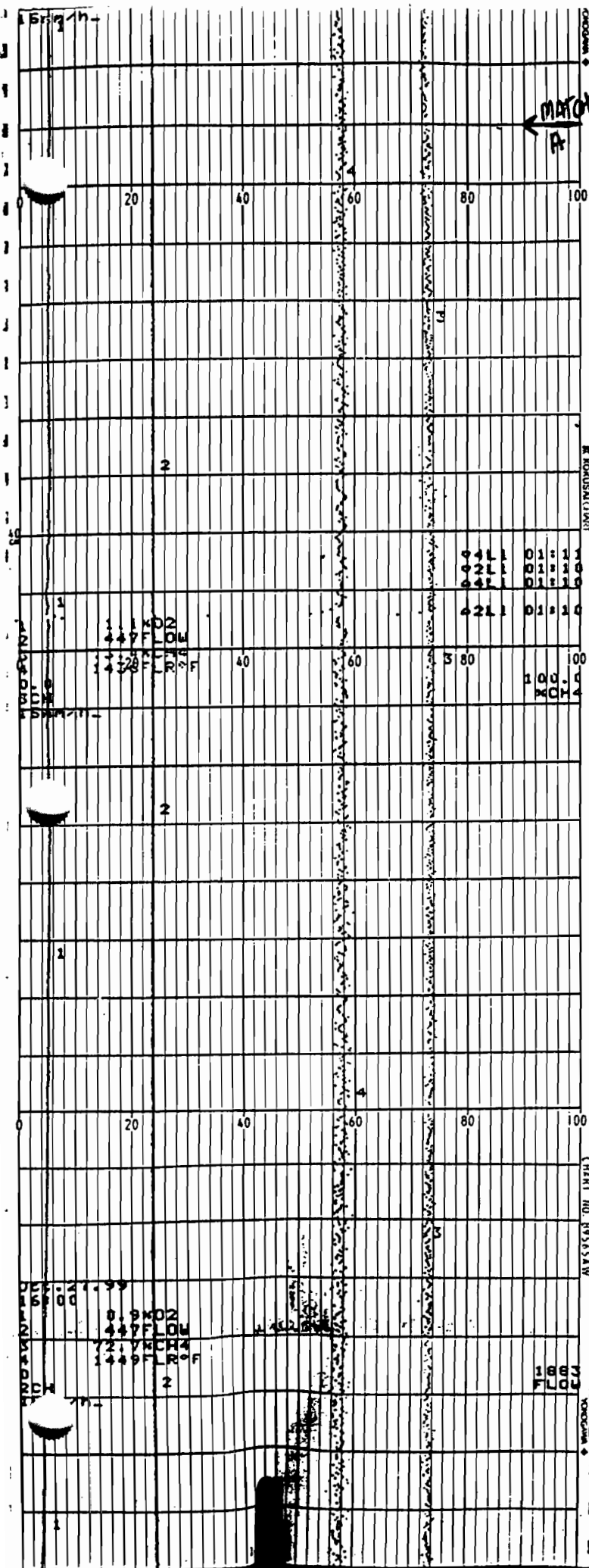
The non-methane organic compounds were determined by utilizing EPA Method 18 procedures utilizing a gas chromatograph (GC) equipped with a flame ionization detector (FID). The GC was setup to separate methane from other hydrocarbon species, and provide good separation between methane and hexane. Methane eluted from the column approximately four minutes after injection, and hexane eluted approximately eight minutes after injection. Each sample analytical run was continued for at least sixteen minutes (twice the elution time of hexane) to detect NMOC heavier than hexane. Calibration injections were initially run for 16 minutes to insure the column was clean, then terminated at twelve minutes for the successive injections for that standard.

The FID was calibrated with standards prepared in bags from pure hexane (99.6%) injected into a bag that was filled with a mixture of 70.1 ppm methane in nitrogen. The use of the mixture provided a methane reference point for each standard injection. Triplicate injections of three calibration standards were conducted before and after the sample analysis, and all 18 responses were used to calculate the linear regression for the calibration curve.

Samples were analyzed by making triplicate injections from the sample bag and averaging the response. As stated above, no NMOC was detected in any of the sample injections. Low concentrations of methane were detected in each sample bag. A limit of detection (LOD) and limit of quantification (LOQ) were calculated for the GC-FID using the 19 methane values recorded during the pre- and post-test calibrations. The methane values were chosen because they comprised a sufficient base to calculate a reliable standard deviation. Only six repetitions of any hexane calibration were performed, and EPA guidelines recommend a minimum of seven values for calculation of a standard deviation. The methane LOQ (equal to ten times the standard deviation) was 4.8 ppm as methane. This highest value was divided by six and reported as the non-detect level for NMOC. This is a very conservative approach because EPA guidelines permit the use of one half the LOD for use in calculations for non-detect target compounds.

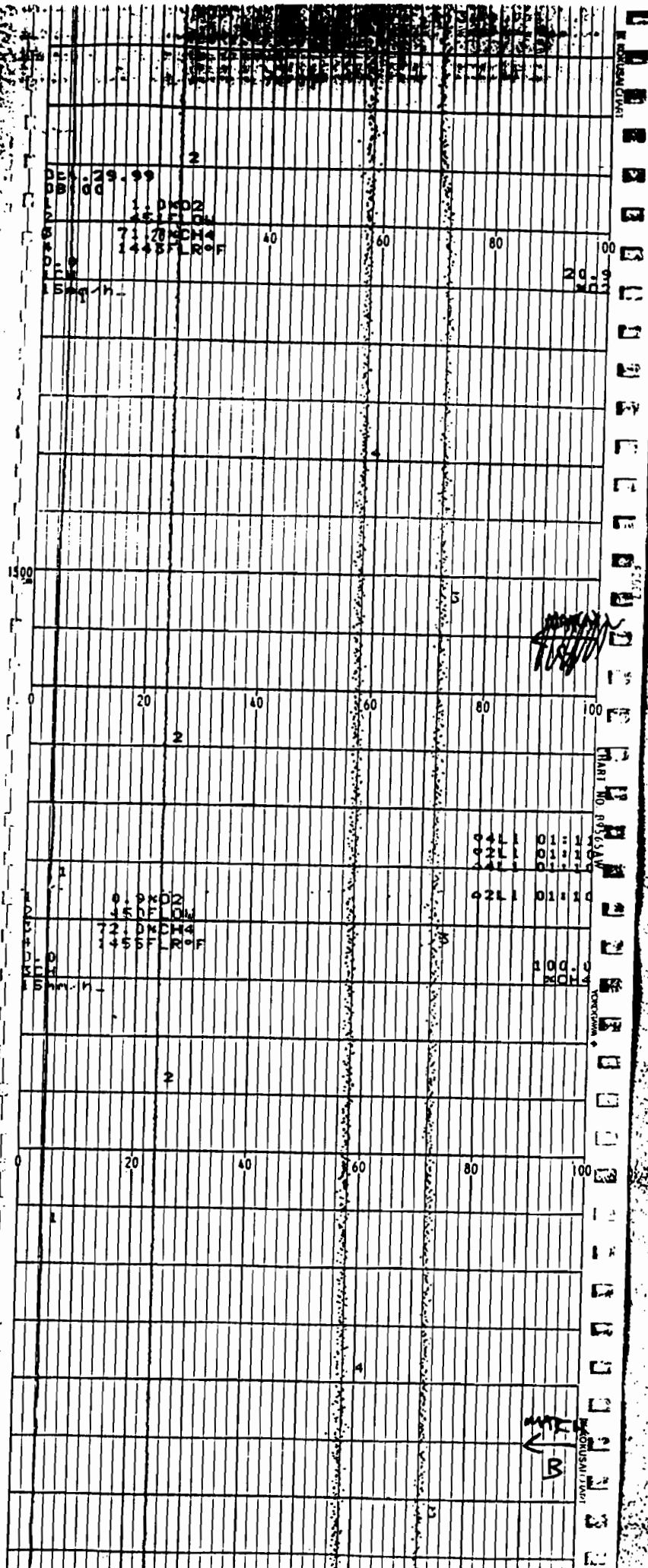
The recovery study for Method 18 requires spiking a sample (after analysis) to a level 1.5 times higher than the measured concentration. Since no NMOC was detected, the recovery study was conducted by spiking a sample to 10 ppm as hexane, which is approximately 1.5 times the level required to demonstrate compliance with the NMOC emission standard. The hexane recovery was 97%.

APPENDIX A PROCESS DATA



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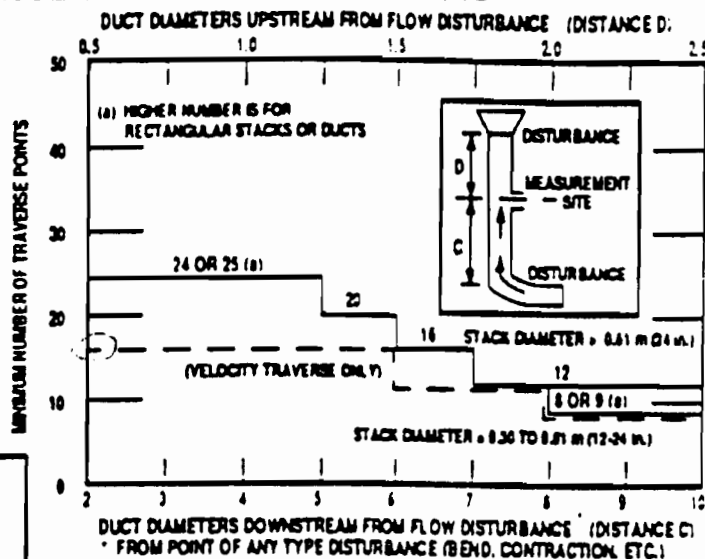
APPENDIX B

RAW AND REDUCED TEST DATA



TRAVERSE POINT LOCATION FOR CIRCULAR AND RECTANGULAR DUCTS

PLANT CLARKSTOWN LANDFILL FLARE
 DATE 10/28/99
 SAMPLING LOCATION on roof
 INSIDE OF FAR WALL TO
 OUTSIDE OF PORT (DISTANCE A) 121
 INSIDE OF NEAR WALL TO
 OUTSIDE OF PORT (DISTANCE B) 8"
 STACK I.D. (DISTANCE A - DISTANCE B) 113"
 NEAREST UPSTREAM DISTURBANCE (C) 20 ft
 NEAREST DOWNSTREAM DISTURBANCE (D) 7 ft
 CALCULATOR 1/2 - Ann 69-644



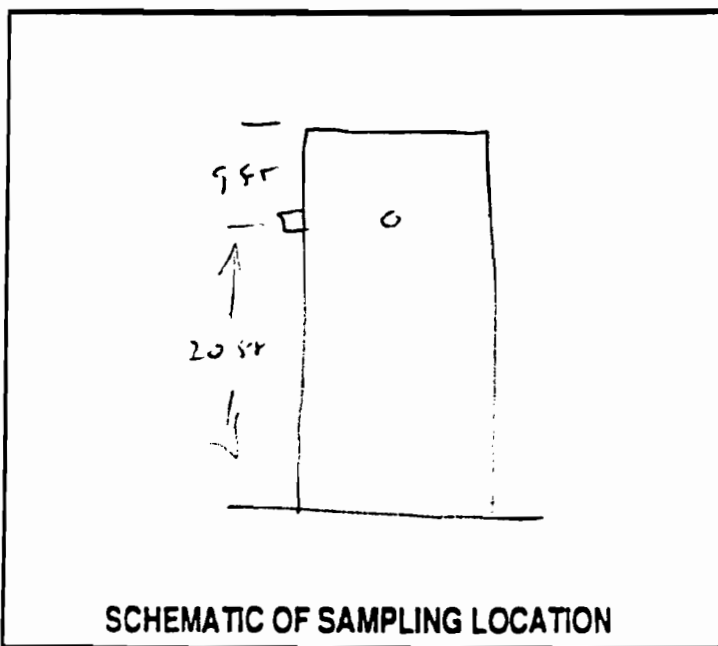
RECTANGULAR DUCT EQUIVALENT DIAMETER DETERMINATION
 FOR THE MINIMUM NUMBER OF TRAVERSE POINTS $= \frac{2L \cdot W}{L+W}$

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.8	2.1	1.8	1.8	1.4	1.3	1.1	1.1
2	25.0	14.6	10.3	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.8	18.4	14.6	11.6	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.8	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.3	25.0	20.1	16.9	14.6	12.9	11.8	10.5
6		95.8	80.8	65.8	35.6	26.9	22.0	18.8	16.5	14.8	13.2
7			88.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.3	29.8	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	68.4	60.7
13							94.3	87.5	81.2	75.0	68.5
14							98.2	91.5	85.4	79.6	73.8
15								95.1	89.1	83.5	78.2
16								98.4	92.5	87.1	82.0
17									95.6	90.3	85.4
18									98.8	93.3	88.4
19										96.1	91.3
20										98.7	94.0
21											96.5
22											98.9
23											
24											

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8



TRAVERSE POINT NUMBER	1	2	3	4	5
	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 1 AND 2 (TO NEAREST 1/8 INCH)	DISTANCE B (PORT DEPTH)	TRAVERSE POINT LOCATION FROM OUTSIDE OF PORT (SUM OF COLUMNS 3 AND 4)
1	0.032	113	3.6	8	11 5/8
2	0.105		11.87		19 7/8
3	0.194		21.92		29 7/8
4	0.323		36.497		44 1/2
5	0.677		76.5		84 1/2
6	0.806		91.078		99
7	0.894		101.135		109 1/8
8	0.966		109.384		117 3/8
9					
10					
11					
12					

Determination of Stack Gas Velocity - Method 2

Client CLARKSTOWN LANDFILL Operator PAC/BMS Pitot Coeff (Cp) 0.84
 Location/Plant FLARE Date 10/23/99 Stack Area, ft² (As) 69.644
 Source STACK W.O. Number _____ Pitot Tube/Thermo ID F145

Run Number	<u>025</u>	<u>120</u>
Time	<u>12:00</u>	<u>18:16</u>
Barometric Press, in Hg (Pb)	<u>30.10</u>	<u>30.05</u>
Static Press, in H ₂ O (Pstatic)	<u>-0.010</u>	<u>-0.045</u>
Source Moisture, % (BWS)	<u>3.2</u>	<u>5.3</u>
O ₂ , %	<u>4.4</u>	<u>4.3</u>
CO ₂ , %	<u>14.1</u>	<u>14.2</u>

Cyclonic Flow Determination		Traverse Location		Leak Check good ? -Y/N		Leak Check good ? Y/N		Leak Check good ? Y / N	
Delta P at 0°	Angle yielding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
		W B	1	0.005	1081	0.005	990		
			2	0.015	1069	0.003	995		
			3	0.020	1051	0.010	1000		
			4	0.005	1038	0.010	1020		
			5	0.010	1026	0.010	1043		
			6	0.005	1063	0.005	1035		
			7	0.010	1030	0.010	1020		
			8	0.010	1070	0.010	993		
		N A	1	0.010	1044	0.010	973		
			2	0.015	1040	0.010	978		
			3	0.010	1020	0.010	970		
			4	0.010	1040	0.015	976		
			5	0.005	1030	0.005	990		
			6	0.010	1048	0.010	998		
			7	0.005	1043	0.005	1025		
			8	0.005	1046	0.005	1006		

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * \text{avg} \sqrt{\Delta P} * \sqrt{Tsa / (Ps * MWs)}$$

$$Qs(\text{act}) = 60 * Vs * As$$

$$Qs(\text{std}) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(\text{act})$$

Comments _____

where:

MWd = Dry molecular weight source gas, lb/lb-mole.

MWs = Wet molecular weight source gas, lb/lb-mole.

Tsa = Source Temperature, absolute (°R)

Ps = Absolute stack static pressure, inches Hg.

Vs = Average gas stream velocity, ft/sec.

Qs(act) = Volumetric flow rate of wet stack gas at actual,

Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Determination of Moisture Content in Stack Gases - Method 4

Client CLARKSTOWN
Location/Plant LAMBHILL
Source FLARE

Operator PELOH
Meter Box ID BOX 5

Date 10/20/99
Meter Box Y 9956

W.O. Number _____ Temperature °C or °F F Sample Volume, ft³ or L F+3

Run Number	Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H ₂ O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
ONE			Inlet	Outlet				35.127 H+6	Initial 0.004/15" Hg
End Test	15:10	520.475	105	101	1.5	216	878.7		Final 0.001/30
Baro Press., Pb (in Hg)	Start Test	14:10	483.420	95	98	1.5	200	870	Moisture Volume, Vw(std)
30.1	Avg. or Total	60	37.055	99.75	1.5	16	8.7	1.16 38.02	Percent Moisture (%), BWS H+6

3.2

Run Number	Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H ₂ O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
TWO			Inlet	Outlet				35.27	Initial 0.005/30" Hg
End Test	16:40	558.700	104	98	1.5	231	889.9		Final 0.0025/15" Hg
Baro Press., Pb (in Hg)	Start Test	15:40	521.257	96	97	1.5	200	878.6	Moisture Volume, Vw(std)
30.1	Avg. or Total	60	37.143	98.75	1.5	31	11.1	1.59	Percent Moisture (%), BWS 5.3

Run Number	Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H ₂ O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
			Inlet	Outlet					Initial
End Test									Final
Baro Press., Pb (in Hg)	Start Test								Moisture Volume, Vw(std)
	Avg. or Total								Percent Moisture (%), BWS

$$Vm(std) = \frac{17.64 \cdot Y \cdot Vm \cdot (Pb + (\Delta H / 13.6))}{(Tm + 460)}$$

$$\text{if } Tm \text{ is } ^\circ\text{C than } Tm = (Tmc \cdot 1.8) + 32$$

$$\text{if } Vm \text{ is liters than } Vm = Vml \cdot 28.32$$

$$Vw(std) = (0.04707 \cdot Vwc) + (0.04715 \cdot Vwsg)$$

$$BWS = \left(\frac{Vw(std)}{Vw(std) + Vm(std)} \right) \cdot 100$$

WHERE:

Vm(std)= Sample volume corrected to standard temp and pressure, scf or L

Vm= Actual sample volume, calculated, scf

Vml= Actual sample volume, calculated, Liters

Y= Dry gas meter calibration factor.

Pb= Barometric pressure, in. Hg

delta H= Meter pressure, in H₂O

Tm= Average temperature of meter (DGM is used) or rotometer, degrees °

Tmc= Average temperature of meter (DGM is used) or rotometer, degrees °

Vw(std)= Volume of water vapor at standard conditions, scf or L

Vwc= Volume of water condensed, mL

Vwsg= Weight of Silica Gel, g

Bws= Water vapor in gas stream, percent

WESTON
MANUFACTURING CONSULTANTS

Use either ft³ or liters in calculations. DO NOT MIX CUBIC FEET AND LITERS IN ANY CALCULATION.

CHARLES TOWN LANSFILL FURB

Performed by:

Prache

[illegible]

GAS ANALYSIS DATA FORM

Plant: CLARKSTOWN LANDFILL

Sample Location: FLARE OUTLET

Date: 10/28/99

Operator.

Sample Type: SINGLE POINT or MULTIPOINT: GRAB or INTEGRATED

Analytical Method: ORSAT

Leak Check:

Run Number	Sample Location/Train ID	% CO ₂	% O ₂		% N ₂
		Reading 1	Reading 2	Net (1)	100 - Reading 2
Run 1	P/W	6.0	20.5	14.5	79.5
	P/W	4.3	17.5	13.2	
		4.5	18.5	14.0	
		4.3	18.4	14.1	
		4.3	18.5	14.2	
	Run 1 Avg	(4.4)		(14.1)	
Run 2		4.5	18.8	14.3	
		4.4	18.6	14.2	
		4.5	18.7	14.2	
	Run 2 Avg	(4.46)		(14.23)	
Run 3		4.1	18.4	14.3	
		4.0	18.2	14.2	
		4.0	18.3	14.3	
	Run 3 Avg	(4.07)		(14.26)	
AVERAGES					

$$\%N_2 = 100 - (\%CO_2 + \%O_2 + \%CO)$$
$$MW_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

Integrated Bag Limits

CO₂ > 4% - 0.3% by vol

~~<=~~4% - 0.2% by vol

O2 >= 15% - 0.2% by vol

< 15% - 0.3% by vol

(1) Net %O₂ = Reading 2 - Reading 1

**CLARKSTOWN LANDFILL
GAS FLOW DATA SUMMARY
FLARE STACK
28-Oct-99**

RUN NUMBER		1			2		
TIME		12:00			18:16		
LOCATION		FLARE STACK			FLARE STACK		
Traverse Point No.		Velocity Head in. H ₂ O	Stack Temp. deg F	Static Press. in. H ₂ O	Velocity Head in. H ₂ O	Stack Temp. deg F	Static Press. in. H ₂ O
Point 1	West	0.0050	1081		0.0050	990	
Point 2		0.0150	1069		0.0050	995	
Point 3		0.0100	1051		0.0100	1000	
Point 4		0.0050	1038		0.0100	1020	
Point 5		0.0100	1026		0.0100	1043	
Point 6		0.0050	1063		0.0050	1035	
Point 7		0.0100	1030		0.0100	1020	
Point 8		0.0100	1070	-0.04	0.0100	993	-0.05
Point 1	North	0.0100	1044		0.0100	973	
Point 2		0.0150	1040		0.0100	978	
Point 3		0.0100	1020		0.0100	970	
Point 4		0.0100	1040		0.0150	976	
Point 5		0.0050	1030		0.0050	990	
Point 6		0.0100	1048		0.0100	998	
Point 7		0.0050	1043		0.0050	1005	
Point 8		0.0050	1046		0.0050	1006	
Averages		0.0088	1046.2	-0.040	0.0084	999.5	-0.05
Velocity Inputs							
Avg. Square Root of Delta P, in. H ₂ O		0.09183			0.09042		
Pitot Tube Coefficient		0.84			0.84		
Barometric Pressure, in. Hg		30.10			30.05		
Static Pressure, in. H ₂ O		-0.040			-0.05		
Stack Pressure, in. Hg		30.10			30.05		
Stack Cross-sectional Area, ft ²		69.644			69.644		
Moisture Inputs							
Avg. orifice press. diff., in H ₂ O		1.50			1.50		
Avg. dry gas meter temp., deg F		99.8			98.8		
Dry gas meter calibration factor		0.9956			0.9956		
Sample vol. at meter cond., dcf		30.135			31.698		
Volume H ₂ O imp. (ml)		16.0			31.0		
Weight chnge sil. gel (g)		8.7			11.1		
Sample vol. at std. cond., dscf (1)		28.564			30.049		
Std. vol. of H ₂ O vapor coll., cu.ft.		1.163			1.983		
H ₂ O vapor in gas stream, prop. by vol.		0.039			0.062		
Stack Gas Composition							
Temperature, deg F		1046.2			999.5		
Moisture, %		3.9			6.2		
CO ₂ Concentration, %		4.4			4.3		
O ₂ Concentration, %		14.2			14.3		
Molecular Weight, lb/lb-mole		28.8			28.6		
Volumetric Flow Rate							
Velocity, ft/sec		8.7			8.5		
At Stack Conditions, ACFM		36304			35388		
At Standard Conditions, DSCFM		12296			12056		
Wet SCFM		12797			12851		

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 inches Hg (760mm Hg).

APPENDIX C

ANALYTICAL DATA

GC Parameters for Hexane Analyses

E: Methane (70.1 ppm) in Air

Calibration Range: [2.8ppm - 20.2ppm]

Date: 28-Oct-99

Operators: EMS & PAC

GC Model: Shimadzu GC-Mini 2 Gas Chromatograph**Serial Number:** 60532DN**Integrator Model:** Shimadzu Chromatopac CR601**Detector:** Flame Ionization Detector (FID)**Detector Temperature (°C):** 250**Carrier Gas:** Zero Nitrogen**Column:** 10% SP-2100 100/120 Supelcoport**Isothermal Column Temperature (°C):** 95**Sample Loop Volume (ml):** 1.0 ml**Sample Loop Temperature (°C):** 95**Injection Port Temperature (°C):** 95**Attenuation:** 1**Range:** 10**Chart Speed (mm/min):** 5**Flow Rates**

	Cylinder Number	Starting Pressure (psi)	Final Pressure (psi)	Regulator Pressure (psi)	Flow Rate (ml/min)
Hydrogen	LL25136	1900	1700	30	38
Zero Air	SX30075	1800	1650	40	400
Nitrogen	CC39248	2200	2100	30	55

Pretest Hexane Calibration (28 Oct 99)**Balance:** Methane (70.1 ppm) in Air**Cylinder Number:** CC25484**Starting Pressure (psi):** 1000**Ending Pressure (psi):** 300**Range:** 10**Attenuation:** 1**Date:** 28-Oct-99**Operator:** EMS & PAC**Physical Properties of Hexane****Molecular Formula:** C₆H₁₄**Molecular Weight:** 86.2**Density:** 0.659**Standard Preparation:**

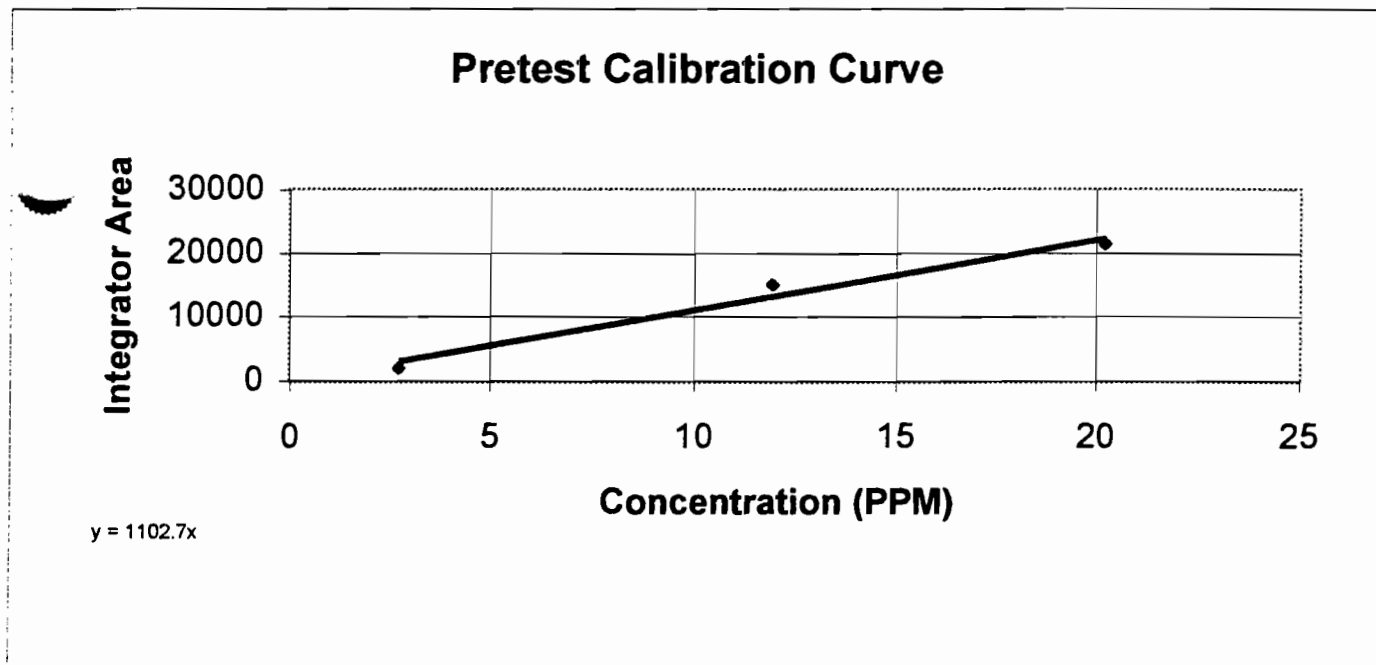
Standard Number	Amount of Hexane (μ L)	Liters of Balance (L)	Target Concentration of Standard (ppm)
1	0.33	20	3
2	1.30	20	12
3	2.17	20	20

Standard Number (ppm)	Actual Amount of Hexane (μ L)	Measured Liters of Balance (L)	Actual Concentration of Standard (ppm)
1	0.30	20.0	2.8
2	1.30	20.0	12.0
3	2.20	20.0	20.2

Pretest Hexane Calibration (28 Oct 99) (cont.)

Standard (ppm)	Run Number	Retention Time (min)	Error (± 5%)	Integrator Area	Error (± 5%)		Average Integrator Area
2.8	A	8.258	0.8	1901	0.0		
	B	8.323	0.0	1868	1.7		
	C	8.342	-0.2	1921	-1.1		
						Standard 1	1897
12.0	A	8.373	0.1	15026	0.0		
	B	8.385	0.0	15026	0.0		
	C	8.390	-0.1	15033	0.0		
						Standard 2	15028
20.2	A	8.412	0.1	21365	0.0		
	B	8.417	0.0	21449	-0.4		
	C	8.435	-0.2	21318	0.2		
						Standard 3	21377

Pretest Calibration Curve (28 Oct 99)



Post-test Hexane Calibration (28 Oct 99)

Gain: 10

Attenuation: 1

Date: 28-Oct-99

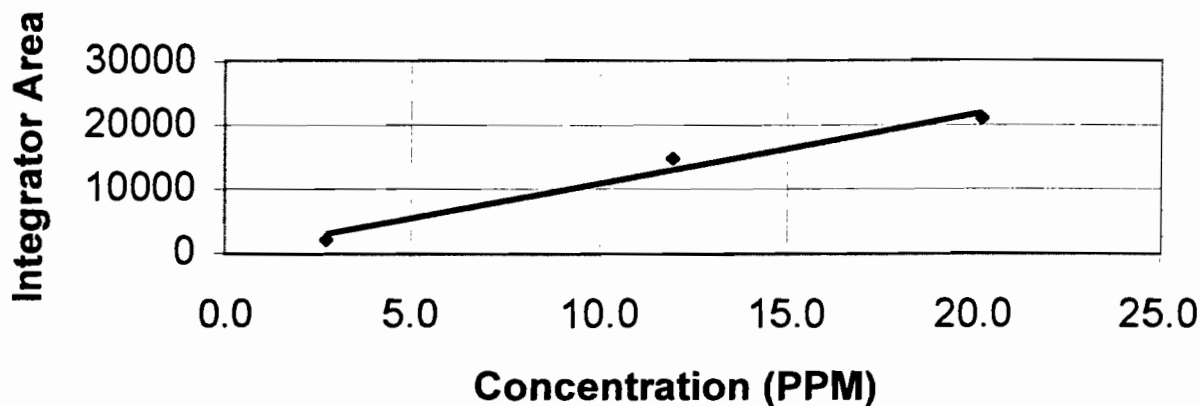
Operator: EMS & PAC

Post Test Calibration (28 Oct 99)

Standard (ppm)	Run Number	Retention Time (min)	Error (± 5%)	Integrator Area	Error (± 5%)		Average Integrator Area
2.8	A	8.492	0.0	1933	1.6		
	B	8.483	0.1	1965	0.0		
	C	8.492	0.0	1995	-1.5		
						Standard 1	1964
12.0	A	8.517	0.2	14789	0.0		
	B	8.532	0.0	14796	0.0		
	C	8.543	-0.1	14648	1.0		
						Standard 2	14744
20.2	A	8.567	0.2	20926	0.1		
	B	8.582	0.0	20956	0.0		
	C	8.642	-0.7	21124	-0.8		
						Standard 3	21002

Post Test Calibration Curve (28 Oct 99)

Post Test Calibration Curve



$y = 1083.4x$

Final Calibration for Hexane (28 Oct 99)

Date:	28-Apr-99
Operator:	EMS & PAC

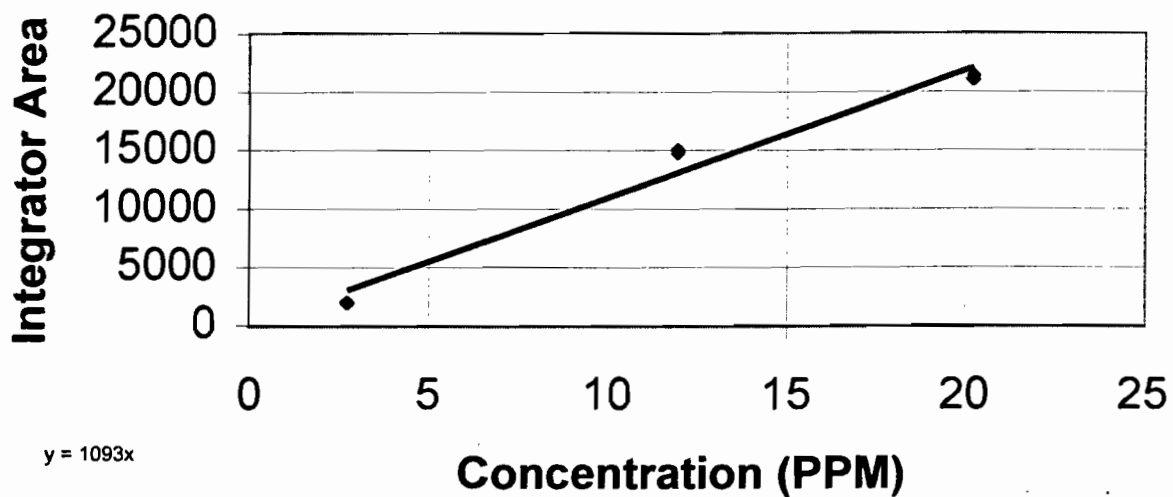
Pretest Standard Concentrations (ppm)	Pretest Average Intergrator Area
2.8	1897
12.0	15028
20.2	21377

Percent Difference (%)
-3.6
1.9
1.8

Post Test Standard Concentrations (ppm)	Post Test Average Intergrator Area
2.8	1964
12.0	14744
20.2	21002

Average Percent Difference
2.4

Final Calibration Curve



Recovery Study for Hexane
Range: 10
Attenuation: 1

Date: 28-Oct-99
Operator: EMS & PAC

Physical Properties of Recovery Study for Hexane

Molecular Formula:	C ₆ H ₁₄
Molecular Weight:	86.2
Density:	0.659

Spiking Preparation:

Sample	Actual Amount of Hexane (μL)	Measured Liters of Sample (L)	Actual Concentration of Standard (ppm)
Run 3	1.20	21.3	10.4

Sample	Run Number	Retention Time (min)	Error (± 5%)	Integrator Area	Error (± 5%)	Average Integrator Area	Concentration (ppm)
Run 3	A	8.482	0.1	11045	0.6	11141	10.1
	B	8.492	0.0	11113	0.0		
	C	8.492	0.0	11266	-1.4		

Sample	Initial Concentration (ppm)	Spike Concentration (ppm)	Actual Concentration (ppm)	Percent Recovery [70-130] (%)
Run 3	0	10.4	10.1	97

Sample Analyses: Run 1 through Run 3 (28 Oct 99)

Date: 28-Oct-99
Operator: EMS & PAC

Since no peaks other than Methane were present, Methane was used to meet Method 18 reproducibility requirements.

Sample	Run Number	Retention Time (min)	Error (± 5%)	Integrator Area	Error (± 5%)		Average Integrator Area	Concentration (ppm)
Run 1	A	4.325	0.5	6749	1.8			
	B	4.345	0.0	6917	-0.7			
	C	4.367	-0.5	6872	0.0	Run 1		
							6846	26.9
Run 2	A	4.375	-0.6	6304	0.0			
	B	4.348	0.0	6284	0.3			
	C	4.290	1.3	6413	-1.7	Run 2		
							6334	24.9
Run 3	A	4.300	0.4	8282	0.8			
	B	4.317	0.0	8449	-1.2			
	C	4.323	-0.1	8350	0.0	Run 3		
							8360	32.9

Pretest

Area	Error (± 5%)
17792	0.2
17715	0.6
17804	0.1
17803	0.1
18079	-1.4
17864	-0.2
17915	-0.5
18017	-1.1
17833	0.0
17824	0.0
Average	17865 -0.2

Post Test

Area	Error (± 5%)
18012	-1.7
17893	-1.1
17859	-0.9
17861	-0.9
17705	0.0
17687	0.1
17697	0.0
17679	0.1
17662	0.2
Average	17784 -0.4

Final Average

Area	Error (± 5%)
17824	-0.3

Final Analyses

Run 1 26.9

One Point Estimated Methane Conc.

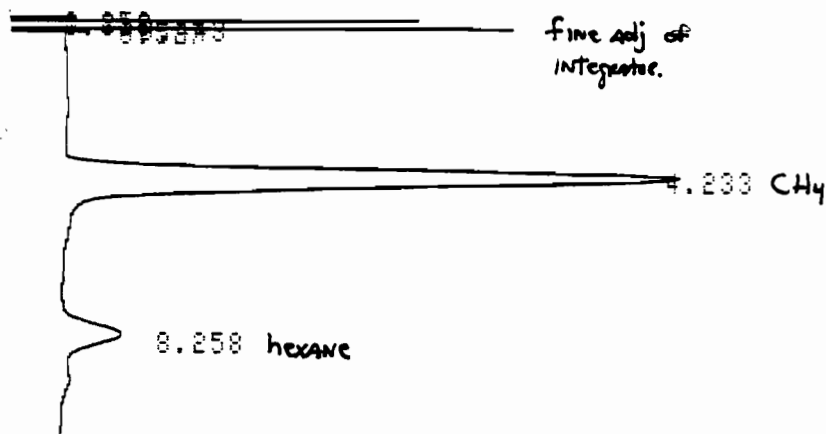
Run 2 24.9

One Point Estimated Methane Conc.

Run 3 32.9

One Point Estimated Methane Conc.

STOP.TM(0)=11
START

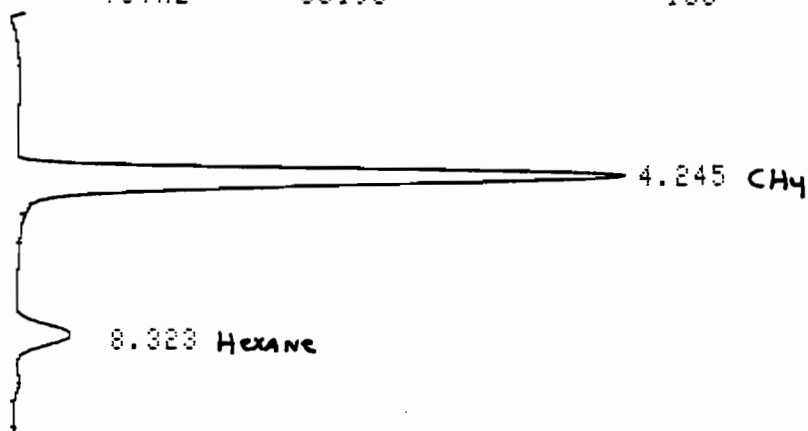


2.8 ppm standard
hexane in 70.1 ppm
methane/air balance
Run 1, 2
Stop time 11 min

CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 8

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.252	7904			14.3193	
2	0.318	11359	V		20.5806	
3	0.443	11013			19.9524	
4	0.527	5226	V		9.4689	
5 →	4.233	17792			32.2344	CH ₄
6 →	8.258	1901			3.4443	hexane
TOTAL		55195			100	



CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 10

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.245	17804			90.5028	CH ₄
2 →	8.323	1868			9.4972	hexane
TOTAL		19672			100	

STOP.TM(0)=24

START

0.153

electrical
Interference

4.27 CHy

8.342 hexane

Stop time 24 min

2.8 ppm standard
hexane in 70.1 ppm
methane/Air balance
Run 3
Stop time 24 min

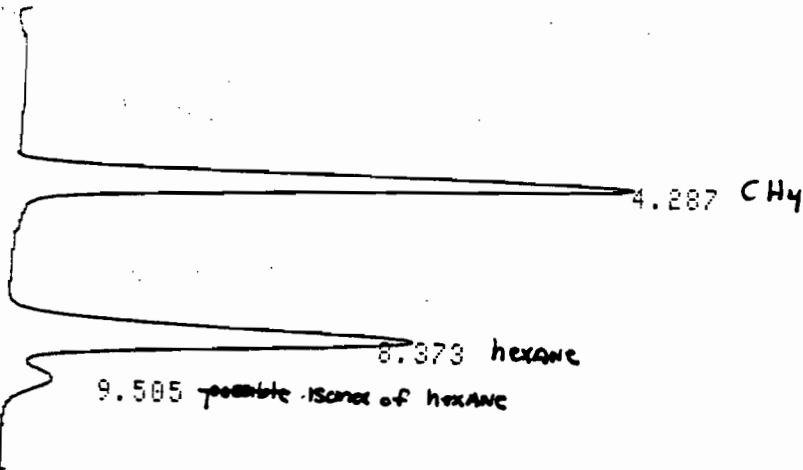
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 11

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.153	12			0.0608	
2 →	4.27	17803			90.204	CHy
3 →	8.342	1921			9.7352	hexane
TOTAL		19736			100	

STOP.TM(0)=12

START



12.0 ppm standard
hexane in 70.1 ppm
methane/air balance
Stop time 11 min
Run 1, 2

116

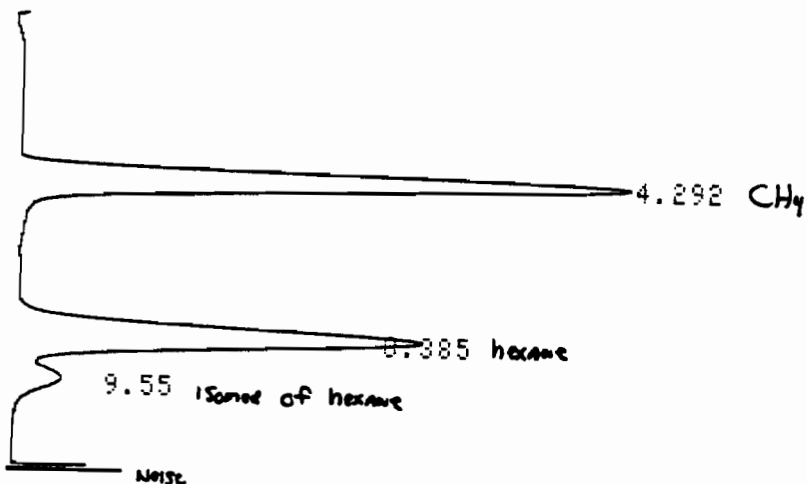
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 12

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	→ 4.287	18079			51.7675	CH ₄
2	→ 8.373	15026			43.0243	hexane
3	9.505	1819			5.2082	
TOTAL		34924			100	

} 10.8% Area Count

START



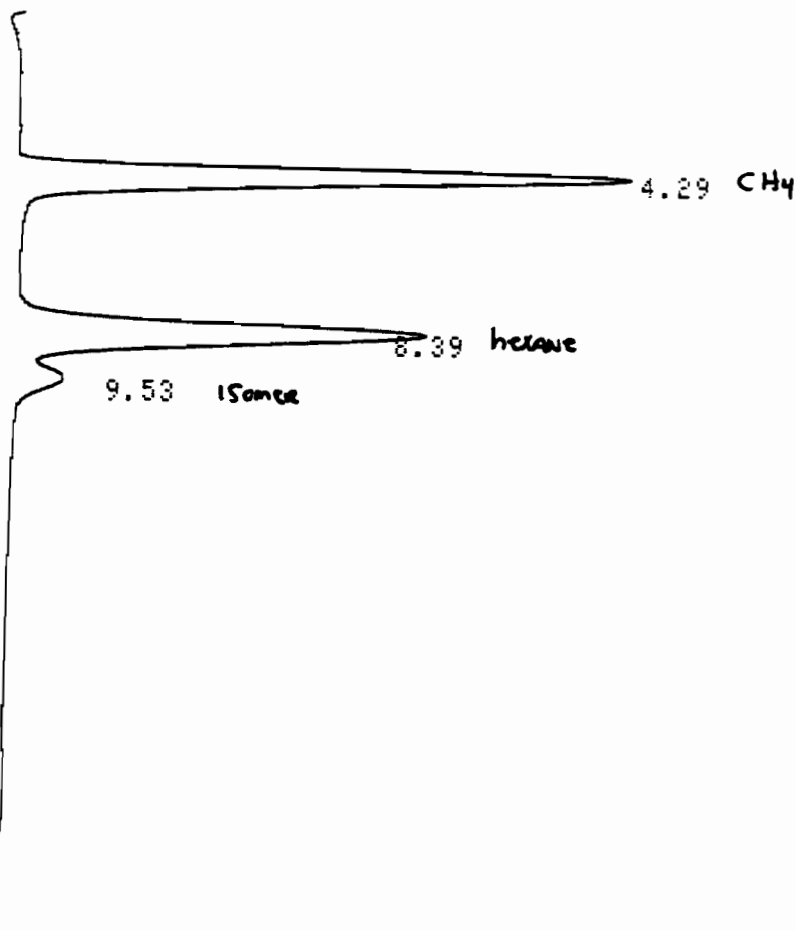
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 13

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	→ 4.292	17864			51.4868	CH ₄
2	→ 8.385	15026			43.3057	hexane
3	9.55	1807			5.2074	
TOTAL		34696			100	

} 10.7% Area Count

START



12.0 ppm Standard
hexane in 70.1 ppm
methane / Air balance
Run 3
Stop time 24 min

CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 15

FILE 0
METHOD 41

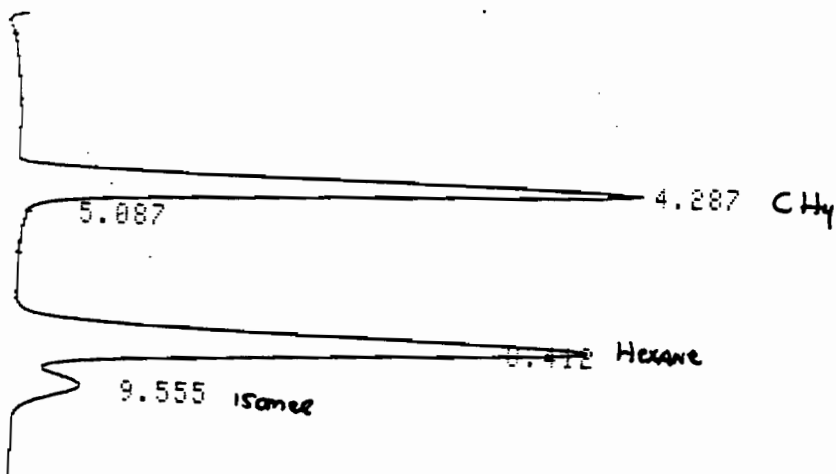
PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.29	17915			51.5934	CH ₄
2 →	8.39	15033			43.2929	hexane
3	9.53	1776			5.1137	
TOTAL		34723			100	

STOP.TM(0)=12

Handwritten note: 10.6 % Area count

START

20.2 ppm Standard
hexane in 70.1 ppm
methane/air balance
Run 1,2
Stop time 11min



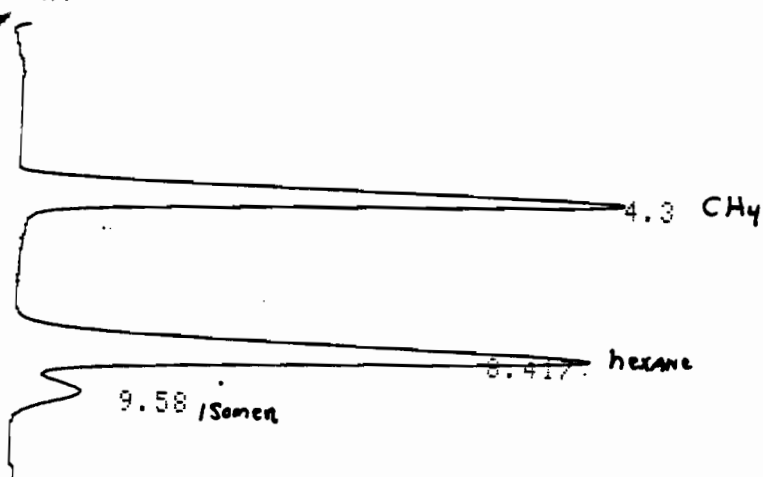
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 16

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.287	18017	S		42.9556	CH ₄
2 →	8.412	21365			50.9368	hexane
3	9.555	2582			6.1076	
TOTAL		41944			100	

10.7% Area count

START



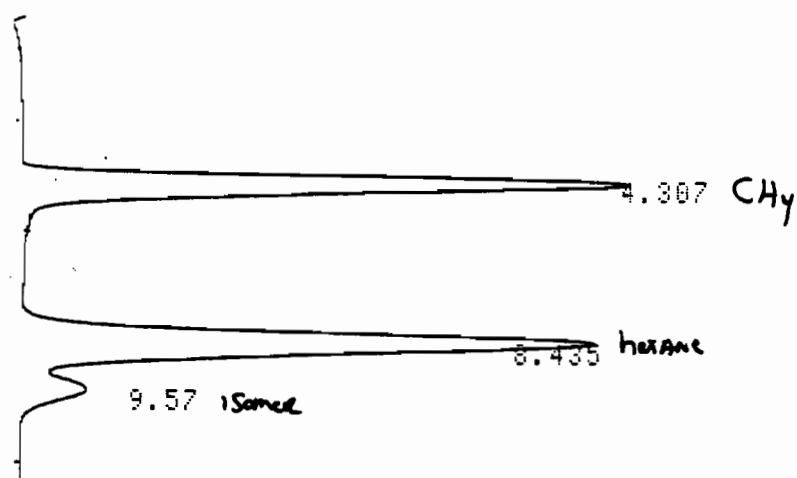
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 17

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.3	17833			42.5931	CH ₄
2 →	8.417	21449			51.2301	hexane
3	9.58	2586			6.1768	
TOTAL		41868			100	

10.8% Area count

START



20.2 ppm standard
hexane in 70:1 ppm
methane/air balance
Run 3
stop time 11 min

CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 18

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.307	17824			42.7877	CHy
2 →	8.435	21318			51.1757	met hexane
3	9.57	2515			6.0366	
TOTAL		41657			100	

STOP.TM(0)=12

V 10.5% Area count

STOP.TM(0)=24
START

Run 1
Inj 1
Run time 24 min

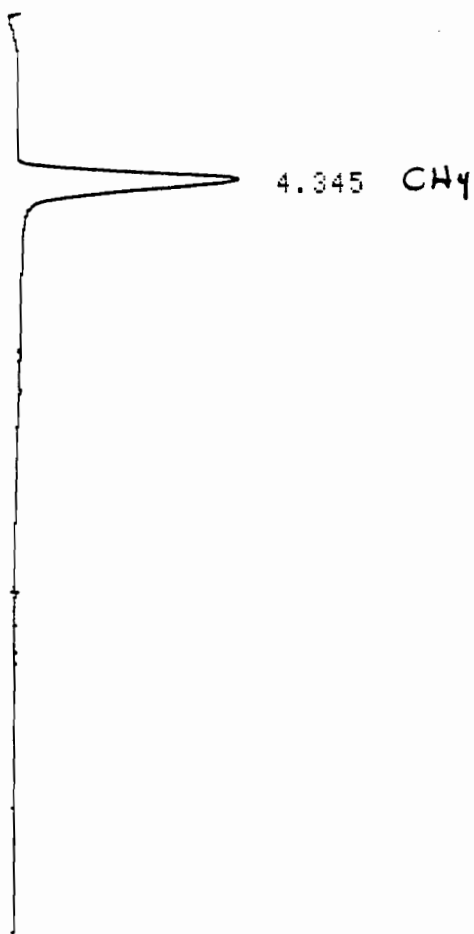


CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 19

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	→ 4.325	6749			100	CH4
TOTAL		6749			100	

START



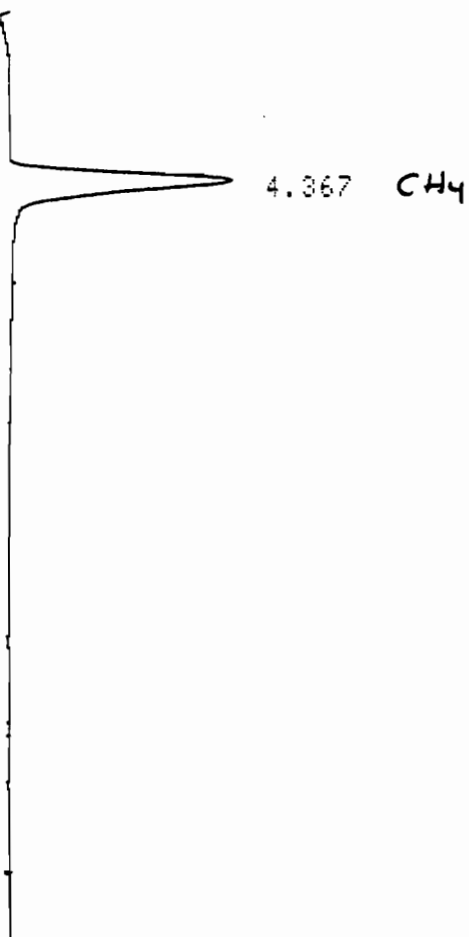
Run 1
Inj 2
stop time 24 min

CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 21

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	→ 4.345	6917			100	CH4
TOTAL		6917			100	

START



Run 1
Inj 3
Step time 24min

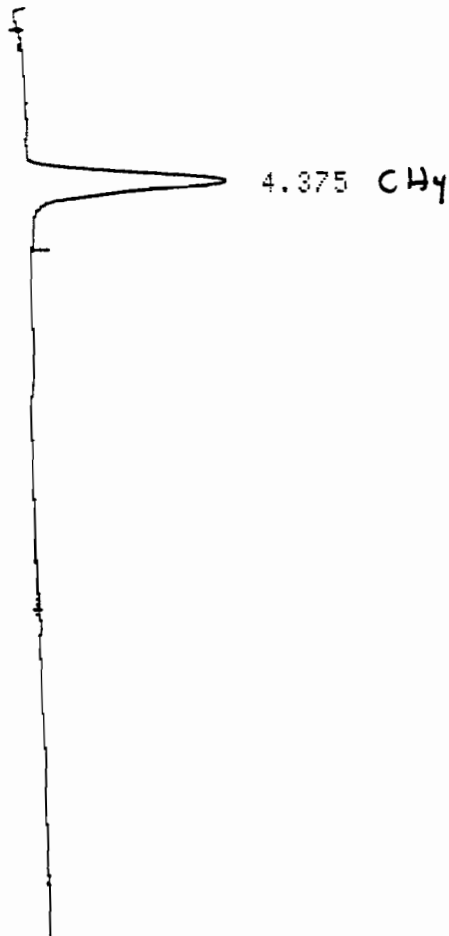
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 22

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	→ 4.367	6872			100	CH ₄
TOTAL		6872			100	

START

Run 2
inj 1
Step time 24 min



CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 23

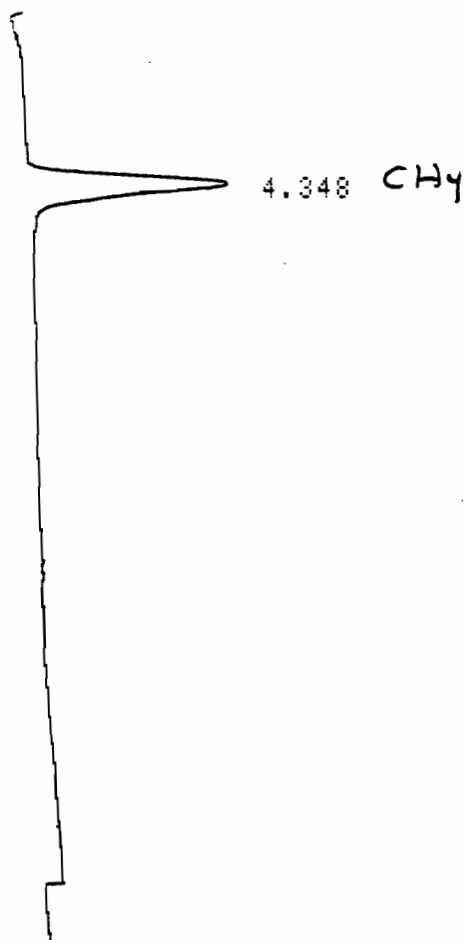
FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	→4.375	6304			100	CH4
TOTAL		6304			100	

122

START

Run 2
Inj 2
Stop time 24 min



CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 24

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	→ 4.348	6284			100	CH4
TOTAL		6284			100	

START

0.382

noise

4.29 CHy

Run 2

inj 3

Stop time 24 min

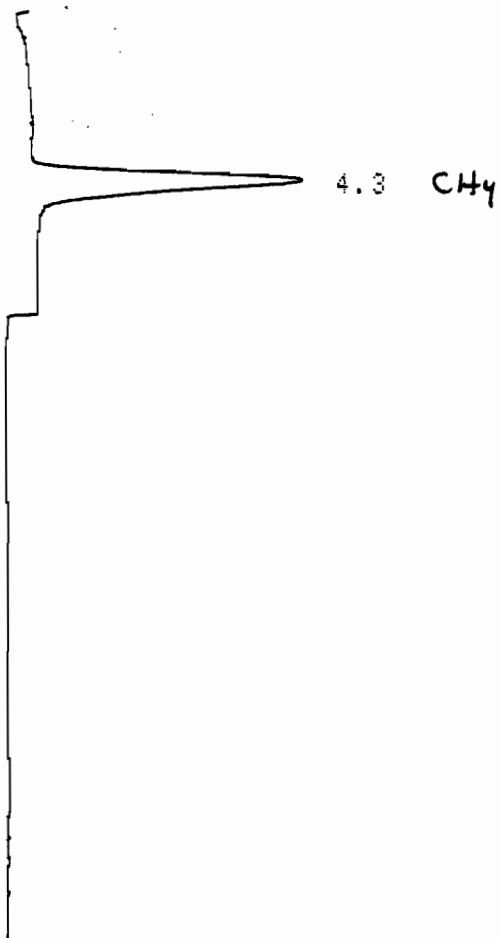
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 25

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.382	10			0.1588	
2	→ 4.29	6413			99.8412	CHy
TOTAL		6423			100	

START

Run 3
Inj 1
Step time 24 min



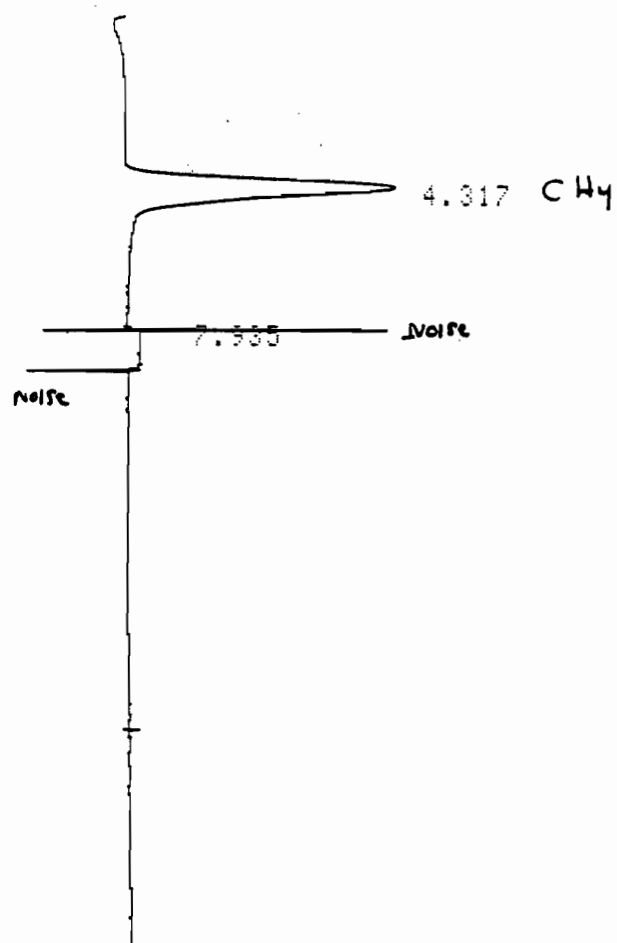
124

CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 27

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	4.3	8282			100	CH4
TOTAL		8282			100	

START



Run 3
INJ 2
Stop time 24min

CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 28

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.317	8449			100	CH ₄
TOTAL		8449			100	

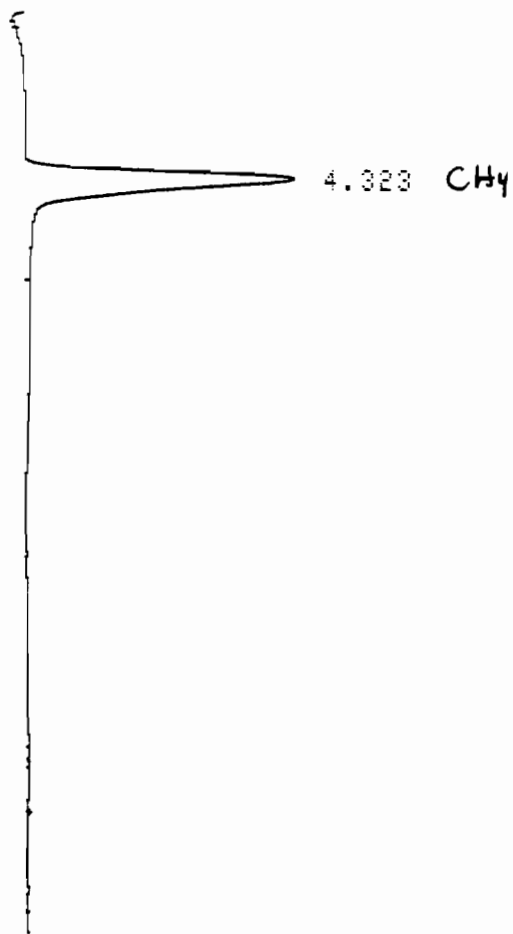
105

START

RUN 3

INJ 3

Stop time 24 min



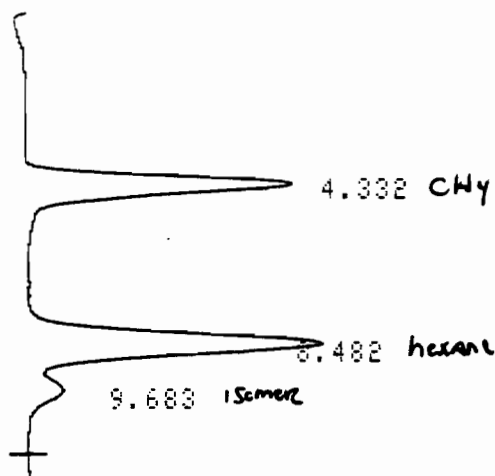
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 29

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.323	8350			100	CH4
TOTAL		8350			100	

STOP.TM(0)=12
START

Run 3
recovery study
10.4 ppm Spike hexane
inj 1
inj 2

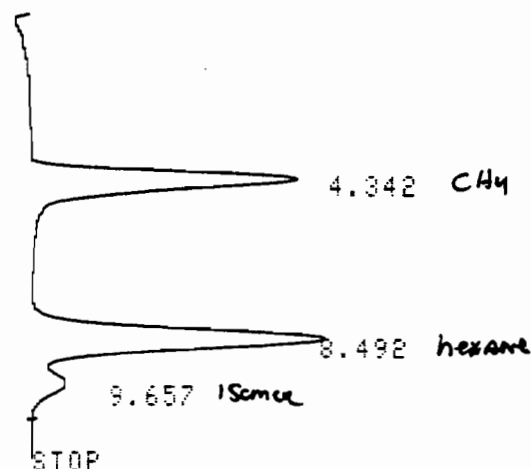


CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 30

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.332	8221			39.9197	CH ₄
2 →	8.482	11045			53.6291	hexane
3	9.683	1329	V		6.4513	
TOTAL		20594			100	

START



CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 31

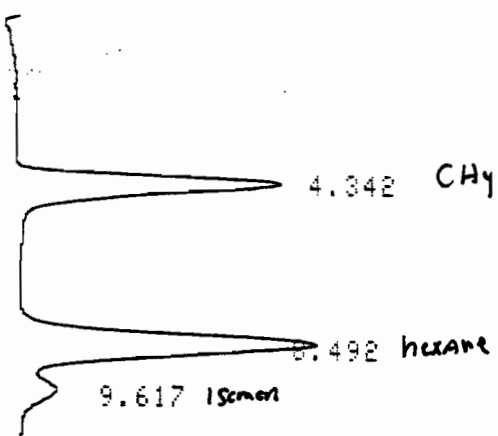
FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.342	8423			40.4376	CH ₄
2 →	8.492	11113			53.353	hexane
3	9.657	1293	V		6.2094	
TOTAL		20830			100	

STOP.TM(0)=11

START

Run 3
Recovery Study
10.4 ppm spike hexane
inj 3



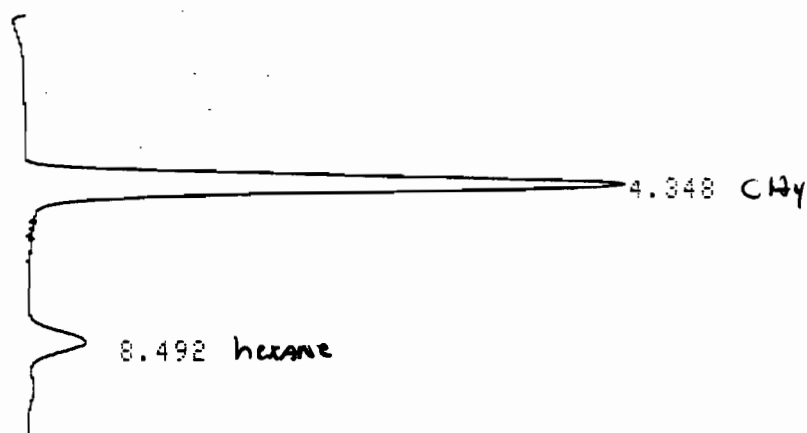
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 32

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	4.342	8236			39.5012	CH ₄
2	8.492	11266			54.0299	hexane
3	9.617	1349	V		6.4688	
TOTAL		20851			100	

START

2.9 ppm standard
postcal
inj 1,2



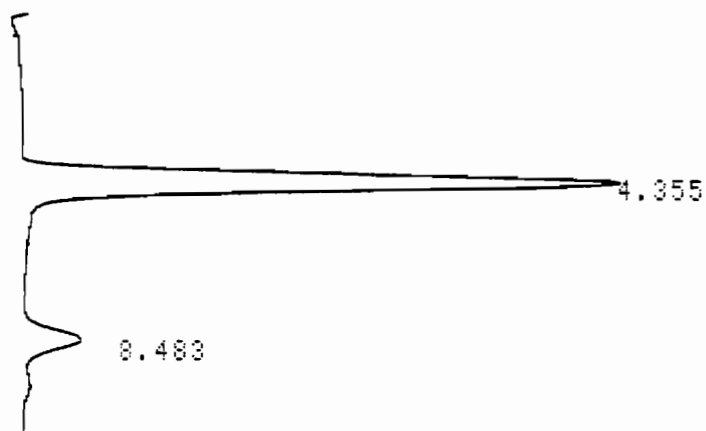
127

CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 33

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.348	18012			90.3071	
2 →	8.492	1933			9.6929	
TOTAL		19945			100	

START

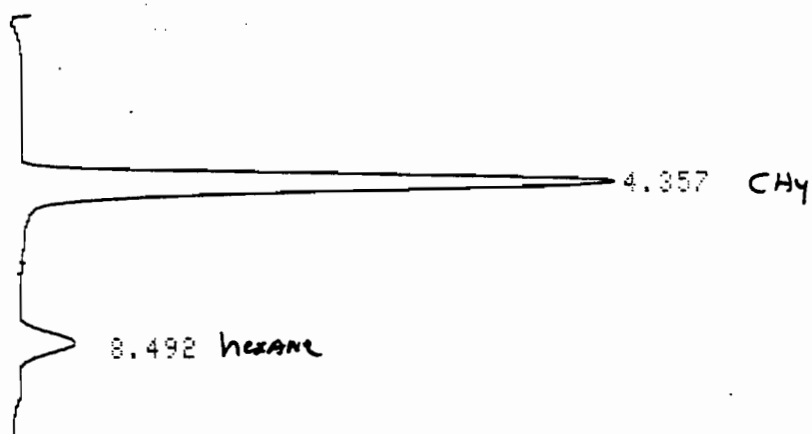


CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 34

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.355	17893			90.1031	
2 →	8.483	1965			9.8969	
TOTAL		19859			100	

START



2.9 ppm standard
post cal
inj 3

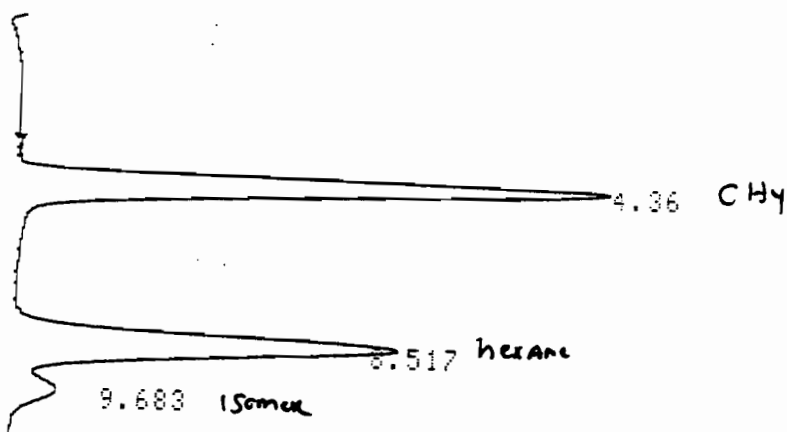
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 35

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.357	17859			89.9505	
2 →	8.492	1995			10.0494	
TOTAL		19855			100	

12.0 ppm Standard
post cal
inj 1,2

START

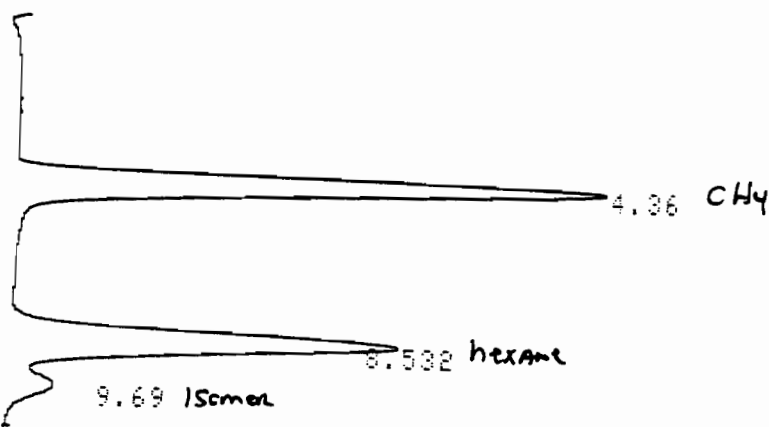


CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 36

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.36	17861			51.8475	
2 →	8.517	14789			42.9296	
3	9.683	1799	V		5.2229	
TOTAL		34450			100	

START



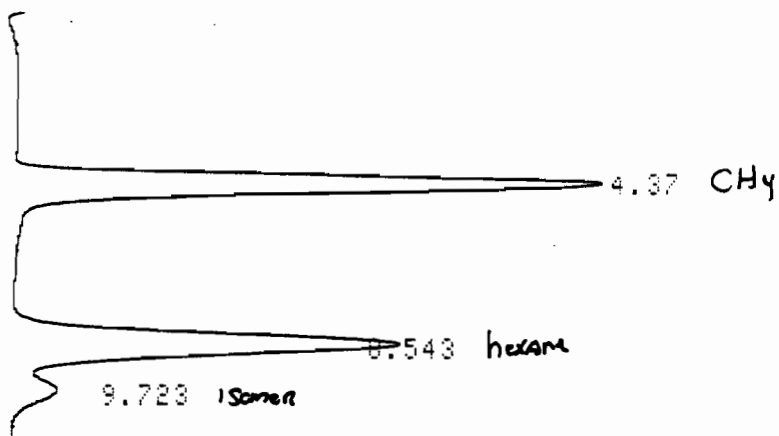
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 37

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.36	12705			51.6863	
2 →	8.532	14796			43.1921	
3	9.69	1754	V		5.1216	
TOTAL		34256			100	

START

12.0 ppm standard
postcal
inj 3



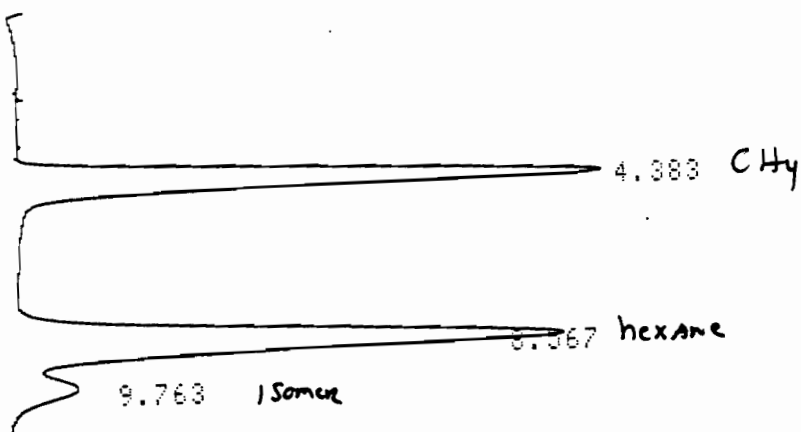
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 38

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
→ 1	4.37	17687			51.8798	
→ 2	8.543	14648			42.9634	
3	9.723	1758	V		5.1568	
TOTAL		34093			100	

START

20.2 ppm Standard
port cool
inj 1,2

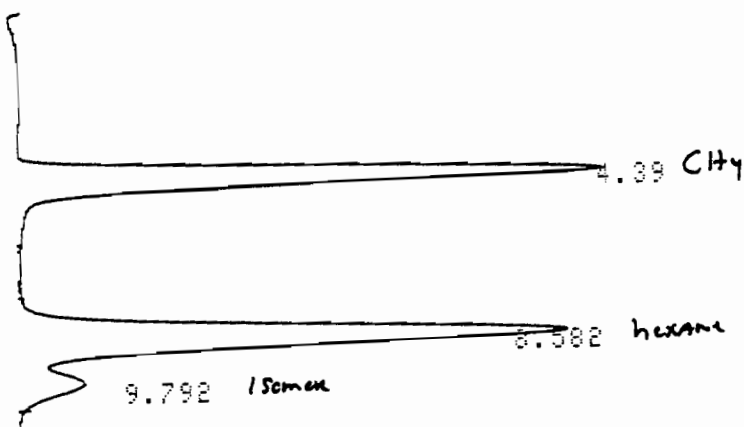


CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 39

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.383	17697			43.0766	
2 →	8.567	20926			50.9354	
3	9.763	2460	V		5.988	
TOTAL		41083			100	

ART



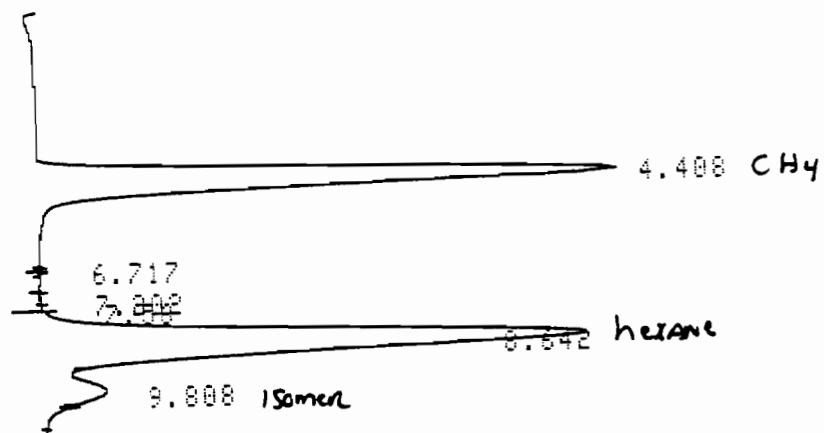
CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 40

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1 →	4.39	17679			43.0346	
2 →	8.582	20956			51.0108	
3	9.792	2446	V		5.9546	
TOTAL		41081			100	

START

20.2 ppm Standard
post Cal
Inj 3



CHROMATOPAC CR601
SAMPLE NO 0
REPORT NO 42

FILE 0
METHOD 41

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
→ 1	4.408	17662			42.6635	
2	7.202	31			0.0744	
3	7.56	59			0.1422	
4 →	8.642	21124	V		51.0257	
5	9.808	2523	V		6.0943	
TOTAL		41398			100	

APPENDIX D

SAMPLE CALCULATIONS

**SAMPLE CALCULATIONS FOR
CORRECTING NON-METHANE ORGANIC COMPOUNDS TO 3% OXYGEN**

Client: Clarkstown Landfill
Test Number: Run 1
Test Location: Flare Stack

Plant: Clarkstown, NY
Test Date: 10-28-99
Test Period: 14:14- 15:14

1. NMOC Concentration Corrected to 3% Oxygen

$$C@3\%O_2 = \frac{Ci \times (20.9 - 3)}{(20.9 - \%O_2)}$$

$$C@3\%O_2 = \frac{<0.8 \times (20.9 - 3)}{(20.9 - 14.10)}$$

$$= <2.1$$

Where:

- $C@3\%O_2$ = Concentration of NMOC as hexane at 3% oxygen, ppm.
- Ci = Concentration of NMOC as hexane at stack conditions, as measured by triplicate Method 18 analyses, ppm.
Note: NMOC was below detection limits, < 0.8 represents limit of quantitation for methane, reported as hexane.
- $\%O_2$ = Measured stack oxygen concentration, %.

APPENDIX D

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS FOR CORRECTING NON-METHANE ORGANIC COMPOUNDS TO 3% OXYGEN

Client: Clarkstown Landfill
Test Number: Run 1
Test Location: Flare Stack

Plant: Clarkstown, NY
Test Date: 10-28-99
Test Period: 14:14-15:14

1. NMOC Concentration Corrected to 3% Oxygen

$$C@3\%O_2 = \frac{Ci \times (20.9 - 3)}{(20.9 - \%O_2)}$$

$$C@3\%O_2 = \frac{<0.8 \times (20.9 - 3)}{(20.9 - 14.10)}$$

$$= <2.1$$

Where:

$$C@3\%O_2 = \text{Concentration of NMOC as hexane at 3\% oxygen, ppm.}$$

$$Ci = \text{Concentration of NMOC as hexane at stack conditions, as measured by triplicate Method 18 analyses, ppm.}$$

Note: NMOC was below detection limits, < 0.8 represents limit of quantitation for methane, reported as hexane.

$$\%O_2 = \text{Measured stack oxygen concentration, \%}$$

APPENDIX E
EQUIPMENT CALIBRATION RECORDS



PITOT TUBE IDENTIFICATION NUMBER: P145

TYPE S PITOT TUBE INSPECTION DATA FORM

PITOT TUBE ASSEMBLY LEVEL? ☒ (YES) ☐ (NO)

PITOT TUBE OPENINGS DAMAGED? ☐ (YES-EXPLAIN BELOW) ☒ (NO)

$\alpha_1 = 0^\circ$ ($< 10^\circ$)

$\alpha_2 = 0^\circ$ ($< 10^\circ$)

$\beta_1 = 0^\circ$ ($< 5^\circ$)

$\beta_2 = 0^\circ$ ($< 5^\circ$)

$\gamma = 1^\circ$

$\theta = 0^\circ$

$A = 94$ in.

$z = A \sin \gamma = .01$ in.; ($< 1/8$ in.),

$w = A \sin \theta = 0$ in.; ($< 1/32$ in.),

$P_a = 47$ in.

$P_b = 47$ in.

$D_1 = .38$ in.

$P_a = P_b$? ☒ (YES) ☐ (NO)

COMMENTS _____

CALIBRATION REQUIRED? ☐ (YES) ☒ (NO)

INSPECTOR Tom Bueff DATE 12-22-98



125 Mr. Larson Court

Cincinnati, OH 45210

(513) 750-6807

FAX (513) 750-6842

CERTIFICATE OF ANALYSIS

Date. 9/24/97 Record Number 3062
Customer Name. KEYSTONE AIRGAS
Purchase Order #. 1478-1
Grade of Product. CERTIFIED

Cylinder Number	Component	Required Concentration	Actual Concentration
0725484	Methane	70 ppm	70.1 ppm
	AIR	Balance	Balance

Uncertainty Of Analytical Results. 2%


Approval Signature

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Calibrator

P. Mack

Date 11/10/99 Meter box number 5 Plant GM
Barometric pressure, $P_b =$ 29.26 in. Hg Dry gas meter number RFW 9869 Pretest $Y =$ 1.0227

Setting	Gas Volume		Temperature				Time (e). min.	Vacuum Setting. in. Hg.	Y _i	Y _i = $\frac{V_o P_o (t_o + 460)}{V_i (P_o + \frac{\Delta H}{13.3}) (t_o + 460)}$
	Wet test meter	Dry gas meter	Wet test meter	Dry gas meter						
				(t _i) °F	Average (t _a) °F					
Orifice Manometer	(V _i) ft ³	(V _d) ft ³	(t _i) °F	Inlet (t _d) °F	Outlet (t _d) °F	Average (t _a) °F				
1.5	10	575.918 565.907	70	—	22.7782	77	16.3	2	1.0083	
1.5	10	586.020 575.918	70	—	82.8588	85	16.3	2	1.0141	
1.5	10	596.254 576.020	70	—	88.9092	90	16.3	2	1.0102	
Y = 1.0109										

There is only one thermometer on the dry gas meter, record the temperature under t_d .

= Gas volume passing through the wet test meter, ft^3 .

= Gas volume passing through the dry gas meter, ft^3 .

= Temperature of the gas in the wet test meter, $^{\circ}F$.

= Temperature of the inlet gas of the dry gas meter, $^{\circ}F$.

= Temperature of the outlet gas of the dry gas meter, $^{\circ}F$.

= Average temperature of the gas in the dry gas meter, $t_d = \frac{t_d + t_o}{2}$.

= Pressure differential across orifice, in. H_2O .

= Ratio of accuracy of wet test meter to dry gas meter for each run.

= Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest $Y \pm 0.05Y$.

= Barometric pressure, in. Hg.

= Time of calibration run, min.

Long calibration required? Yes No

$$\Delta H \theta_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_d + 460) \theta_i}{V_i} \right]^2$$

APPENDIX F

PROJECT PARTICIPANTS

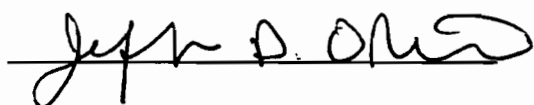
PROJECT PARTICIPANTS

Neil Nowak, PE Project Manager	Mid West Division
Paul Clarke Technical Manager	Emission Testing Practice
Eric Swisher Project Scientist	Emission Testing Practice
Tim Leonard Project Scientist	New England Division

**CLARKSTOWN LANDFILL
SOURCE EMISSIONS TEST REPORT
CLARKSTOWN LANDFILL GAS FLARE SYSTEM**

Prepared for:

**CLARKSTOWN LANDFILL
CLARKSTOWN, NEW YORK**

 FOR PAC

Paul A. Clarke
Technical Manager

Prepared by:

ROY F. WESTON, INC.
Raritan Plaza III Suite 2B
101 Fieldcrest Avenue
Edison, New Jersey 08837

NOVEMBER 1999

W. O. No. 03228.018.001

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1. INTRODUCTION

The Clarkstown Landfill Gas Flare was identified as part of a Remedial Investigation/Feasibility Study conducted by Roy F. Weston Inc., (WESTON) for the Town of Clarkstown pursuant to a Consent Order Agreement between the Town and the New York State Department of Environmental Conservation (NYSDEC). The Clarkstown Landfill has been listed by the NYSDEC as a Class 2 Inactive Hazardous Waste Site. The landfill gas collection and flare system installation are part of the Clarkstown Landfill Inactive Hazardous Disposal Site Remediation plan which also includes capping of the landfill, leachate collection and landfill gas extraction.

WESTON was retained to conduct a source emission testing and analysis program on the Clarkstown Landfill Gas (LFG) flare system.

The object of the test program was to determine target pollutant emission concentrations, mass rates and destruction and removal efficiencies (DRE's) with regards to the Federal New Source Performance Standards (NSPS) (40 CFR Part 60) landfill flare performance requirements and requirements outlined by the NYSDEC.

Testing procedures conformed to the specifications of the U.S. Environmental Protection Agency (EPA) and NYSDEC. All test program sampling and analysis procedures were conducted as specified in the emission test protocol approved by NYSDEC.

This report presents the results of the Emission Test Program. Section 2 summarizes all the emission test results. A description of the sampling locations is provided in Section 3. A description of sampling equipment is provided in Section 4. Sampling and analytical procedures are provided in Section 5. Section 6 provides discussion of the test results and includes detailed test data and results on Tables 6-1 through 6-14

Process operations data, raw test data, laboratory results, example calculations, equipment calibration records and a list of WESTON project participants are provided in Appendices A through F, respectively.

2. SUMMARY

WESTON Emission Testing personnel performed an emission test program on the Clarkstown LFG system on February 17 and 18, 1999.

Table 2-1 presents a summary of the specific parameters and associated sampling methods conducted during the emission test program.

Testing procedures conformed to the specifications of the U.S. Environmental Protection Agency (EPA). All test program sampling and analysis procedures were conducted as specified in the emissions test protocol approved by NYSDEC in February 1999.

Continuous emission monitoring (CEM) procedures were conducted on the LFG flare stack to determine emission rates for sulfur dioxide (SO₂), oxides of nitrogen (NO_x), carbon monoxide (CO), oxygen (O₂), and carbon dioxide (CO₂). Each test run was approximately 1 hour in duration and is comprised of a tabulation of one-minute averages. Oxides of nitrogen were not measured on February 17, 1999 due to an unexpected analyzer failure. The analyzer was replaced and oxides of nitrogen emissions were measured on February 18, 1999. The CEM emission results are summarized in Table 2-2. Particulate emissions were conducted on the LFG flare outlet stack on February 17, 1999. The particulate results are summarized on Table 2-3.

Sampling was conducted simultaneously at the LFG flare inlet and outlet to determine DRE's for volatile organic compounds (VOC), non-methane organic hydrocarbons (NMOC), sulfur compounds and methane. A summary of the targeted VOC emissions and DRE's are presented in Table 2-4. During analysis there were additional VOC compounds quantified. These additional VOC results are presented in Tables 6-8 through 6-11 and are reported in the analytical laboratory reports in Appendix C.

A summary of the sulfur compounds, NMOC and methane results are presented in Table 2-5. Hydrogen sulfide and carbonyl sulfide are the only sulfur compounds detected in the landfill gas and therefore are the only sulfur compounds presented in summary Table 2-5. Additional sulfur compound data and test results are presented in Table 6-12 through 6-14 and are reported in the analytical laboratory reports in Appendix C. Test results indicate that many of the DRE's and

Table 2-1

**Charlestown Landfill Remediation Project
Clarkstown, New York**

Emission Test Parameters and Methods

Parameter	Method¹
Location: Outlet Gas Flare	
Gas Velocity and Volumetric Flow Rate	EPA 1, 2
Gas Composition (CO ₂ and O ₂)	EPA 3A
Gas Moisture Content (Preliminary)	EPA 4
Particulate Concentration and Mass Rate	EPA 5
Nitrogen Oxides (As and NO ₂) Concentration and Mass Rate	EPA 7E
Sulfur Dioxide Concentration Mass Rate	EPA 6C
Carbon Monoxide Concentration and Mass Rate	EPA 10
Volatile Organics Concentrations and Mass Rates	EPA 0030 ²
Hydrogen Sulfide Concentration and Mass Rate	Modified ASTM Method 5504
Methane Concentration and Mass Rate	EPA Method 25C
NMOC Concentration and Mass Rate	EPA Method 25C
Location: Inlet Gas Flare	
Hydrogen Sulfide Concentration and Mass Rate	Modified ASTM Method 5504
Volatile Organics Concentration and Mass Rate	EPA TO-14
Methane Concentration and Mass Rates	EPA Method 25C
NMOC Concentration and Mass Rate	EPA Method 25C

1 EPA – U.S. Environmental Protection Agency 40CFR60, Appendix A – Reference Methods.

2 EPA-SW-846 – Test methods for evaluating solid waste physical/chemical methods.

Table 2-2

**Clarkstown Landfill Gas Flare
Clarkstown, NY**

Summary of Continuous Emission Monitoring Test Results

Date	Run	Sample Period	Oxygen Concentration %	Carbon Dioxide Concentration %	Oxides of Nitrogen ⁽¹⁾		Sulfur Dioxide		Carbon Monoxide	
					Concentration ppm/v	Mass Rate lb/hr	Concentration ppm/v	Mass Rate lb/hr	Concentration ppm/v	Mass Rate lb/hr
2/17/99	1	1112-1212	15.6	4.8	---	---	1.6	0.18	16.4	0.81
	2	1405-1511	15.8	4.7	---	---	1.1	0.10	17.3	0.75
	3	1537-1637	16.0	4.5	---	---	1.4	0.15	16.2	0.73
	Avg.		15.8	4.7	---	---	1.4	0.14	16.6	0.76
2/18/99	1	0937-1037	15.5	4.7	12.5	0.99	---	---	---	---
	2	1048-1148	15.4	4.7	12.8	1.00	---	---	---	---
	3	1200-1300	15.9	4.5	12.4	0.94	---	---	---	---
	Avg.		15.6	4.6	12.6	0.97	---	---	---	---

⁽¹⁾ Oxides of Nitrogen were not monitored on 2/17/99 due to instrument failure.

Table 2-3

Clarkstown Landfill Gas Flare
Clarkstown, NY

Summary of Particulate Emission Results

Date	Run	Time Period	Volumetric Flowrate ⁽¹⁾ dscf/m	Concentration gr/dscf	Mass Rate lb/hr
2/17/99	1	1112-1248	11,300	0.0008	0.08
2/17/99	2	1331-1511	10,000	0.0012	0.10
2/17/99	3	1546-1724	10,300	0.0014	0.12
	Average		10,500	0.0011	0.10

⁽¹⁾ dscf/m = dry standard cubic feet/min (68°F and 29.92 inches Hg)

Table 2-4

**Clarkstown Landfill Gas Flare
Clarkstown, NY**

Summary of Volatile Organic Compound Emission Results

Parameter	Run	Inlet		Outlet		DRE ⁽²⁾ %
		Concentration $\mu\text{g}/\text{m}^3$	Mass Rate lb/hr	Concentration $\mu\text{g}/\text{m}^3$	Mass Rate lb/hr	
Methylene Chloride	1	<52	<8.3E-5	<0.50	<2.1E-5	---
	2	<38	<6.0E-5	0.52	1.9E-5	67.5
	3	<47	<7.7E-5	2.6	9.9E-5	---
	Avg.	<46	<7.3E-5	1.21	≤4.6E-5	---
Carbon Tetrachloride	1	<93	<1.5E-4	<0.50	<2.1E-5	---
	2	<69	<1.1E-4	<0.51	<1.9E-5	---
	3	<86	<1.4E-4	<0.52	<2.0E-5	---
	Avg.	<83	<1.3E-4	<0.51	<2.0E-5	---
Benzene ⁽¹⁾	1	570	9.1E-4	12.2	5.2E-4	43.5
	2	960	1.5E-3	3.3	1.2E-4	91.9
	3	1100	1.8E-3	1.2	4.5E-5	97.5
	Avg.	877	1.4E-3	5.57	2.3E-4	77.6
1,2 Dichloroethane	1	<60	<9.6E-5	<0.50	<2.1E-5	---
	2	<44	<7.0E-5	<0.51	<1.9E-5	---
	3	<55	<9.0E-5	<0.52	<2.0E-5	---
	Avg.	<53	<8.5E-5	<0.51	<2.0E-5	---
Toluene	1	3600	5.8E-3	10.4	4.4E-4	>92.3
	2	6500	1.0E-3	0.62	2.3E-5	99.8
	3	7200	1.2E-3	0.76	2.9E-5	99.7
	Avg.	5767	9.3E-3	3.93	1.6E-4	97.3
Ethyl Benzene	1	4700	7.5E-3	<0.50	<2.1E-5	99.7
	2	8100	1.3E-3	<0.51	<1.9E-5	>99.8
	3	8800	1.4E-3	<0.52	<2.0E-5	>99.9
	Avg.	7200	1.2E-3	<0.51	<2.0E-5	>99.8
M-P Xylene	1	5400	8.7E-3	0.58	2.5E-5	99.7
	2	9700	1.5E-3	<0.51	<1.9E-5	>99.9
	3	11000	1.8E-3	0.65	2.5E-5	99.9
	Avg.	8700	1.4E-3	≤0.58	≤2.3E-5	>99.8
O Xylene	1	2700	4.3E-3	<0.50	<2.1E-5	>99.5
	2	4900	7.8E-3	<0.51	<1.9E-5	>99.7
	3	5400	8.8E-3	<0.52	<2.0E-5	>99.7
	Avg.	4300	7.0E-3	<0.51	<2.0E-5	>99.6
Styrene	1	200	3.2E-4	<0.50	<2.1E-5	>93.3
	2	390	6.2E-4	<0.51	<1.9E-5	>96.9
	3	440	7.2E-4	<0.52	<2.0E-5	>97.2
	Avg.	343	5.5E-4	<0.51	<2.0E-5	>95.8

(1) Benzene run 1 outlet concentrations and mass rates are based on tube pair 3. Tube pairs 1 and 2 are suspect due to possible probe contamination.

(2) Due to the extremely low concentrations several inlet and most outlet concentrations are below detection limits. DRE's are undefined for inlets concentrations below detection limits and DRE's are only approximations for outlet concentrations below detection limits.

Table 2-5

**Clarkstown Landfill Gas Flare
Clarkstown, NY**

Summary of Sulfur Compounds, NMOC, and Methane Emission Results

Parameter	Run	Inlet		Outlet		DRE ⁽²⁾ %
		Concentration ppm/v	Mass Rate lb/hr	Concentration ppm/v	Mass Rate lb/hr	
Hydrogen Sulfide	1	22	0.056	<0.056	<3.4E-4	>99.4
	2	33	0.084	<0.058	<3.1E-4	>99.6
	3	32	0.082	<0.058	<3.2E-4	>99.6
	Avg.	29	0.074	<0.057	<3.2E-4	>99.5
Carbonyl Sulfide	1	0.47	0.0021	0.010	1.1E-3	49.7
	2	0.80	0.0036	0.011	1.1E-3	70.5
	3	0.80	0.0036	0.009	9.2E-4	74.9
	Avg.	0.69	0.0031	0.010	1.0E-3	65.0
NMOC (as Hexane) at 3% O ₂ ⁽¹⁾	1	170	0.8	54	1.8	---
	2	186	0.9	44	1.3	---
	3	188	1.0	140	3.2	---
	Avg.	181	0.9	79.3	2.1	---

Parameter	Run	Inlet		Outlet		DRE ⁽²⁾ %
		Concentration %	Mass Rate lb/hr	Concentration %	Mass Rate lb/hr	
Methane	1	46	490	<0.14	<40	>92
	2	48	505	<0.15	<37	>93
	3	48	520	<0.15	<38	>93
	Avg.	47.3	505	<0.147	<38	>92.5

(1) LFG flare outlet concentration of NMOC (as hexane) at 3%O₂ is not less than 20 ppm as required by NYCRR Part 360-2.21(c)(2)(c)(2). The lower detection limit of the measurement method (Method 25C) and carbon dioxide analytical interference probably contributes to this result.

(2) DRE's are based upon inlet and outlet mass rates. Due to the design of the LFG flare there is a large difference between the inlet and outlet volumetric airflow. Although there is a reduction in concentration between the LFG flare inlet and outlet the large difference in volumetric airflows greatly influences the mass rates and DRE's. When outlet concentrations are below detection limit, the reported DRE's are only approximations.

the LFG stack outlet NMOC concentrations do not conform to NYSDEC requirements. Additional discussion is provided in the Test Results Discussion (Section 6) of this report.

3. DESCRIPTION OF TEST LOCATIONS

Emission testing was performed simultaneously at the landfill flare gas inlet and outlet. The following subsections present schematics and descriptions of the sample locations. The drawings which accompany this section are not to scale.

3.1 LANDFILL GAS FLARE OUTLET

The LFG flare outlet is a round stack oriented vertical with a 113 inch inside diameter. The stack height is 32 feet 8 inches tall. Four (4) four inch ID sample ports are located 90° apart approximately 25 feet (2.5 stack diameters) from the nearest upstream flow disturbance, the LFG flare inlet. The stack outlet, which is the nearest downstream disturbance is approximately 9 feet (~1 stack diameter) downstream of the sample ports.

A schematic of the sample point and orifice flare location is presented in Figure 3-1.

3.2 LANDFILL GAS FLARE INLET

The LFG flows from two ID fans through approximately 35 feet of 8-inch diameter horizontal stainless steel pipe into the LFG flare. The LFG flare inlet volumetric flowrates were measured by an orifice plate located in a straight section of the pipe approximately 25 feet upstream of the flare stack inlet. The LFG inlet sample location is a $\frac{3}{8}$ -inch valve located upstream of the flame arrestor positioned approximately 3 feet prior to the LFG flare stack inlet. The inlet sample location is downstream of 25-foot straight section of pipe thus assuring uniform mixing.

A schematic of the sample point and orifice plate location is presented in Figure 3-2.

CLARKSTOWN LANDFILL GAS FLARE CLARKSTOWN, NEW YORK

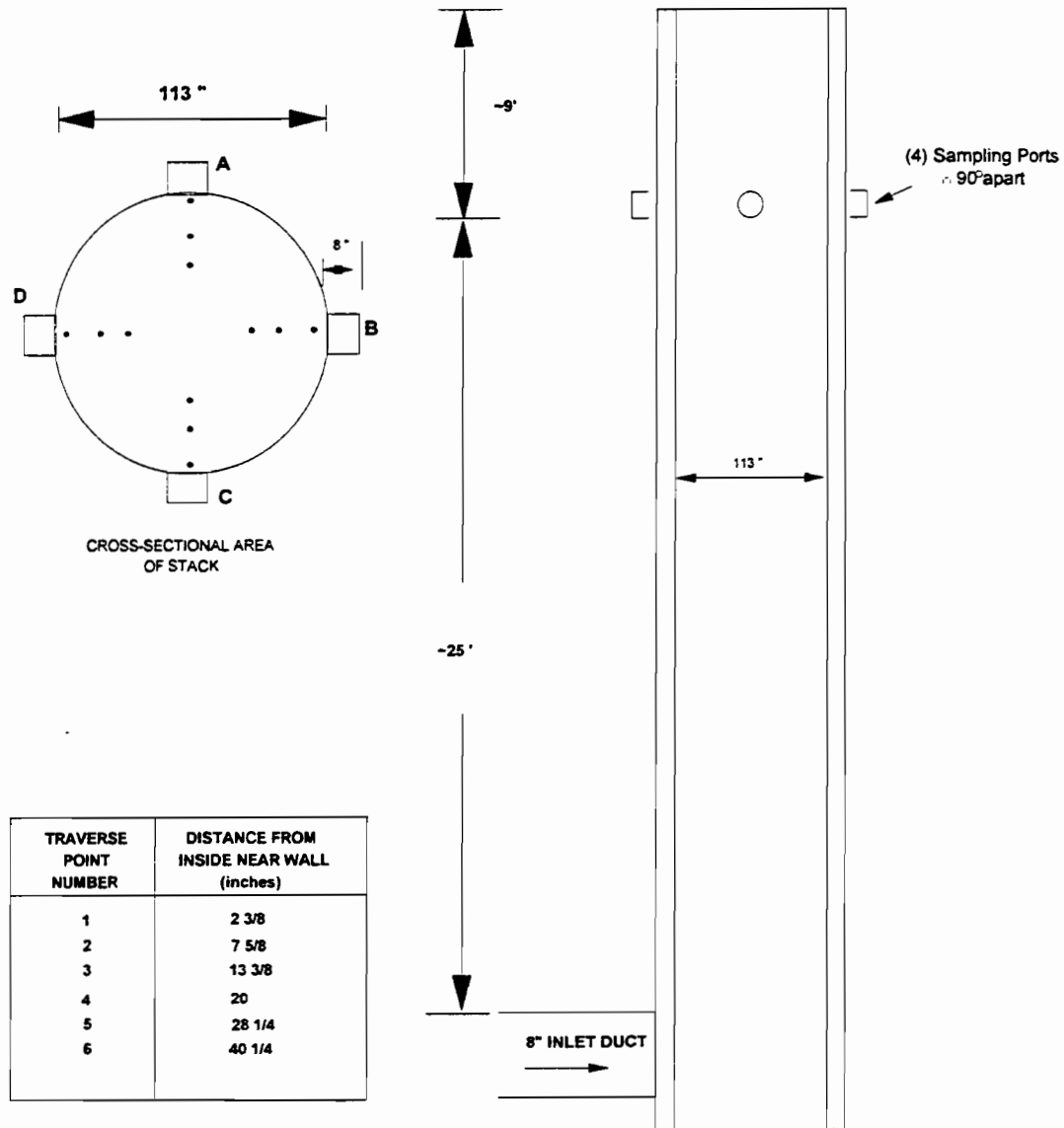


FIGURE 3-1
LANDFILL GAS FLARE OULET
PORT AND TRAVERSE POINT LOCATIONS

CLARKSTOWN LANDFILL GAS FLARE CLARKSTOWN, NEW YORK

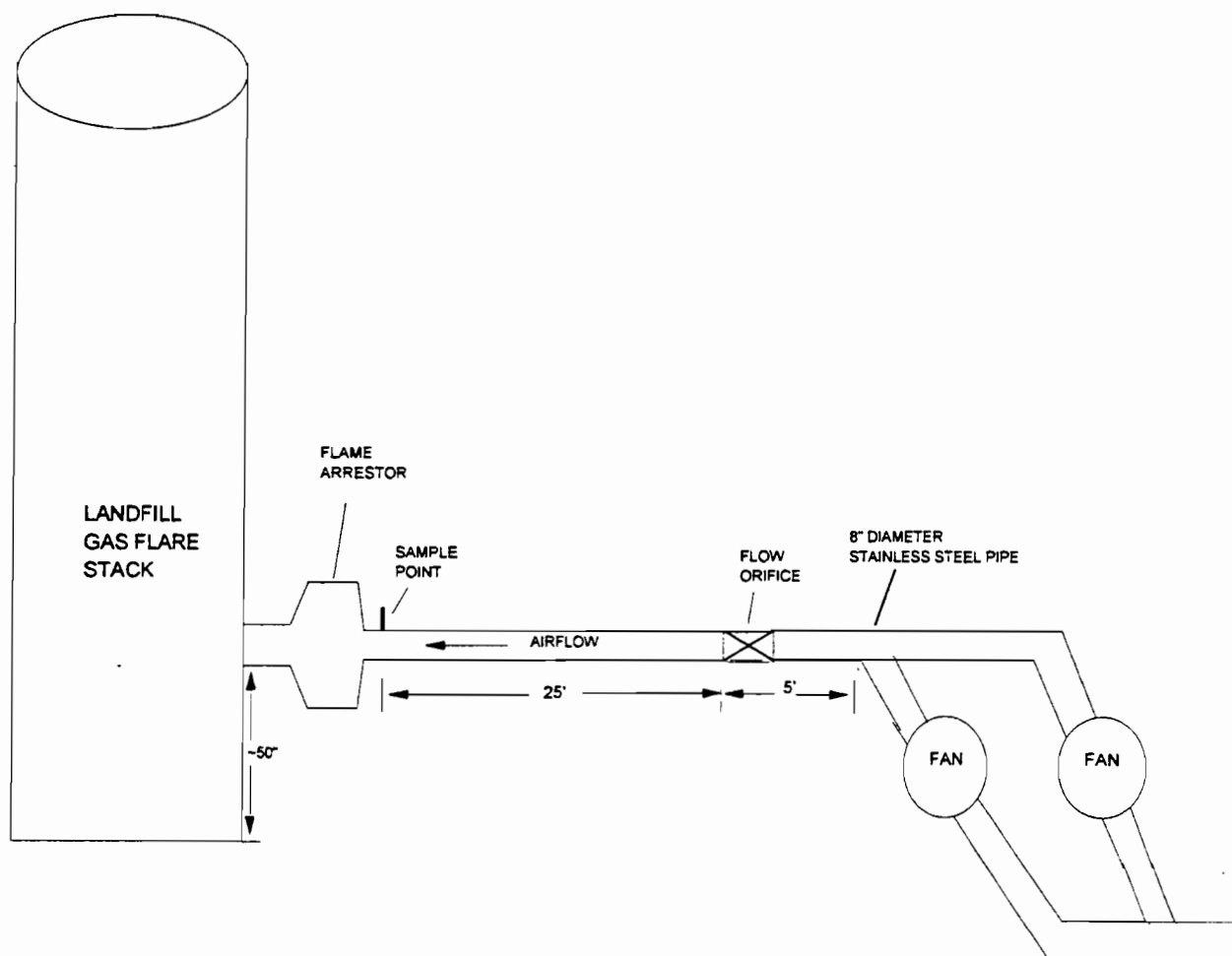


FIGURE 3-2
LANDFILL GAS FLARE INLET
SAMPLE POINT LOCATION

Fig. clarkstown1

4. DESCRIPTION OF SAMPLING EQUIPMENT

This section describes the sampling equipment utilized for the emission test program. The equipment conforms to EPA source testing requirements.

4.1 GAS VOLUMETRIC FLOW RATE – EPA METHOD 1 AND 2

The gas velocity at the LFG flare outlet stack was measured using EPA Methods 1 and 2. Stack geometry measurements and traverse point distances were measured and calculated according to EPA Method 1 procedures. LFG flare outlet stack velocity measurements were performed utilizing "S-type" pitot tubes and inclined manometers. Flue gas temperatures were measured with calibrated digital temperature readouts equipped with chromel-alumel (K-type) thermocouples.

An orifice plate located as described in Section 3-2 was utilized to measure volumetric airflow for the LFG flare inlet. The orifice plate adhered to EPA Method 2D procedures and recorded volumetric flowrate continuously on a strip-chart.

4.2 GAS STREAM MOISTURE CONTENT – EPA METHOD 4

The sampling train utilized to perform the gas stream moisture sampling was an EPA Method 4 train. An unheated stainless steel probe was connected to a series of four impingers by a flexible line. The first and second impingers each contained 100 ml of distilled water; the third impinger was dry; and the fourth impinger contained 300 grams of dry preweighed silica gel. The second impinger was a standard Greenburg-Smith type, the first, third and fourth were of a modified design. All impingers were maintained in a crushed ice bath. A meter box control console with a leakless vacuum pump, a calibrated dry gas meter, a calibrated orifice, an electronic temperature readout, vacuum gauge, and dual inclined manometer were connected to the final impinger via an umbilical cord to complete the train.

A diagram of the EPA Method 4 moisture sampling train is presented in Figure 4-1.

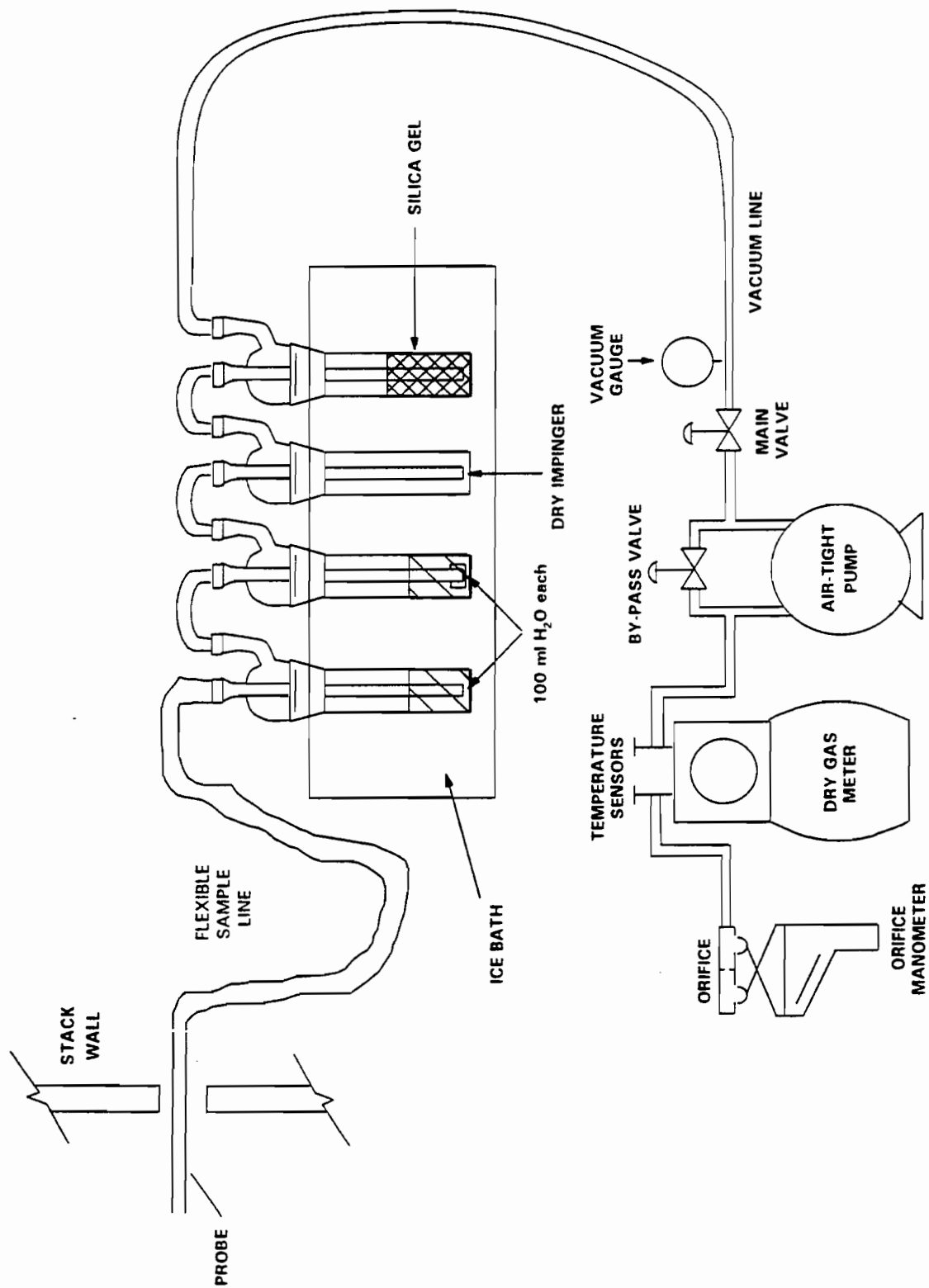


FIGURE 4-1
EPA METHOD 4 MOISTURE SAMPLING TRAIN

Gas stream moisture content at the LFG flare was determined by wet bulb/dry bulb temperature measurement and psychrometry.

4.3 PARTICULATE-EPA METHOD 5

The sampling train utilized for the particulate sampling at the LFG flare outlet stack was an EPA Method 5 sampling train.

A calibrated quartz nozzle was attached to a heated (~250°F) quartz probe. The probe was connected to a heated (~250°F) borosilicate filter holder containing a 9-cm glass or quartz fiber filter (preweighed to a constant 0.1 mg weight). The first and second impingers each contained 100 ml of distilled water, the third impinger was dry, and the fourth impinger contained 300 grams of dry preweighed silica gel. The second impinger was a standard Greenburg-Smith type, the first, third and fourth were of a modified design. All impingers were maintained in a crushed ice bath. A meter box control console with a leakless vacuum pump, a calibrated dry gas meter, a calibrated orifice an electronic temperature readout, vacuum gauge, and dual inclined manometer were connected to the final impinger via an umbilical cord to complete the train.

A diagram of the EPA Method 5 particulate sampling train is presented in Figure 4-2.

4.4 CONTINUOUS MONITORING SYSTEM

A Continuous Emissions Monitoring (CEM) system was employed to measure oxygen, carbon dioxide, carbon monoxide, sulfur dioxide and oxides of nitrogen by EPA Methods 3A, 10, 6C and 7E, respectively.

A stainless steel probe was used to collect a sample at the approximate centroid of the stack. A filter and a stainless steel tee were located in a heated box at the back end of the sample probe. Attached to one leg of the tee was a Teflon® line which is connected to a manifold and calibration gases. Attached to the second leg of the tee was the heated Teflon® sample line. The sample was drawn through heated Teflon® sample line to a sample conditioner. Unheated Teflon® tubing connected the outlet of the conditioner to the CEM. The output from the CEM

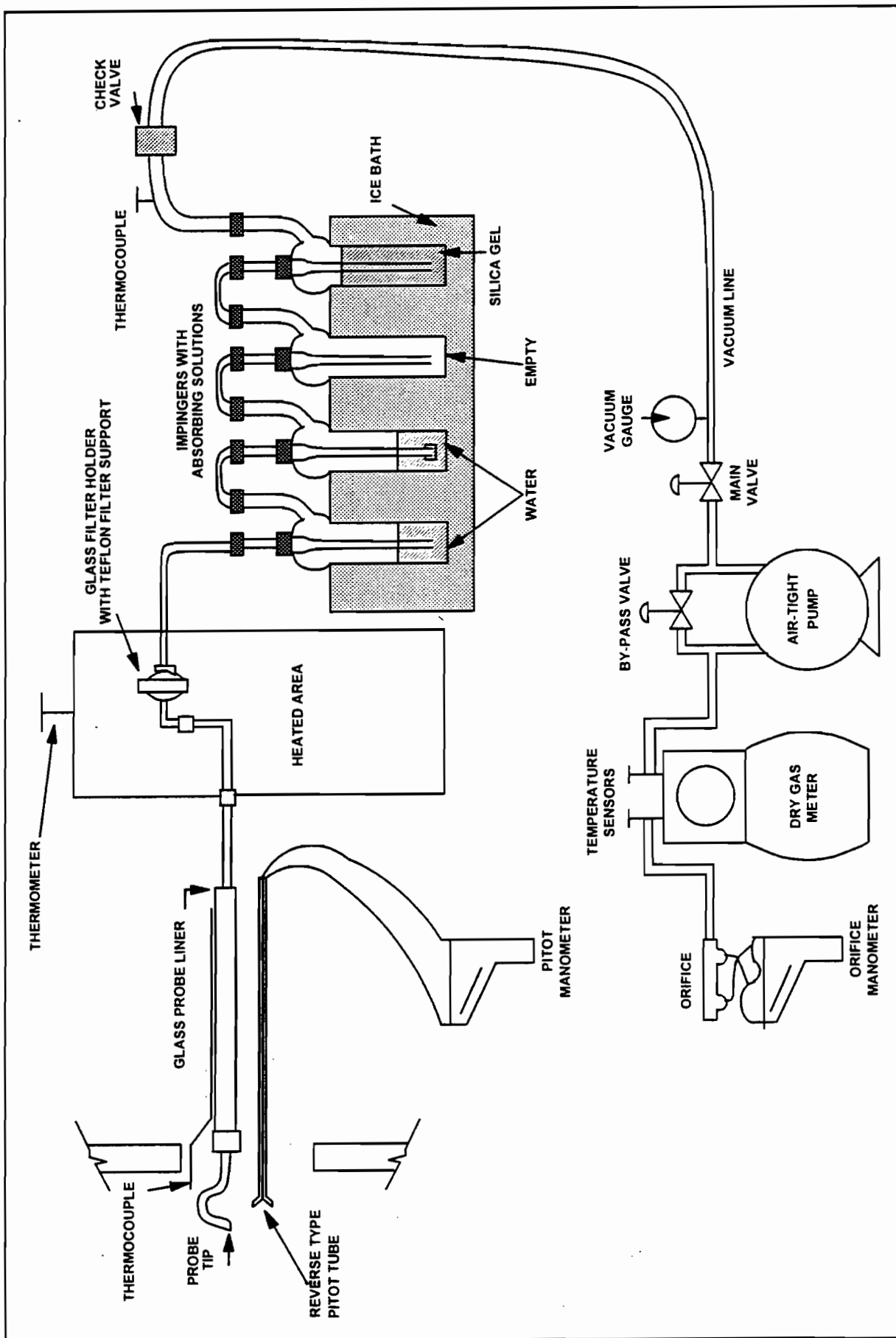


FIGURE 4-2
EPA METHOD 5 - PARTICULATE SAMPLING TRAIN

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system was recorded on a strip-chart and digitized by a Molytek® data logger. One-minute averages were recorded using an IBM compatible computer.

A schematic of the CEM system is presented in Figure 4-3.

4.4.1 Carbon Monoxide – EPA Method 10

The carbon monoxide emission content of the stack gas was measured according to EPA Method 10 procedures. A Thermo-Environmental Model 48, Gas Phase Correlation Filter Non-dispersive Infrared Analyzer was used for carbon monoxide analysis. This analyzer is not affected by carbon dioxide in the sample gas. During the initial calibration, a CO₂ calibration gas was introduced to the CO analyzer. A zero reading verified the absence of CO₂ interference. Interference checks are presented in Appendix D. The analyzer was calibrated prior to the start of the test program, and performance was demonstrated with system bias checks before and after each test run. The CO analyzer was calibrated with EPA Protocol One certified carbon monoxide gas standards. Calibration gas certificates are presented in Appendix E.

4.4.2 Oxides of Nitrogen – EPA Method 7E

Oxides of nitrogen (NO_x) emissions were determined using EPA Method 7E procedures. A TECO Model 42H chemiluminescent analyzer was used to measure NO_x (NO + NO₂) concentrations. The analyzer was calibrated prior to the start of the test program, and performance was demonstrated with system bias checks before and after each test run. The NO_x analyzer will be calibrated with EPA Protocol One certified nitrogen oxide gas standards. Calibration gas certificates, Interference checks and a NO₂ to NO converter efficiency check are presented in Appendix E.

4.4.3 Oxygen and Carbon Dioxide – EPA Method 3A

The oxygen and carbon dioxide content of the stack gas was measured according to EPA Method 3A procedures. A Siemens Oxymat® 5 analyzer was used to measure oxygen content. An Infrared Model 702 analyzer was used to measure carbon dioxide content of the stack gas. Both

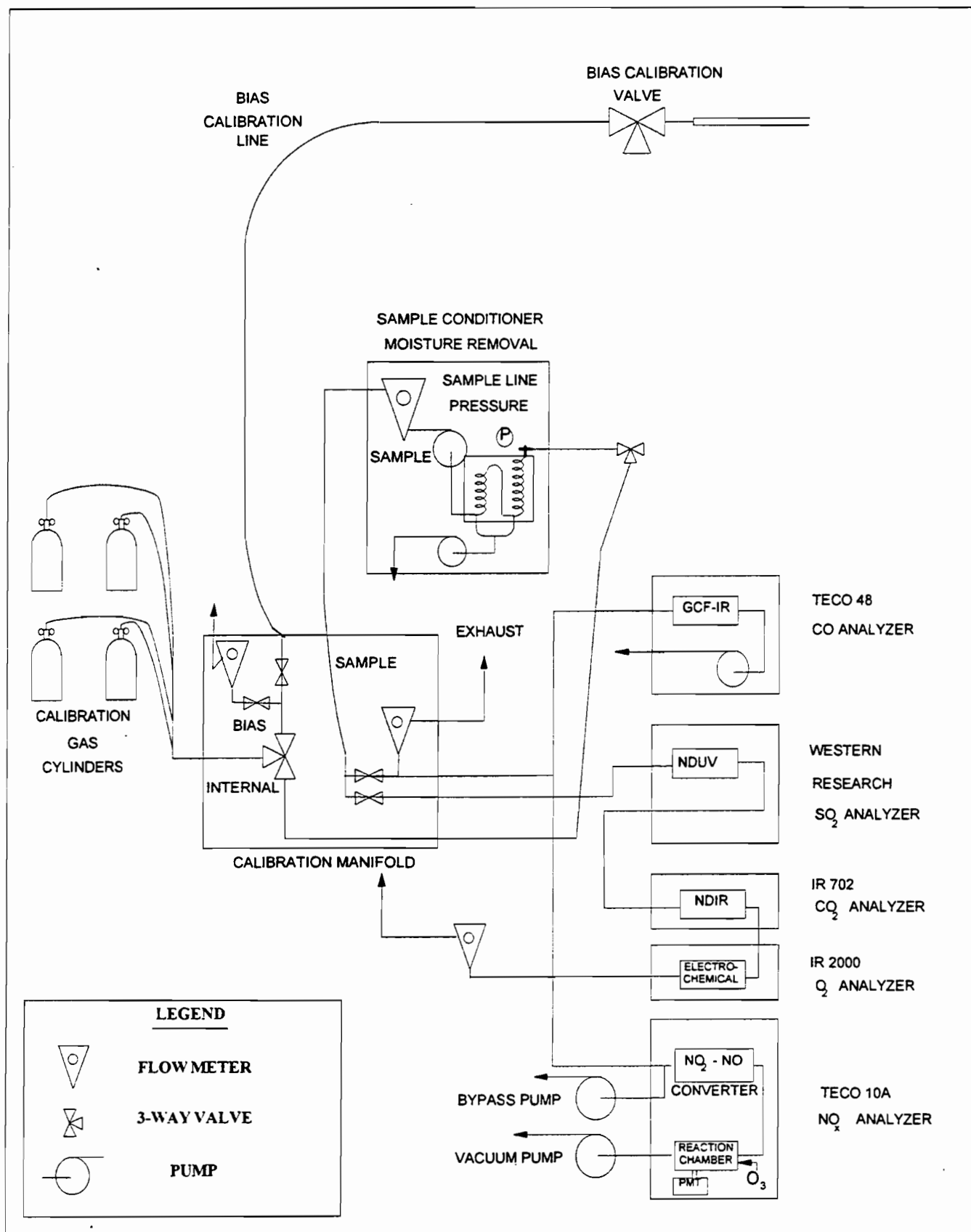


FIGURE 4-3
Continuous Emission Monitoring System

artsemicmndwul_cem.dwg

Analyzers were calibrated prior to the start of the test program and performance was verified by sample bias checks before and after each test run utilizing EPA Protocol One certified gas standards. Calibration gas certificates are provided in Appendix E.

4.4.4 Sulfur Dioxide – EPA Method 6C

Sulfur dioxide (SO₂) concentrations were determined using EPA Method 6C procedures. A Western Research Model 721 AT analyzer was used to measure the SO₂ concentration. The analyzer measured SO₂ concentrations continuously using a non-dispersive ultraviolet light detection principle. The analyzer was calibrated with EPA Protocol One certified sulfur dioxide gas standards prior to the start of the test program and system bias checks were performed before and after each test run. Sulfur dioxide interference checks for CO₂, O₂, CO, and NO_x were performed by EPA Method 7E procedures. Sulfur dioxide interference checks were not performed by EPA Method 6C (EPA 6 titration method) as discussed and approved in the test protocol. Sulfur dioxide interference checks and calibration gas certificates are provided in Appendix E.

4.5 VOLATILE ORGANICS - EPA METHOD 0030

The test train utilized for measuring specific volatile organics at the LFG flare outlet stack was a VOST train utilizing the procedures outlined in EPA Method 0030.

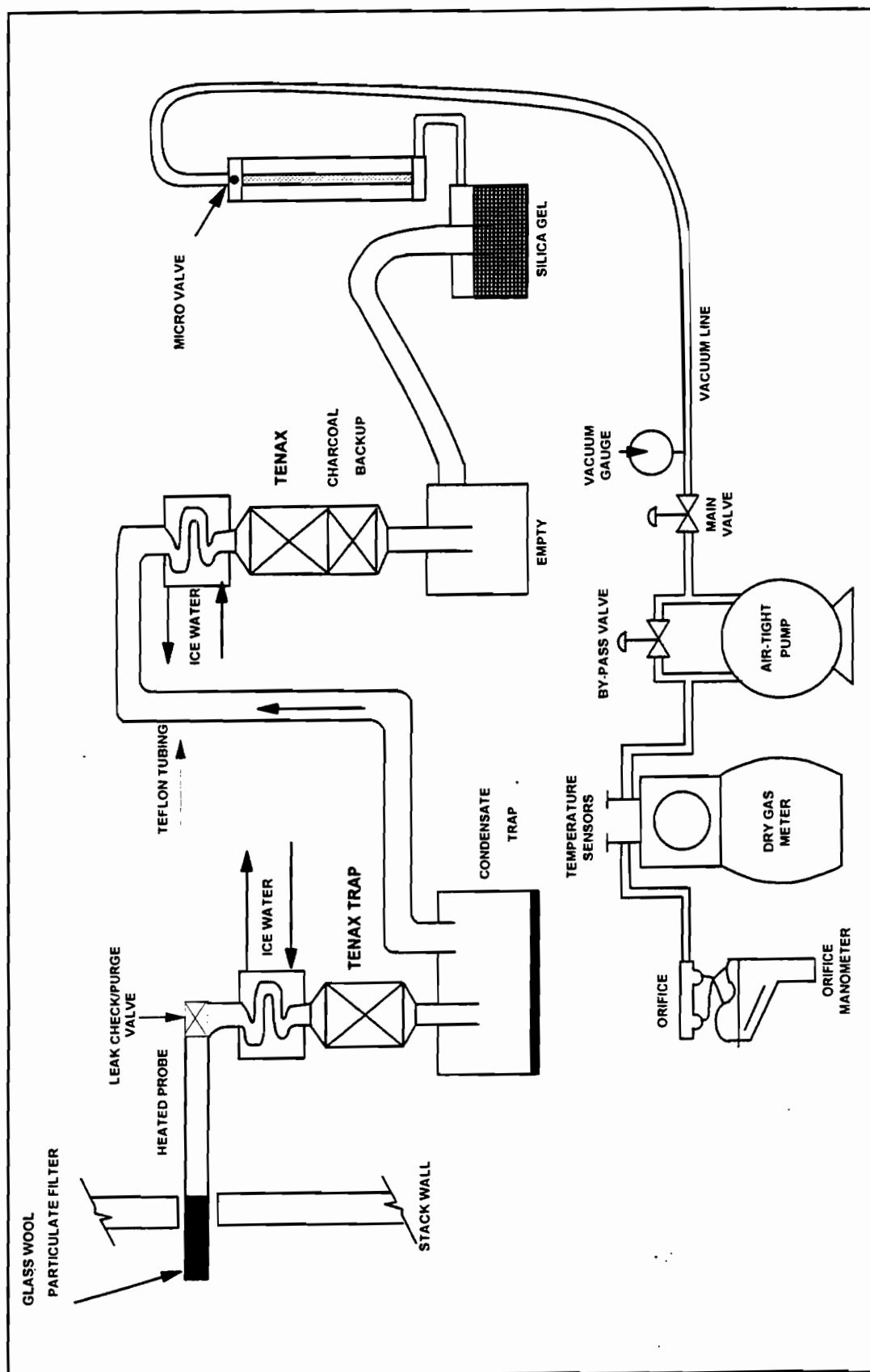
A heated 3-foot borosilicate probe containing a glass wool particulate filter was connected to a borosilicate manifold with shut-off valves. The manifold was connected to an ice-water cooled spiral condenser followed by an adsorption cartridge (containing 1.6 grams of Tenax 35/60 mesh) and a condensate trap. A section of Teflon® tubing connected the outlet of the condensate trap to an ice-water cooled straight condenser which was followed by a second absorption cartridge (containing one gram of Tenax and one gram of SKC petroleum-based charcoal). The second absorption cartridge was connected to a second condensate trap followed by a small impinger which contained indicating type silica gel.

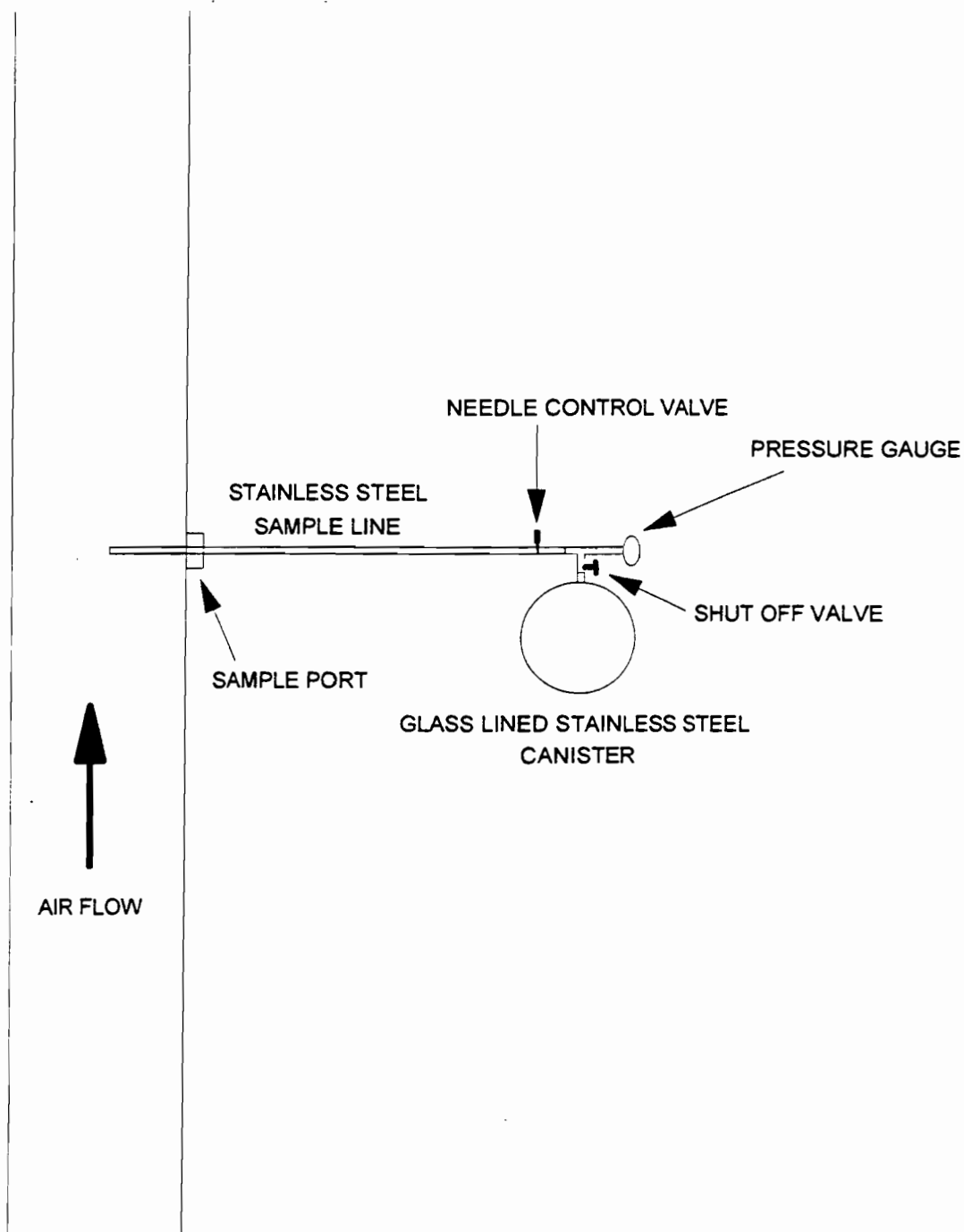
The silica gel impinger was connected via an umbilical cable to a VOST control console containing flow controllers, a calibrated dry gas meter (liters), sample pump, rotometer, a temperature readout indicator and other components.

A diagram of the EPA Method 0030 VOST sampling train is presented in Figure 4-4.

4.6 SULFUR COMPOUNDS, METHANE, VOCS, NMOC

Samples for sulfur compounds, methane, VOC and NMOC were collected by utilizing pre-evacuated glass lined (Silco) SUMMA® canisters. The Silco SUMMA® canister created an inert layer between the canister wall and the sample gas. This allowed reactive compounds, such as H₂S, to be stored in the canister for periods up to 36 hours without significant degradation. Each Silco SUMMA® canister was pre-evacuated at the analytical laboratory where it was certified clean prior to use. A sample probe consisting of a length of stainless steel at the LFG outlet or a length of Teflon® tubing at the LFG inlet was connected to the evacuated Silco SUMMA® canister. No sample pump was necessary because the vacuum of the pre-evacuated Silco SUMMA® canister was used to extract the sample. The flow rate of the Silco SUMMA® canister samples was regulated by critical orifices. The orifices introduced sample into the evacuated Silco SUMMA® canister at a constant rate over a 60-minute sample period. A vacuum gauge was used to monitor the Silco SUMMA® canister vacuum during the test periods. The Silco SUMMA® canister had several inches of vacuum remaining at the conclusion of each test run. This remaining vacuum aided in preserving the samples. The Silco SUMMA® canister-sampling system is schematically presented in Figure 4-5.





DRAWING NOT TO SCALE

FIGURE 4-5

SILCO SUMMA CANISTER SAMPLING SYSTEM

5. DESCRIPTION OF SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical methods performed in this program conformed to EPA Reference Methods (40, CFR60, Appendix A).

5.1 PRELIMINARY DETERMINATIONS

Preliminary test data was obtained at the LFG flare outlet stack location. Stack geometry measurements were recorded, and traverse point distances calculated. A check for the presence or absence of cyclonic flow was conducted at the LFG flare stack outlet test location prior to formal testing. The cyclonic flow check proved to be negative ($\alpha \leq 20^\circ$) thus verifying the suitability of the test site for obtaining representative samples.

A preliminary velocity traverse was performed at the LFG flare outlet stack location utilizing a calibrated "S" type pitot tube and an inclined micro-manometer to determine velocity profiles. Flue gas temperatures were observed with a calibrated direct readout pyrometer equipped with a chromel-alumel thermocouple. Water vapor content was measured by conducting an EPA Method 4 moisture test train.

Preliminary test data was used for nozzle sizing and sampling rate determinations for the particulate (isokinetic) sampling.

5.2 FORMAL TESTS

Three test repetitions were performed for each target parameters during the test program. Test duration for all parameters was a minimum of one hour. VOST, SO₂, CO and canister sampling were conducted in conjunction with the EPA Method 5 particulate sampling. Volumetric flow-rates derived from the EPA Method 5 particulate sampling were used for determining LFG flare outlet mass rates for these pollutants. Additionally canister sampling was conducted simultaneously at the LFG inlet and outlet. LFG flare inlet and outlet mass rates are used to derive DREs. The volumetric flow-rate at the LFG flare inlet was continuously measured by Orifice plate instrumentation. The LFG flare inlet volumetric flow-rate data was manually recorded at approximate 5-minute increments in addition recorded on a strip-chart. This data is

presented in Appendices A and B respectively. The NO_x sampling was not conducted in conjunction with the particulate samples. The NO_x analyzer was inoperable on February 17, 1999. NO_x measurements were conducted the morning of February 18, 1999 utilizing a replacement NO_x analyzer. Separate airflow velocity measurements, gas composition and moisture tests were performed by EPA Methods 1, 2, 3, and 4 respectively. These measurements were used to determine volumetric flow-rate and mass rates for the NO_x test runs.

5.3 PARTICULATE SAMPLING PROCEDURES

The EPA Method 5 test train was used to measure particulates at the LFG flare outlet stack location. A total of three (3) runs 72 minutes in duration were conducted.

The EPA Method 5 sample for particulate was conducted isokinetically. For isokinetic sampling, gas stream velocities were measured by inserting a calibrated "S" type pitot tube into the gas stream adjacent to the sampling nozzle. The velocity pressure differential was observed immediately after positioning the nozzle at each traverse point and the sampling rate was adjusted to maintain isokineticity $\pm 10\%$. Stack gas temperature was measured by a calibrated direct readout temperature pyrometer equipped with a chromel-alumel thermocouple positioned near the sample nozzle. Temperature measurements were taken at the probe exit, filter box, impinger outlet and dry gas meter outlet. Isokinetic field data was recorded at each traverse point on standardized data sheets during the test run. Leak checks were performed as required by EPA Method 5 requirements.

At the conclusion of each test, the sampling train was dismantled, the openings sealed, and the components transported to the field laboratory. Sample integrity was assured by maintaining chain-of-custody records.

A consistent procedure was employed for sample recovery as follows:

- The glass or quartz fiber filter(s) was removed from its filter holder with tweezers and placed in its original container (petri dish), along with any loose particulate and filter fragments (Sample Type 1).
- The probe and nozzle were separated and the particulate rinsed with acetone into a borosilicate container with a Teflon® lined closure while brushing a minimum of three times. Particulate adhering to the brush was rinsed with acetone into the same container.

The front-half of the filter holder and connecting glassware was rinsed with acetone while brushing a minimum of three times. The rinses were combined (Sample Type 2).

- The total liquid content of impingers one, two and three were measured volumetrically. The impinger liquid was discarded.
- The silica gel was removed from the last impinger and immediately weighed to the nearest 0.5 g.
- Blank samples of a filter and acetone were retained and analyzed.

Each sample bottle was labeled and its contents clearly identified. The height of the fluid level was marked on each bottle. The samples were then placed in a locked shipping crate and transported to PHILIP ANALYTICAL located in Reading, Pennsylvania.

The particulates were analyzed as follows:

- The filters (Sample Type 1) and any loose fragments were desiccated for 24 hours and weighed to the nearest 0.1 milligram to a constant (± 0.5 mg) weight.
- The front-half acetone wash samples (Sample Type 2) and an acetone blank were transferred to tared 250-ml beakers, and evaporated to dryness at ambient temperature and pressure. The samples were then be heated to 200-230 °F, desiccated at room temperature and weighed to a constant 0.1-mg weight. Final front-half wash residue weights were determined by correcting for the acetone blank factor.

The weight of the material collected on the glass fiber filter plus the residue weight of the acetone wash sample is the total catch weight used to calculate the particulate emission results.

5.4 CONTINUOUS MONITORING SAMPLING PROCEDURES

A Continuous Emissions Monitoring (CEM) system was used to measure carbon dioxide, oxygen, carbon monoxide, sulfur dioxide and oxides of nitrogen concentrations. Each CEM test run performed on the LFG outlet stack was a minimum of 60 minutes in duration. The CEM test runs with the exception of NO_x were run in conjunction with the EPA method 5 particulate testing. As stated earlier the NO_x test was conducted independently on February 18, 1999.

Each analyzer was set up and calibrated internally by introduction of calibration gas standards through a calibration manifold. The manifold vented the excess gas to the atmosphere to

maintain the calibration at ambient pressure. The direct calibration sequence consisted of alternate injections of zero and mid-range gases with appropriate adjustments made until the desired response was obtained. The high and low range standards were then be introduced in sequence without further adjustment.

An initial leak check of the sampling system was conducted by capping the sample probe and the end of the sample line attached to the analyzers and pulling a vacuum on the Teflon calibration line. The vacuum was monitored to check the leaks. The sample line integrity was verified by conducting pre- and post-test bias checks. The sampling system bias test consists of introducing the zero gas and one high range calibration standard to the stainless steel tee at the back-end the probe with the system operating normally. Calibration gas was supplied in excess and permitted flow out through the front-end of the probe to maintain sampling system pressure. Instrument bias check responses were compared to internal calibration responses thus verifying sample line integrity. All calibration gas standards were EPA Protocol One certified standards. Calibration gas certifications are presented in Appendix E.

The output of the CEM analyzers was recorded on a strip chart and digitized by a Molytek® datalogger. One-minute averages were recorded on an IBM compatible computer.

5.5 VOLATILE ORGANIC SAMPLING AND ANALYTICAL PROCEDURES – EPA METHOD 0030

The specific volatile organic compounds at the LFG flare outlet were determined by utilizing EPA Method 0030 sampling procedures. Each test run was comprised of four 20-minute sample periods. During each 20-minute sample period one VOST tube pair consisting of adsorption cartridges containing of Tenax and Tenax/charcoal was collected. Three of the VOST tube pairs were analyzed for each test run and the fourth pair was archived. The VOST tube pair samples were collected at a single point and at a constant rate of approximately 1 liter/minute. The complete VOST sampling train was leak checked before and after each test run by capping off the probe inlet, pulling a vacuum of 15 inches (mercury) and monitoring the leak rate. At the completion of each 20-minute sample period the VOST tube pairs were changed. Leak checks were performed before and after each VOST tube pair changeover by closing the inlet manifold, pulling a vacuum in excess of the maximum sampling vacuum encountered during sampling.

VOST probe temperature, dry gas meter temperature, and condenser exit temperatures, sample rate data, sample volumes and sample vacuum were recorded every 5 minutes on standardized field data sheets for the test runs. VOST sample recovery was conducted in the following manner:

- Each VOST tube pair sample collected was removed from the sample train, sealed with stainless steel caps, and placed in a glass transport receptacle with Teflon lined cap and labeled.
- At the completion of the test run the liquid from the condensate traps was collected and placed in a 40-ml glass VOA vials, sealed with Teflon lined caps and labeled.
- High purity liquid chromatography distilled water (HPLC) was used to rinse the VOST train components. The rinses were added to the VOA vial containing the condensate. There was sufficient quantity of the HPLC distilled water rinses to fill headspace in the VOA vial.
- One set of VOST tube pair field blanks, one set of VOST tube pair site blanks and a blank HPLC distilled water sample were collected and submitted for analysis along with the emission samples.
- Each VOST sample was clearly labeled and identified on a chain-of-custody record. The samples were maintained at 4°C temperature and transported to Air Toxics Analytical Laboratory located in Folsom, CA for analysis.

The VOST samples were analyzed according to EPA Method 5040 SW-846, third edition by procedures outlined in the test protocol. Each Tenax tube and Tenax/charcoal tube were analyzed in tandem.

The VOST tubes were heated and purged with organic-free helium to be thermally desorbed and transferred to a purge and trap system. Analysis was conducted by a quadruple GC/MS following analysis by Method 5041A/8260B procedures. The condensate samples were placed in a sparge vessel of the purge and trap (P&T) and analyzed in a similar manner. (Air Toxics Ltd. has incorporated modifications of the method into their SOP's. A description of the modifications may be provided upon request.)

5.6 SULFUR COMPOUNDS, METHANE, VOC, AND NMOC – CANISTER SAMPLING AND ANALYSIS PROCEDURES

Samples for sulfur compounds, methane, VOC and NMOC were collected by using EPA Method 25C, EPA Method TO-14 sampling technique utilizing pre-evacuated glass lined (Silco) Summa® canisters at the flare inlet location. The pre-evacuated canisters own vacuum was used to draw a constant rate sample (without a pump) through a critical flow orifice. The critical orifices were set for a constant rate 60-minute sample. At the conclusion of the sample period there was vacuum remaining which hindered condensation and aided in sample preservation. A vacuum gauge located on the Silco Summa® canister was used to monitor the canister vacuum during the test. At the completion of the test runs the Summa® canisters were shut off, capped, identified and documented on a chain-of-custody for transport to Air Toxics Analytical Laboratory located in Folsom, CA. The analysis was conducted as described in the following subsections.

5.6.1 Analysis of Oxygen, Nitrogen, Methane, Carbon Dioxide and NMOC by EPA Method 25C – Inlet and Outlet Sampling

A Hewlett-Packard 6890 gas chromatograph was specially modified by Wasson*ECE Instrumentation, Inc. (Fort Collins, CO) exclusively for 25C and 3C analyses. It is equipped with both flame-ionization (FID) and thermal-conductivity (TCD) detectors. The Silco Summa canisters were directly connected to the GC. Sample was withdrawn from the Summa canister by positive pressure. Ultra High Purity helium is used to pressurize the Summa canisters. Following sample injection, NMOC was separated from the permanent gases, oxidized to carbon dioxide, reduce to methane and finally measured using a FID. Carbon dioxide, methane, oxygen and nitrogen are measured simultaneously using the TCD. Triplicate NMOC analyses agreed within 5%.

5.6.2 Analysis of Volatile Organic Compounds in Summa™ Polished Canisters using Modified EPA Method TO-14 – Inlet Samples Only

EPA Method TO-14 analytical techniques are for the analysis of airborne VOC's in Summa canisters. One liter of air was withdrawn from the canister through a mass flow controller and cryofocused at -189°C in a dewar of liquid argon. The focused air sample was then flash heated through a hydrophobic drying system which removes water from the sample stream prior to

analysis by full scan GC/MS. The Air Toxics' interface used a proprietary drier, which removed moisture without affecting the recovery of polar compounds. Acceptable results were achieved for Surrogates and Internal Standards that were added to all samples, blanks and standards.

5.6.3 Analysis of Sulfur Compounds by Modified ASTM Method 5504 – Inlet and Outlet Sampling

An aliquot of whole air sample from either a Silco Summa canister was flushed through a 1.0-ml sample loop and loaded directly onto a chromatographic column. Analysis was carried out on a Hewlett-Packard 5980 Series II gas chromatograph equipped with a Restek RTX-1 column and a Sievers Sulfur Chemiluminescence Detector (SCD). The SCD has three characteristics which make it ideal for the analysis of trace level sulfur compounds in environmental samples: (1) Detector sensitivity is high-- single digit part-per-billion detection limits can be achieved without cryofocusing which simplifies the analysis and enhances both precision and accuracy. (2) Detector response is independent of sample matrix. High background levels of hydrocarbons (e.g., the presence of TPH) or halocarbons do not quench detector response. This makes it possible to accurately measure sulfur compounds in a complex matrix such as landfill gas. (3) The SCD has a linear range in excess of 10^5 . This eliminates the need to dilute those samples which have a number of target compounds present over a wide range of concentrations. Both "highs" and "lows" can often be obtained on a single run.

6. TEST RESULTS AND DISCUSSION

Many of the DRE's for the VOC, NMOC, sulfur compounds and methane are less than 98%. Inherent in the flare design there is a much smaller volumetric flowrate of the LFG flare stack inlet compared to the LFG gas volumetric flowrate exiting the flare stack.

This difference in flow-rate is due to the combustion of the methane and the influx of combustion and cooling air through the opening in the bottom of the stack. This dramatic difference between the LFG inlet and outlet volumetric flow-rates correlates to inlet and outlet mass rates that are on the same order of magnitude even though there is substantial difference between the concentrations. It should be noted that although the DRE's for many of the VOC's and sulfur compounds is less than 98% the mass rates are minimal.

LFG stack outlet benzene results for tube pair one and two are suspect. Examination of the benzene quantities shows a proportional decrease from Tube Pair 1 to Tube Pair 3. The elevated benzene quantities are potentially due to a sample train bias from contamination. Tube Pairs 1 and 2 were not included in the mass emission rate calculations.

The NMOC emission test data does not meet the 98% DRE because of the above aforementioned argumentation. Additionally, the NMOC LFG stack outlet concentration exceeds the 20 ppm/v as hexane corrected to 3% O₂ requirements of NSPS. This may be a result of analytical error from EPA Method 25C procedures. EPA Method 25C analytically is conducted by the following steps:

- All the CO₂ is removed from the sample. (The sample contains 4% or 40,000 ppm CO₂).
- The NMOC are oxidized to CO₂.
- The CO₂ is converted to CH₄.
- The CH₄ is measured on a GC/FID and is reported as NMOC.

The procedure will bias the NMOC results high if a small fraction of the CO₂ is not removed in the initial step. The CO₂ would convey into the other analytical steps and be reported as NMOC.

Some of the specific VOCs and sulfur compounds at the LFG inlet concentrations were not in significant quantities to accurately determine DREs when compared to LFG outlet emissions. There are significant quantities of methane in the LFG inlet gas stream for DRE determination however the LFG outlet emissions quantities approximately are 1500 ppm. (analytical detection limits). This LFG outlet detection limit concentration is substantial when determining the mass rates this effecting the DRE.

All tests sampling procedures met the reference method acceptance criteria. Mr. John Helmes of NYSDEC was present to observe the testing conducted on February 17, 1999.

A summary of emission test results is included in Tables 2-2 through 2-5 in section 2. Particulate detailed test data and test results are included in Tables 6-1. CEM (CO, SO₂, CO₂, and O₂) detailed test data and test results are provided in tables 6-2 through 6-4. NO_x detailed test data and test results are provided in Tables 6-5 through 6-7. Specific VOC's (EPA SW-846 Method 5040/5041 8260B list) detailed test data and test results for the LFG inlet and outlet are provided in Tables 6-8 through 6-11, respectively. Sulfur compound detailed test data and test results for the LFG inlet and outlet are provided in Tables 6-12 through 6-14.

Process operations data was recorded by WESTON representatives and is provided in Appendix A. Raw field data and computerized data input spreadsheets are provided in Appendix B. Analytical laboratory reports are provided in Appendix C. Example calculations are provided in Appendix D. Equipment calibration records and calibration gas certifications are provided in Appendix E. A list of WESTON project participants is provided in Appendix F.

TABLE 6-1
CLARKSTOWN LANDFILL
SUMMARY OF PARTICULATE TEST DATA AND TEST RESULTS

TEST DATA:			
Test run number	1	2	3
Location		FLARE STACK	
Test date	2/17/99	2/17/99	2/17/99
Test time period	1112-1248	1331-1511	1546-1724
SAMPLING DATA:			
Sampling duration, min.	72.0	72.0	72.0
Nozzle diameter, in.	0.800	0.800	0.800
Cross sectional nozzle area, sq. ft.	0.003491	0.003491	0.003491
Barometric pressure, in. Hg	30.07	30.04	29.98
Avg. orifice press. diff., in H ₂ O	1.17	0.92	0.90
Avg. dry gas meter temp., deg F	59.8	62.8	67.0
Avg. abs. dry gas meter temp., deg. R	520	523	527
Total liquid collected by train, ml	46.2	59.9	49.3
Std. vol. of H ₂ O vapor coll., cu. ft.	2.2	2.8	2.3
Dry gas meter calibration factor	1.0116	1.0116	1.0116
Sample vol. at meter cond., dcf	40.393	36.231	35.929
Sample vol. at std. cond., dscf (1)	41.815	37.231	36.557
Percent of isokinetic sampling	102.3	103.5	98.4
GAS STREAM COMPOSITION DATA:			
CO ₂ , % by volume, dry basis	4.8	4.5	4.5
O ₂ , % by volume, dry basis	15.6	16.0	15.0
N ₂ , % by volume, dry basis	79.6	79.5	80.5
Molecular wt. of dry gas, lb/lb mole	29.39	29.36	29.32
H ₂ O vapor in gas stream, prop. by vol.	0.049	0.070	0.060
Mole fraction of dry gas	0.951	0.930	0.940
Molecular wt. of wet gas, lb/lb mole	28.83	28.56	28.64
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:			
Static pressure, in. H ₂ O	-0.04	-0.04	-0.04
Absolute pressure, in. Hg	30.07	30.04	29.98
Avg. temperature, deg. F	1094	1099	1076
Avg. absolute temperature, deg.R	1554	1559	1536
Pitot tube coefficient	0.84	0.84	0.84
Total number of traverse points	24	24	24
Avg. gas stream velocity, ft./sec.	8.4	7.6	7.6
Stack/duct cross sectional area, sq.ft.	69.644	69.644	69.644
Avg. gas stream volumetric flow, wacf/min.	34929	31565	31808
Avg. gas stream volumetric flow, dscf/min.	11335	9973	10295
PARTICULATE LABORATORY REPORT DATA			
Front half acetone rinse, g	0.0012	0.0022	0.0027
Filter, g	0.0009	0.0006	0.0005
Total catch, g	0.0021	0.0028	0.0032
PARTICULATE EMISSIONS			
Conc., gr/dscf	0.0008	0.0012	0.0014
Emission rate, lbs/hr	0.08	0.10	0.12

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 inches Hg (760mm Hg).

TABLE 6-2
CLARKSTOWN LANDFILL, NY
FLARE STACK
CONTINUOUS EMISSION MONITORING TEST DATA AND TEST RESULTS
TEST DATE: 17-FEB-99
TIME PERIOD: 1112-1212

TEST RUN 1

DATE	TIME	CO ₂ (%)	O ₂ (%)	SO ₂ (ppm)	CO (ppm)
17 Feb 99	11:12	4.8	15.8	1.1	17.5
17 Feb 99	11:13	4.8	15.9	1.1	17.5
17 Feb 99	11:14	5.2	15.2	1.2	13.2
17 Feb 99	11:15	4.7	15.9	1.1	16.8
17 Feb 99	11:16	4.8	15.8	1.2	15.1
17 Feb 99	11:17	5.0	15.7	1.2	11.3
17 Feb 99	11:18	5.8	14.6	1.2	10.8
17 Feb 99	11:19	5.5	14.6	1.3	12.5
17 Feb 99	11:20	4.7	16.0	1.3	15.1
17 Feb 99	11:21	5.2	15.2	1.3	13.7
17 Feb 99	11:22	4.8	15.7	1.4	17.5
17 Feb 99	11:23	5.0	15.6	1.4	17.5
17 Feb 99	11:24	5.0	15.6	1.5	16.0
17 Feb 99	11:25	5.5	15.0	1.6	16.9
17 Feb 99	11:26	5.3	14.9	1.7	15.7
17 Feb 99	11:27	4.8	15.7	1.6	15.5
17 Feb 99	11:28	4.9	15.7	1.6	15.6
17 Feb 99	11:29	4.9	15.6	1.7	14.6
17 Feb 99	11:30	4.7	15.8	1.6	15.5
17 Feb 99	11:31	4.7	15.8	1.6	14.4
17 Feb 99	11:32	5.0	15.6	1.7	18.2
17 Feb 99	11:33	5.2	15.2	1.8	16.8
17 Feb 99	11:34	5.5	15.0	1.9	15.9
17 Feb 99	11:35	5.3	15.1	1.9	15.0
17 Feb 99	11:36	5.1	15.3	1.8	16.4
17 Feb 99	11:37	5.2	15.3	1.9	17.0
17 Feb 99	11:38	5.1	15.2	1.8	15.0
17 Feb 99	11:39	4.8	15.7	1.8	14.9
17 Feb 99	11:40	5.0	15.4	1.9	17.0
17 Feb 99	11:41	4.9	15.6	1.8	17.0
17 Feb 99	11:42	4.9	15.7	1.9	17.3
17 Feb 99	11:43	5.0	15.5	1.9	17.0
17 Feb 99	11:44	4.9	15.5	1.8	17.2
17 Feb 99	11:45	5.3	15.2	1.9	17.8
17 Feb 99	11:46	5.1	15.3	1.9	15.7
17 Feb 99	11:47	5.0	15.4	1.9	16.7
17 Feb 99	11:48	4.7	15.8	1.8	14.2
17 Feb 99	11:49	4.9	15.6	1.9	15.3
17 Feb 99	11:50	4.6	15.9	1.8	13.7
17 Feb 99	11:51	4.8	15.7	1.9	15.4
17 Feb 99	11:52	5.2	15.3	1.9	16.6
17 Feb 99	11:53	5.0	15.4	1.9	16.3
17 Feb 99	11:54	4.4	15.9	1.8	17.3
17 Feb 99	11:55	4.4	16.3	1.7	19.0
17 Feb 99	11:56	5.0	15.6	1.9	19.2
17 Feb 99	11:57	4.9	15.5	1.9	16.9
17 Feb 99	11:58	4.9	15.5	1.8	14.8
17 Feb 99	11:59	4.8	15.6	1.8	15.4
17 Feb 99	12:00	4.8	15.8	1.7	17.1
17 Feb 99	12:01	4.8	15.7	1.8	17.3
17 Feb 99	12:02	4.9	15.7	1.8	15.0
17 Feb 99	12:03	4.6	15.8	1.8	15.3
17 Feb 99	12:04	4.8	15.6	1.8	17.4
17 Feb 99	12:05	4.7	15.9	1.8	18.6
17 Feb 99	12:06	4.4	16.0	1.8	19.3
17 Feb 99	12:07	5.2	15.3	2.0	17.5
17 Feb 99	12:08	5.1	15.3	2.0	16.9
17 Feb 99	12:09	4.6	15.9	1.9	18.7
17 Feb 99	12:10	5.1	15.4	2.0	19.5
17 Feb 99	12:11	4.7	15.7	1.8	20.9
17 Feb 99	12:12	4.7	15.7	1.9	21.9
AVERAGE		4.9	15.5	1.7	16.3
BIAS ZERO		0.1	0.1	0.2	0.2
BIAS STANDARD		8.1	14.0	38.8	25.0
STANDARD VALUE		7.95	14.07	40.80	25.17
CORRECTED AVERAGE (DRY)		4.8	15.6	1.6	16.4
VOLUMETRIC FLOW (dscfm)		11335			
MASS RATE (lbs/hr)				0.18	0.81

TABLE 6-3
CLARKSTOWN LANDFILL, NY
FLARE STACK
CONTINUOUS EMISSION MONITORING TEST DATA AND TEST RESULTS
TEST DATE: 17-FEB-99
TIME PERIOD: 1405-1511

TEST RUN 2						
DATE	TIME	CO ₂ (%)	O ₂ (%)	SO ₂ (ppm)	CO (ppm)	
17 Feb 99	14:05	4.1	15.9	2.9	19.4	
17 Feb 99	14:06	4.6	15.7	1.5	18.4	
17 Feb 99	14:07	4.6	15.6	1.0	18.3	
17 Feb 99	14:08	4.7	15.8	0.8	18.1	
17 Feb 99	14:09	4.8	15.7	0.7	17.6	
17 Feb 99	14:10	5.0	15.3	0.7	18.7	
17 Feb 99	14:11	5.0	15.6	0.7	18.7	
17 Feb 99	14:12	5.4	14.9	0.6	13.4	
17 Feb 99	14:13	4.9	15.7	0.6	17.9	
17 Feb 99	14:14	4.8	15.7	0.6	19.7	
17 Feb 99	14:15	4.9	15.6	0.6	17.5	
17 Feb 99	14:16	5.0	15.6	0.5	17.1	
17 Feb 99	14:17	4.8	15.5	0.6	19.4	
17 Feb 99	14:18	5.3	15.2	0.5	18.2	
17 Feb 99	14:19	4.7	15.8	0.5	17.4	
17 Feb 99	14:20	5.4	14.9	0.6	13.9	
17 Feb 99	14:21	5.1	15.4	0.5	18.5	
17 Feb 99	14:22	4.5	16.0	0.5	19.2	
17 Feb 99	14:23	5.4	15.1	0.6	15.7	
17 Feb 99	14:24	4.6	15.8	0.6	16.5	
17 Feb 99	14:25	5.0	15.6	0.7	17.7	
17 Feb 99	14:26	4.6	15.9	0.6	16.6	
17 Feb 99	14:27	4.5	15.9	0.6	17.1	
17 Feb 99	14:28	4.1	16.6	0.5	18.6	
17 Feb 99	14:29	4.5	16.1	0.7	18.7	
17 Feb 99	14:30	4.9	15.3	0.8	20.8	
17 Feb 99	14:31	4.8	15.7	0.7	18.0	
17 Feb 99	14:32	4.6	16.0	0.8	17.9	
17 Feb 99	14:33	4.4	15.9	0.8	18.6	
17 Feb 99	14:34	4.5	16.0	0.8	19.1	
17 Feb 99	14:35	4.8	15.8	0.9	18.3	
17 Feb 99	14:36	5.8	14.4	1.1	10.8	
17 Feb 99	14:37	4.6	15.9	1.1	17.5	
17 Feb 99	14:38	5.5	15.0	1.2	17.5	
17 Feb 99	14:39	5.1	15.1	1.3	10.6	
17 Feb 99	14:40	4.7	16.0	1.2	19.7	
17 Feb 99	14:41	4.3	16.0	1.3	20.6	
17 Feb 99	14:42	5.3	15.4	1.4	14.6	
17 Feb 99	14:43	4.7	15.5	1.5	15.7	
17 Feb 99	14:44	4.9	15.6	1.5	19.7	moved cem probe
17 Feb 99	14:48	4.1	16.1	1.3	18.0	
17 Feb 99	14:49	4.4	16.0	1.4	17.9	
17 Feb 99	14:50	4.7	15.4	1.6	15.9	
17 Feb 99	14:51	4.2	16.2	1.5	18.0	
17 Feb 99	14:52	4.3	16.3	1.4	17.9	
17 Feb 99	14:53	5.1	15.3	1.7	17.9	
17 Feb 99	14:54	5.0	15.3	1.7	17.1	
17 Feb 99	14:55	5.0	15.4	1.7	14.6	
17 Feb 99	14:56	4.6	15.8	1.7	15.4	
17 Feb 99	14:57	5.1	15.3	1.8	15.2	
17 Feb 99	14:58	5.0	15.5	1.9	16.4	
17 Feb 99	14:59	5.1	15.3	1.9	16.0	
17 Feb 99	15:00	5.5	14.9	1.9	15.8	
17 Feb 99	15:01	4.9	15.3	2.0	16.6	
17 Feb 99	15:02	4.2	16.4	1.8	17.0	
17 Feb 99	15:03	5.1	15.6	2.0	17.1	
17 Feb 99	15:04	4.5	15.7	2.0	15.8	
17 Feb 99	15:05	4.5	16.1	1.8	17.5	
17 Feb 99	15:06	4.2	16.2	1.8	17.5	
17 Feb 99	15:07	4.3	16.1	1.9	17.7	
17 Feb 99	15:08	4.3	16.2	1.9	17.0	
17 Feb 99	15:09	5.1	15.1	2.1	12.6	
17 Feb 99	15:10	4.7	15.9	2.0	16.4	
17 Feb 99	15:11	4.3	16.0	2.0	16.7	
AVERAGE		4.8	15.7	1.2	17.2	
BIAS ZERO		0.2	0.1	0.2	0.2	
BIAS STANDARD		8.0	14.0	39.6	24.9	
STANDARD VALUE		7.95	14.07	40.80	25.17	
CORRECTED AVERAGE (DRY)		4.7	15.8	1.1	17.3	
VOLUMETRIC FLOW (dscfm)		9973				
MASS RATE (lbs/hr)				0.10	0.75	

TABLE 6-4
CLARKSTOWN LANDFILL, NY
FLARE STACK
CONTINUOUS EMISSION MONITORING TEST DATA AND TEST RESULTS
TEST DATE: 17-FEB-99
TIME PERIOD: 1537-1637

TEST RUN 3						
DATE	TIME	CO ₂ (%)	O ₂ (%)	SO ₂ (ppm)	CO (ppm)	
17 Feb 99	15:37	4.6	16.1	2.2	17.8	
17 Feb 99	15:38	5.1	15.3	2.4	15.6	
17 Feb 99	15:39	5.1	15.2	2.4	15.0	
17 Feb 99	15:40	5.7	14.9	2.5	13.6	
17 Feb 99	15:41	4.7	15.3	2.4	11.9	
17 Feb 99	15:42	5.6	14.9	2.5	12.0	
17 Feb 99	15:43	4.3	16.1	2.2	16.4	
17 Feb 99	15:44	4.5	16.0	2.2	17.2	
17 Feb 99	15:45	5.4	15.0	2.5	11.3	
17 Feb 99	15:46	4.3	16.2	2.3	15.6	
17 Feb 99	15:47	4.6	15.7	2.4	15.6	
17 Feb 99	15:48	4.4	16.2	2.3	17.4	
17 Feb 99	15:49	5.0	15.3	2.6	15.6	
17 Feb 99	15:50	4.5	15.7	2.5	16.2	
17 Feb 99	15:51	5.1	15.6	2.5	17.3	
17 Feb 99	15:52	5.5	14.6	2.8	10.8	
17 Feb 99	15:53	5.0	15.5	2.5	16.6	
17 Feb 99	15:54	4.6	15.7	2.5	17.2	
17 Feb 99	15:55	4.2	16.3	2.4	18.0	
17 Feb 99	15:56	4.4	16.0	2.5	18.1	
17 Feb 99	15:57	4.6	15.9	2.5	18.4	
17 Feb 99	15:58	4.5	16.0	2.5	17.1	
17 Feb 99	15:59	4.6	15.6	2.7	16.1	
17 Feb 99	16:00	4.5	16.0	2.5	17.5	
17 Feb 99	16:01	4.0	16.4	2.4	17.7	
17 Feb 99	16:02	4.5	16.1	2.5	17.3	
17 Feb 99	16:03	4.9	15.3	3.0	15.2	
17 Feb 99	16:04	4.2	15.0	2.6	16.9	
17 Feb 99	16:05	4.1	16.3	2.5	16.8	
17 Feb 99	16:06	4.3	16.1	2.6	16.5	
17 Feb 99	16:07	4.3	16.0	2.7	17.0	
17 Feb 99	16:08	4.3	16.0	2.7	15.3	
17 Feb 99	16:09	4.8	15.3	2.8	15.7	
17 Feb 99	16:10	4.6	15.3	2.7	17.7	
17 Feb 99	16:11	4.4	15.9	2.7	16.5	
17 Feb 99	16:12	4.3	15.9	2.6	13.8	
17 Feb 99	16:13	4.1	16.4	2.5	17.0	
17 Feb 99	16:14	4.4	16.2	2.5	16.6	
17 Feb 99	16:15	4.2	16.0	2.7	14.4	
17 Feb 99	16:16	4.4	16.1	2.6	16.4	
17 Feb 99	16:17	4.2	16.2	2.6	17.2	
17 Feb 99	16:18	4.0	16.4	2.5	17.3	
17 Feb 99	16:19	4.5	15.9	2.6	17.0	
17 Feb 99	16:20	4.3	15.6	2.8	14.5	
17 Feb 99	16:21	4.0	16.0	2.4	19.1	
17 Feb 99	16:22	4.7	15.2	2.8	14.2	
17 Feb 99	16:23	4.0	16.4	2.5	18.0	
17 Feb 99	16:24	4.9	15.4	2.8	14.8	
17 Feb 99	16:25	4.9	15.4	2.7	14.3	
17 Feb 99	16:26	4.2	15.9	2.7	12.9	
17 Feb 99	16:27	4.0	16.5	2.4	14.7	
17 Feb 99	16:28	4.0	16.5	2.4	14.7	
17 Feb 99	16:29	4.5	15.6	2.7	16.3	
17 Feb 99	16:30	4.2	16.2	2.6	15.5	
17 Feb 99	16:31	4.1	16.4	2.6	15.6	
17 Feb 99	16:32	4.3	16.4	2.6	17.0	
17 Feb 99	16:33	4.6	15.6	2.9	17.2	
17 Feb 99	16:34	4.7	16.0	2.8	17.5	
17 Feb 99	16:35	4.7	15.4	2.9	13.3	
17 Feb 99	16:36	4.3	16.2	2.6	17.3	
17 Feb 99	16:37	4.3	16.2	2.7	17.2	
AVERAGE		4.5	15.8	2.6	16.0	
BIAS ZERO		0.15	0.05	0.3	0.15	
BIAS STANDARD		7.95	13.9	40.0	24.8	
STANDARD VALUE		7.95	14.07	25.17	25.17	
CORRECTED AVERAGE (DRY)		4.5	16.0	1.4	16.2	
VOLUMETRIC FLOW (dscfm)		10295				
MASS RATE (lbs/hr)				0.15	0.73	

TABLE 6-5
CLARKSTOWN LANDFILL, NY
FLARE STACK
OXIDES OF NITROGEN TEST DATA AND TEST RESULTS
TEST DATE: 18-FEB-99
TIME PERIOD: 937-1037

RUN 1

	DATE	TIME	CO ₂ (%)	O ₂ (%)	NO _x (ppm)	
18	Feb	99	9:37	5.4	14.5	13.7
18	Feb	99	9:38	4.5	15.2	13.4
18	Feb	99	9:39	4.4	15.6	11.9
18	Feb	99	9:40	4.4	15.6	12.0
18	Feb	99	9:41	4.5	15.6	12.1
18	Feb	99	9:42	4.8	15.4	12.4
18	Feb	99	9:43	4.7	15.3	12.7
18	Feb	99	9:44	4.4	15.7	11.5
18	Feb	99	9:45	4.6	15.5	12.1
18	Feb	99	9:46	4.9	15.2	12.7
18	Feb	99	9:47	4.4	15.6	12.2
18	Feb	99	9:48	4.8	15.3	12.8
18	Feb	99	9:49	4.5	15.5	13.1
18	Feb	99	9:50	4.6	15.7	11.6
18	Feb	99	9:51	4.7	15.3	12.6
18	Feb	99	9:52	4.5	15.5	12.0
18	Feb	99	9:53	4.3	15.8	11.1
18	Feb	99	9:54	4.5	15.7	11.5
18	Feb	99	9:55	4.7	15.4	12.4
18	Feb	99	9:56	4.8	15.2	13.1
18	Feb	99	9:57	4.6	15.5	12.4
18	Feb	99	9:58	4.7	15.4	12.4
18	Feb	99	9:59	4.7	15.4	12.3
18	Feb	99	10:00	4.7	15.3	12.9
18	Feb	99	10:01	4.8	15.3	12.5
18	Feb	99	10:02	4.9	15.1	13.0
18	Feb	99	10:03	4.8	15.2	13.1
18	Feb	99	10:04	4.6	15.5	12.2
18	Feb	99	10:05	4.7	15.4	12.3
18	Feb	99	10:06	4.7	15.4	12.1
18	Feb	99	10:07	4.9	15.2	12.9
18	Feb	99	10:08	4.6	15.5	12.1
18	Feb	99	10:09	4.5	15.5	12.1
18	Feb	99	10:10	4.7	15.4	12.1
18	Feb	99	10:11	4.7	15.5	11.9
18	Feb	99	10:12	4.7	15.3	12.4
18	Feb	99	10:13	4.6	15.5	11.9
18	Feb	99	10:14	4.6	15.5	11.8
18	Feb	99	10:15	4.6	15.5	11.8
18	Feb	99	10:16	4.9	15.2	12.8
18	Feb	99	10:17	4.7	15.3	12.7
18	Feb	99	10:18	4.7	15.4	12.0
18	Feb	99	10:19	4.9	15.2	12.7
18	Feb	99	10:20	4.9	15.2	12.9
18	Feb	99	10:21	4.8	15.3	12.5
18	Feb	99	10:22	4.7	15.3	12.4
18	Feb	99	10:23	4.8	15.3	12.3
18	Feb	99	10:24	4.9	15.1	13.0
18	Feb	99	10:25	4.8	15.3	12.2
18	Feb	99	10:26	4.8	15.3	12.5
18	Feb	99	10:27	5.2	14.9	13.4
18	Feb	99	10:28	5.4	14.5	15.5
18	Feb	99	10:29	4.9	15.1	13.5
18	Feb	99	10:30	5.0	15.1	13.0
18	Feb	99	10:31	4.7	15.3	12.7
18	Feb	99	10:32	4.6	15.5	11.7
18	Feb	99	10:33	4.8	15.3	12.5
18	Feb	99	10:34	4.8	15.3	12.5
18	Feb	99	10:35	4.9	15.2	12.7
18	Feb	99	10:36	4.7	15.3	12.5
18	Feb	99	10:37	4.7	15.4	12.1
AVERAGE			4.7	15.3	12.5	
BIAS ZERO			0.2	0.1	0.1	
BIAS STANDARD			8.0	13.9	25.6	
STANDARD VALUE			7.95	14.07	25.76	
CORRECTED AVERAGE (DRY)			4.7	15.5	12.5	
VOLUMETRIC FLOW (dscfm)			11071			
MASS RATE (lbs/hr)					0.99	

TABLE 6-6
CLARKSTOWN LANDFILL, NY
FLARE STACK
OXIDES OF NITROGEN TEST DATA AND TEST RESULTS
TEST DATE: 18-FEB-99
TIME PERIOD: 1048-1148

RUN 2					
DATE	TIME	CO ₂ (%)	O ₂ (%)	NO _x (ppm)	
18 Feb 99	10:48	4.5	15.4	10.9	
18 Feb 99	10:49	4.6	15.4	11.2	
18 Feb 99	10:50	4.8	15.1	12.4	
18 Feb 99	10:51	4.7	15.3	12.0	
18 Feb 99	10:52	4.6	15.4	12.1	
18 Feb 99	10:53	4.7	15.4	11.8	
18 Feb 99	10:54	4.6	15.5	11.7	
18 Feb 99	10:55	4.7	15.4	11.8	
18 Feb 99	10:56	4.5	15.5	11.8	
18 Feb 99	10:57	4.7	15.5	11.3	
18 Feb 99	10:58	5.0	15.0	12.8	
18 Feb 99	10:59	4.8	15.2	12.9	
18 Feb 99	11:00	5.1	15.0	13.0	
18 Feb 99	11:01	4.7	15.2	13.1	
18 Feb 99	11:02	5.0	15.1	13.0	
18 Feb 99	11:03	4.9	15.0	13.4	
18 Feb 99	11:04	4.7	15.4	12.2	
18 Feb 99	11:05	4.6	15.4	12.3	
18 Feb 99	11:06	4.5	15.6	11.8	
18 Feb 99	11:07	4.6	15.4	12.0	
18 Feb 99	11:08	4.5	15.6	11.5	
18 Feb 99	11:09	4.6	15.5	11.8	
18 Feb 99	11:10	4.7	15.3	12.2	
18 Feb 99	11:11	4.7	15.4	12.0	
18 Feb 99	11:12	4.7	15.3	12.4	
18 Feb 99	11:13	4.5	15.5	11.9	
18 Feb 99	11:14	5.0	15.0	12.9	
18 Feb 99	11:15	4.4	15.6	11.7	
18 Feb 99	11:16	4.5	15.6	11.3	
18 Feb 99	11:17	4.5	15.5	11.3	
18 Feb 99	11:18	4.6	15.5	11.8	
18 Feb 99	11:19	4.9	15.1	12.8	
18 Feb 99	11:20	4.5	15.5	12.2	
18 Feb 99	11:21	5.4	14.8	13.6	
18 Feb 99	11:22	4.8	14.8	15.1	
18 Feb 99	11:23	4.8	15.3	12.3	
18 Feb 99	11:24	5.1	14.9	13.8	
18 Feb 99	11:25	5.6	14.3	15.3	
18 Feb 99	11:26	5.3	14.4	16.6	
18 Feb 99	11:27	5.2	14.9	13.8	
18 Feb 99	11:28	5.4	14.4	16.0	
18 Feb 99	11:29	4.6	15.5	12.2	
18 Feb 99	11:30	5.5	14.4	15.2	
18 Feb 99	11:31	4.6	15.4	12.8	
18 Feb 99	11:32	4.7	15.4	12.3	
18 Feb 99	11:33	5.4	14.6	14.2	
18 Feb 99	11:34	4.8	14.9	14.7	
18 Feb 99	11:35	4.3	15.8	11.4	
18 Feb 99	11:36	4.6	15.5	11.8	
18 Feb 99	11:37	4.7	15.3	12.6	
18 Feb 99	11:38	4.4	15.7	11.6	
18 Feb 99	11:39	5.4	14.7	14.0	
18 Feb 99	11:40	5.2	14.4	16.1	
18 Feb 99	11:41	4.9	15.2	13.3	
18 Feb 99	11:42	5.1	14.9	13.8	
18 Feb 99	11:43	4.5	15.5	12.5	
18 Feb 99	11:44	4.8	15.4	12.3	
18 Feb 99	11:45	5.2	14.8	14.2	
18 Feb 99	11:46	5.3	14.5	15.0	
18 Feb 99	11:47	4.8	15.2	13.3	
18 Feb 99	11:48	4.5	15.6	11.9	
AVERAGE		4.8	15.2	12.8	
BIAS ZERO		0.3	0.1	0.3	
BIAS STANDARD		8.0	13.9	25.5	
STANDARD VALUE		7.95	14.07	25.76	
CORRECTED AVERAGE (DRY)		4.7	15.4	12.8	
VOLUMETRIC FLOW (dscfm)		10910			
MASS RATE (lbs/hr)				1.00	

TABLE 6-7
CLARKSTOWN LANDFILL, NY
FLARE STACK
OXIDES OF NITROGEN TEST DATA AND TEST RESULTS
TEST DATE: 18-FEB-99
TIME PERIOD: 1200-1300

RUN 3

DATE	TIME	CO ₂ (%)	O ₂ (%)	NO _x (ppm)
18 Feb 99	12:00	4.8	15.8	13.7
18 Feb 99	12:01	4.8	15.7	13.4
18 Feb 99	12:02	4.9	15.7	11.9
18 Feb 99	12:03	4.6	15.8	12.0
18 Feb 99	12:04	4.8	15.6	12.1
18 Feb 99	12:05	4.7	15.9	12.4
18 Feb 99	12:06	4.4	16.0	12.7
18 Feb 99	12:07	5.2	15.3	11.5
18 Feb 99	12:08	5.1	15.3	12.1
18 Feb 99	12:09	4.6	15.9	12.7
18 Feb 99	12:10	5.1	15.4	12.2
18 Feb 99	12:11	4.7	15.7	12.8
18 Feb 99	12:12	4.7	15.7	13.1
18 Feb 99	12:13	4.7	15.8	11.6
18 Feb 99	12:14	4.8	15.6	12.6
18 Feb 99	12:15	4.7	15.9	12.0
18 Feb 99	12:16	4.6	15.9	11.1
18 Feb 99	12:17	4.8	15.7	11.5
18 Feb 99	12:18	4.6	15.8	12.4
18 Feb 99	12:19	4.5	16.1	13.1
18 Feb 99	12:20	4.4	15.7	12.4
18 Feb 99	12:21	4.6	15.5	12.4
18 Feb 99	12:22	4.9	15.2	12.3
18 Feb 99	12:23	4.4	15.6	12.9
18 Feb 99	12:24	4.8	15.3	12.5
18 Feb 99	12:25	4.5	15.5	13.0
18 Feb 99	12:26	4.6	15.7	13.1
18 Feb 99	12:27	4.7	15.3	12.2
18 Feb 99	12:28	4.5	15.5	12.3
18 Feb 99	12:29	4.3	15.8	12.1
18 Feb 99	12:30	4.5	15.7	12.9
18 Feb 99	12:31	4.7	15.4	12.1
18 Feb 99	12:32	4.8	15.2	12.1
18 Feb 99	12:33	4.6	15.5	12.1
18 Feb 99	12:34	5.4	14.6	11.9
18 Feb 99	12:35	4.8	14.9	12.4
18 Feb 99	12:36	4.3	15.8	11.9
18 Feb 99	12:37	4.6	15.5	11.8
18 Feb 99	12:38	4.7	15.3	11.8
18 Feb 99	12:39	4.4	15.7	12.8
18 Feb 99	12:40	5.2	15.3	12.7
18 Feb 99	12:41	5.1	15.3	12.0
18 Feb 99	12:42	4.6	15.9	12.7
18 Feb 99	12:43	4.8	15.7	12.9
18 Feb 99	12:44	4.9	15.7	12.5
18 Feb 99	12:45	4.5	15.5	12.4
18 Feb 99	12:46	4.5	15.7	12.3
18 Feb 99	12:47	4.6	15.5	13.0
18 Feb 99	12:48	4.5	16.1	12.2
18 Feb 99	12:49	4.4	15.7	12.5
18 Feb 99	12:50	5.2	15.3	13.4
18 Feb 99	12:51	5.1	15.3	15.5
18 Feb 99	12:52	4.6	15.9	13.5
18 Feb 99	12:53	4.5	15.7	13.0
18 Feb 99	12:54	4.3	15.8	12.7
18 Feb 99	12:55	4.6	15.5	11.7
18 Feb 99	12:56	4.5	15.6	12.5
18 Feb 99	12:57	4.8	15.4	12.5
18 Feb 99	12:58	4.7	15.3	12.7
18 Feb 99	12:59	4.4	15.7	12.5
18 Feb 99	13:00	4.3	15.8	12.1

AVERAGE	4.7	15.6	12.5
BIAS ZERO	0.3	0.1	0.3
BIAS STANDARD	8.0	13.8	25.7
STANDARD VALUE	7.95	14.07	25.76
CORRECTED AVERAGE (DRY)	4.5	15.9	12.4
VOLUMETRIC FLOW (dscfm)	10583		
MASS RATE (lbs/hr)			0.94

TABLE 6-8
CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK INLET
SUMMARY OF VOLATILE ORGANIC COMPOUNDS TEST DATA AND TEST RESULTS

TEST DATA:

	1	2	3
Test run number	FLARE STACK INLET	FLARE STACK INLET	FLARE STACK INLET
Test location			
Test date	02-17-99	02-17-99	02-17-99
Test time	1116-1216	1331-1431	1546-1646

VOST EMISSIONS (lbs/hr):

Chloromethane	< 4.97E-05	< 3.64E-05	< 4.56E-05
Vinyl chloride	2.24E-03	1.90E-03	< 5.70E-05
Bromomethane	< 9.30E-05	< 6.65E-05	< 8.64E-05
Chloroethane	3.53E-04	5.39E-04	5.70E-04
Freon 11	< 1.33E-04	1.28E-04	1.43E-04
1,1-Dichloroethene	< 9.46E-05	< 6.81E-05	< 8.80E-05
Carbon disulfide	< 2.89E-04	< 2.22E-04	< 2.77E-04
Acetone	5.77E-04	5.23E-04	5.70E-04
Methylene chloride	< 8.34E-05	< 6.02E-05	< 7.66E-05
trans-1,2-Dichloroethene	< 3.85E-04	< 2.69E-04	< 3.58E-04
1,1-Dichloroethane	< 9.62E-05	1.58E-04	< 8.80E-05
Vinyl acetate	< 3.37E-04	< 2.38E-04	< 3.10E-04
2-Butanone	3.05E-04	5.39E-04	6.52E-04
Chloroform	< 1.15E-04	< 8.40E-05	< 1.09E-04
1,1,1-Trichloroethane	< 1.30E-04	< 9.51E-05	< 1.21E-04
Carbon tetrachloride	< 1.49E-04	< 1.09E-04	< 1.40E-04
Benzene	9.14E-04	1.52E-03	1.79E-03
1,2 Dichloroethane	< 9.62E-05	< 6.97E-05	< 8.96E-05
Trichloroethene	3.05E-04	4.44E-04	5.21E-04
1,2-Dichloropropane	< 1.11E-04	< 7.92E-05	< 1.03E-04
Bromodichloromethane	< 6.41E-04	< 4.59E-04	< 6.03E-04
trans-1,3-Dichloropropene	< 1.07E-04	< 7.92E-05	< 1.01E-04
4-Methyl-2-pentanone	< 3.85E-04	< 2.85E-04	< 3.58E-04
Toluene	5.77E-03	1.03E-02	1.17E-02
cis 1,3 Dichloropropene	< 1.07E-04	< 7.92E-05	< 1.01E-04
1,1,2-Trichloroethane	< 1.30E-04	< 9.51E-05	< 1.21E-04
Tetrachloroethene	< 1.60E-04	2.38E-04	2.77E-04
2-Hexanone	< 3.85E-04	< 2.85E-04	< 3.58E-04
Dibromochloromethane	< 8.18E-04	< 5.86E-04	< 7.50E-04
Chlorobenzene	2.08E-03	3.64E-03	4.07E-03
Ethylbenzene	7.54E-03	1.28E-02	1.43E-02
m-/p-Xylene	8.66E-03	1.54E-02	1.79E-02
o-Xylene	4.33E-03	7.76E-03	8.80E-03
Styrene	3.21E-04	6.18E-04	7.17E-04
Bromoform	< 9.78E-04	< 7.13E-04	< 9.12E-04
1,1,2,2-Tetrachloroethane	< 1.60E-04	< 1.19E-04	< 1.53E-04
1,3-Dichlorobenzene	< 1.43E-04	1.11E-04	1.42E-04
1,4-Dichlorobenzene	4.65E-03	8.56E-03	1.01E-02
1,2-Dichlorobenzene	3.85E-04	6.02E-04	7.01E-04
Total Organics (2)	3.84E-02	6.58E-02	7.31E-02
NMOC as hexane	8.41E-01	9.44E-01	9.71E-01
Methane	4.90E+01	5.06E+01	5.20E+01

< = detection limit value.

(1) Test run averages include full detection limit values.

(2) Total Organics is a summation of all the detected quantities in the target compound list.

CLARKSTOWN LANDFILL CLARKSTOWN NY
FLARE STACK OUTLET-RUN 1

SUMMARY OF VOLATILE ORGANIC COMPOUNDS TEST DATA AND TEST RESULTS

TEST DATA:

Test run number
Test location
Test date
Test time
Test tube pair

FLARE STACK
02-17-99
1112-1133
1
FLARE STACK
02-17-99
1143-1203
2
FLARE STACK
02-17-99
1212-1232
3
FLARE STACK
02-17-99
1112-1258
AVERAGE (1)
FLARE STACK INLET
02-17-99
1116-1216
canister
FLARE STACK
02-17-99
1112-1258
%DRE

VOST EMISSIONS (lb/hr):

Chloromethane	3.98E-05	5.72E-05	< 2.25E-05	3.98E-05	< 4.97E-05	19.8695
Vinyl chloride	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	2.24E-03	99.0438
Bromomethane	5.57E-05	6.60E-05	< 2.25E-05	4.81E-05	< 9.30E-05	48.3160
Chloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	3.53E-04	93.9148
Freon 11	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.33E-04	83.8706
1,1-Dichloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 9.46E-05	77.3095
Carbon disulfide	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 2.89E-04	92.5625
Acetone	5.57E-04	1.72E-04	1.53E-04	2.94E-04	5.77E-04	49.1043
Methyl ethyl ketone	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 3.34E-05	74.2550
trans-1,2-Dichloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 3.85E-04	94.4219
1,1-Dichloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 9.62E-05	77.6876
Vinyl acetate	< 9.46E-05	< 1.10E-04	< 1.13E-04	1.07E-04	< 3.37E-04	68.1252
2-Butanone	< 9.46E-05	< 1.10E-04	< 1.13E-04	1.07E-04	< 3.05E-04	64.7700
Chloroform	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.15E-04	81.4064
1,1,1-Trichloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.30E-04	83.4723
Carbon tetrachloride	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.49E-04	85.8049
Benzene	1.99E-02	1.45E-03	5.18E-04	5.18E-04 (2)	9.14E-04	43.3537
1,2-Dichloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 9.62E-05	77.6876
Trichloroethene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	3.05E-04	92.9540
1,2-Dichloropropane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.11E-04	80.5979
Bromodichloromethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 6.41E-04	96.6531
trans-1,3-Dichloropropene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.07E-04	80.0188
4-Methyl-2-pentanone	< 9.46E-05	< 1.10E-04	< 1.13E-04	1.07E-04	< 3.85E-04	72.1095
Toluene	1.31E-03	7.70E-05	3.43E-05	4.43E-04	5.77E-03	92.3315
cis-1,3-Dichloropropene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.07E-04	80.0188
1,1,2-Trichloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.30E-04	83.4723
Tetrachloroethene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.60E-04	86.6126
2-Hexanone	< 9.46E-05	< 1.10E-04	< 1.13E-04	1.07E-04	< 3.85E-04	72.1095
Dibromochloromethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 8.18E-04	97.3750
Chlorobenzene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 2.08E-03	97.8088
Ethylbenzene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	7.54E-03	99.7152
m,p-Xylene	2.98E-03	2.20E-05	2.25E-05	2.44E-05	8.64E-03	99.7134
o-Xylene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	4.33E-03	99.5042
Styrene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	3.21E-04	93.3063
Bromoform	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 9.78E-04	97.8053
1,1,2,2-Tetrachloroethane	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.60E-04	86.6126
1,3-Dichlorobenzene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	< 1.43E-04	84.9580
1,4-Dichlorobenzene	< 1.99E-05	< 2.20E-05	< 2.25E-05	2.15E-05	4.65E-03	99.5384
1,2-Dichlorobenzene	< 1.99E-05	< 3.96E-05	< 2.25E-05	2.73E-05	3.85E-04	92.8969

Total Organics (3)
NMOC as hexane
Methane

7.09E-04
1.82E+00
3.95E+01
3.84E-02
8.41E-01
4.90E+01
98.1552 (4)
-116.6844
>92

< = detection limit value.

- (1) Test run averages include full detection limit values
- (2) Test run averages does not include tube pair 1 or 2. Results are suspected to be bias due to possible probe contamination
- (3) Total Organics is a summation of all the detected quantities in the target compound list
- (4) DRE is based on summation of all the detected quantities in the target compound list at the inlet and outlet

TABLE 6-10
CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK OUTLET-RUN 2
SUMMARY OF VOLATILE ORGANIC COMPOUNDS TEST DATA AND TEST RESULTS

TEST DATA:

Test run number	2	2	2	2	2
Test location	FLARE STACK	FLARE STACK	FLARE STACK	FLARE STACK	FLARE STACK
Test date	02-17-99	02-17-99	02-17-99	02-17-99	02-17-99
Test time	1330-1517	1357-1417	1429-1459	1525-1648	1525-1648
Test tube pair	1	2	3	canister	%DRE

VOST EMISSIONS (lbx/hr):

Chloromethane	< 1.83E-05	< 1.95E-05	5.13E-05	< 2.97E-05	< 3.64E-05	18.5114
Vinyl chloride	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	1.90E-03	98.9915
Bromomethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	2.51E-05	< 2.51E-05	62.2928
Chloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	5.39E-04	96.4407
Freon 11	2.02E-05	7.78E-06	1.38E-05	1.39E-05	1.28E-04	89.1523
1,1-Dichloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	6.81E-05	71.8567
Carbon disulfide	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	2.22E-04	91.3560
Acetone	< 9.17E-05	< 9.73E-05	1.09E-04	9.92E-05	5.23E-04	81.0354
Methyl ethyl ketone	3.67E-06	1.36E-05	4.14E-05	1.96E-05	6.03E-05	67.4931
trans-1,2-Dichloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	2.69E-04	92.8814
1,1-Dichloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	1.58E-04	87.8984
Vinyl acetate	< 9.17E-05	< 9.73E-05	< 9.86E-05	9.59E-05	2.38E-04	59.6613
2-Butanone	< 9.17E-05	< 9.73E-05	< 9.86E-05	9.59E-05	5.39E-04	82.2035
Chloroform	4.22E-05	< 1.95E-05	< 1.97E-05	2.71E-05	8.40E-05	67.7029
1,1,1-Trichloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	9.51E-05	79.8307
Carbon tetrachloride	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	1.09E-04	82.4614
Benzene	1.47E-04	8.37E-05	1.34E-04	1.23E-04	1.52E-03	91.9251
1,2-Dichloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	6.97E-05	72.4964
Trichloroethene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	4.44E-04	95.6780
1,2-Dichloropropane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	7.92E-05	75.7968
Bromodichloromethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	4.59E-04	95.8270
trans-1,3-Dichloropropene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	7.92E-05	75.7968
4-Methyl-2-pentanone	< 9.17E-05	< 9.73E-05	< 9.86E-05	9.59E-05	2.85E-04	66.3844
Toluene	2.38E-05	1.95E-05	2.56E-05	2.30E-05	1.03E-02	99.7769
cis-1,3-Dichloropropene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	7.92E-05	75.7968
1,1,2-Trichloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	9.51E-05	79.8307
Tetrachloroethene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	2.38E-04	91.9323
2-Hexanone	< 9.17E-05	< 9.73E-05	< 9.86E-05	9.59E-05	2.85E-04	66.3844
Dibromochloromethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	5.86E-04	96.7293
Chlorobenzene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	3.64E-03	99.4738
Ethylbenzene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	1.28E-02	99.8506
m,p-Xylene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	1.54E-02	99.8752
o-Xylene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	7.76E-03	99.7530
Styrene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	6.18E-04	96.8970
Bromoforn	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	7.13E-04	97.3108
1,1,2,2-Tetrachloroethane	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	1.19E-04	83.8645
1,3-Dichlorobenzene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	1.11E-04	82.7120
1,4-Dichlorobenzene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	8.56E-03	99.7759
1,2-Dichlorobenzene	< 1.83E-05	< 1.95E-05	< 1.97E-05	1.92E-05	6.02E-04	96.8154
Total Organics (2)				2.59E-04	6.58E-02	99.6061 (3)
NMOC as hexane				1.29E+00	9.44E-01	36.3891
Methane				3.72E+01	5.06E+01	>93

< = detection limit value

(1) Test run averages include full detection limit values

(2) Total Organics is a summation of all the detected quantities in the target compound list

(3) DRE is based on summation of all the detected quantities in the target compound list at the inlet and outlet

11/12/1999 11:50 AM

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TABLE 1

Test run number	Test location	Test date	Test time	Test tube pair
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9
10	10	10	10	10
11	11	11	11	11
12	12	12	12	12
13	13	13	13	13
14	14	14	14	14
15	15	15	15	15
16	16	16	16	16
17	17	17	17	17
18	18	18	18	18
19	19	19	19	19
20	20	20	20	20
21	21	21	21	21
22	22	22	22	22
23	23	23	23	23
24	24	24	24	24
25	25	25	25	25
26	26	26	26	26
27	27	27	27	27
28	28	28	28	28
29	29	29	29	29
30	30	30	30	30
31	31	31	31	31
32	32	32	32	32
33	33	33	33	33
34	34	34	34	34
35	35	35	35	35
36	36	36	36	36
37	37	37	37	37
38	38	38	38	38
39	39	39	39	39
40	40	40	40	40
41	41	41	41	41
42	42	42	42	42
43	43	43	43	43
44	44	44	44	44
45	45	45	45	45
46	46	46	46	46
47	47	47	47	47
48	48	48	48	48
49	49	49	49	49
50	50	50	50	50
51	51	51	51	51
52	52	52	52	52
53	53	53	53	53
54	54	54	54	54
55	55	55	55	55
56	56	56	56	56
57	57	57	57	57
58	58	58	58	58
59	59	59	59	59
60	60	60	60	60
61	61	61	61	61
62	62	62	62	62
63	63	63	63	63
64	64	64	64	64
65	65	65	65	65
66	66	66	66	66
67	67	67	67	67
68	68	68	68	68
69	69	69	69	69
70	70	70	70	70
71	71	71	71	71
72	72	72	72	72
73	73	73	73	73
74	74	74	74	74
75	75	75	75	75
76	76	76	76	76
77	77	77	77	77
78	78	78	78	78
79	79	79	79	79
80	80	80	80	80
81	81	81	81	81
82	82	82	82	82
83	83	83	83	83
84	84	84	84	84
85	85	85	85	85
86	86	86	86	86
87	87	87	87	

Chloromethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 4.56E-05	56.2375
Vinyl chloride	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 5.70E-05	64.9500
Bromomethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 8.64E-05	76.8802
Chloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 5.70E-04	96.4990
Freon 11	< 5.94E-05	< 5.30E-05	< 1.07E-04	< 7.30E-05	< 1.43E-04	49.0963
1,1-Dichloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 8.80E-05	77.3083
Carbon disulfide	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 2.77E-04	92.7921
Acetone	< 1.02E-04	< 1.02E-04	< 9.52E-05	< 9.98E-05	< 5.70E-04	82.4950
Methylene chloride	< 9.21E-05	< 2.65E-05	< 1.81E-04	< 9.98E-05	< 7.68E-05	30.3344
trans-1,2-Dichloroethene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 3.58E-04	94.4302
1,1-Dichloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 8.80E-05	77.3083
Vinyl acetate	< 1.02E-04	< 1.02E-04	< 9.52E-05	< 9.98E-05	< 3.10E-04	67.7540
2-Butanone	< 1.02E-04	< 1.02E-04	< 9.52E-05	< 9.98E-05	< 6.52E-04	84.6831
Chloroform	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.09E-04	81.7112
1,1,1-Trichloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.21E-04	83.4412
Carbon tetrachloride	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.40E-04	85.7517
Benzene	< 4.71E-05	< 4.38E-05	< 4.57E-05	< 4.52E-05	< 1.79E-03	97.4784
1,2-Dichloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 8.96E-05	77.7209
Trichloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 5.21E-04	96.1708
1,2-Dichloropropane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.03E-04	80.5500
Bromodichloromethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 6.03E-04	96.6882
trans-1,3-Dichloropropene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.01E-04	80.2363
4-Methyl-2-pentanone	< 1.02E-04	< 1.02E-04	< 9.52E-05	< 9.98E-05	< 3.58E-04	72.1511
Toluene	< 2.46E-05	< 2.45E-05	< 3.81E-05	< 2.80E-05	< 1.17E-02	99.7325
cis-1,3-Dichloropropene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.01E-04	80.2363
1,1,2-Trichloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.21E-04	83.4412
Tetrachloroethene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 2.77E-04	92.7921
2-Isoxanone	< 1.02E-04	< 1.02E-04	< 9.52E-05	< 9.98E-05	< 3.58E-04	72.1511
Dibromochloromethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 7.50E-04	97.3362
Chlorobenzene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 4.07E-03	99.5099
Ethylbenzene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.43E-02	99.8608
m-p-Xylene	< 2.05E-05	< 2.04E-05	< 3.43E-05	< 2.50E-05	< 1.79E-02	99.8603
o-Xylene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 8.80E-03	99.7731
Styrene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 7.17E-04	97.2151
Bromoform	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 9.12E-04	97.8119
1,1,2,2-Tetrachloroethane	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.53E-04	86.9644
1,3-Dichlorobenzene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.42E-04	85.9155
1,4-Dichlorobenzene	< 2.05E-05	< 2.04E-05	< 1.90E-05	< 2.00E-05	< 1.01E-02	99.8024
1,2-Dichlorobenzene	<					

7.31E-02	99.6369 (3)
9.71E-01	-230.2713
5.20E+01	>93

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TABLE 6-12
CLARKSTOWN LANDFILL, CLARKSTOWN NY
RUN 1
SUMMARY OF SULFUR COMPOUNDS TEST DATA AND TEST RESULTS

TEST DATA:

Test run number	1	1	1
Test location	FLARE STACK OUTLET	FLARE STACK INLET	FLARE STACK
Test date	02-17-99	02-17-99	02-17-99
Test time	1116-1216	1116-1216	%DRE

SULFUR EMISSIONS (lbs/hr):

Hydrogen Sulfide	< 3.37E-04	5.60E-02	99.40
Carbonyl Sulfide	1.06E-03	2.11E-03	49.76
Methyl Mercaptan	< 4.75E-04	< 8.27E-04	42.50
Ethyl Mercaptan	< 6.14E-04	< 1.07E-03	42.50
Dimethyl Sulfide	< 7.53E-04	< 1.31E-03	42.50
Carbon Disulfide	< 9.31E-04	< 1.62E-03	42.50
Isopropyl Mercaptan	< 6.14E-04	< 1.07E-03	42.50
tert-Butyl Mercaptan	< 7.53E-04	< 1.31E-03	42.50
n-Propyl Mercaptan	< 8.91E-04	< 1.55E-03	42.50
Ethyl Methyl Sulfide	< 7.53E-04	< 1.31E-03	42.50
Thiophene	< 7.53E-04	< 1.31E-03	42.50
Isobutyl Mercaptan	< 8.32E-04	< 1.45E-03	42.50
Diethyl Sulfide	< 8.91E-04	< 1.55E-03	42.50
Butyl Mercaptan	< 8.91E-04	< 1.55E-03	42.50
Dimethyl Disulfide	< 8.91E-04	< 1.55E-03	42.50
3-Methylthiophene	< 9.70E-04	< 1.69E-03	42.50
Tetrahydrothiophene	< 8.71E-04	< 1.52E-03	42.50
2-Ethylthiophene	< 1.11E-03	< 1.93E-03	42.50
2,5-Dimethylthiophene	< 1.11E-03	< 1.93E-03	42.50
Diethyl Disulfide	< 1.21E-03	< 2.10E-03	42.50

TABLE 6-13
CLARKSTOWN LANDFILL, CLARKSTOWN NY
RUN 2
SUMMARY OF SULFUR COMPOUNDS TEST DATA AND TEST RESULTS

TEST DATA:

Test run number	2	2	2
Test location	FLARE STACK OUTLET	FLARE STACK INLET	FLARE STACK
Test date	02-17-99	02-17-99	02-17-99
Test time	1332-1432	1331-1431	%DRE

SULFUR EMISSIONS (lbs/hr):

Hydrogen Sulfide	< 3.06E-04	8.41E-02	99.64
Carbonyl Sulfide	1.06E-03	3.59E-03	70.48
Methyl Mercaptan	< 4.75E-04	< 9.35E-04	49.14
Ethyl Mercaptan	< 6.14E-04	< 1.21E-03	49.14
Dimethyl Sulfide	< 7.53E-04	< 1.48E-03	49.14
Carbon Disulfide	< 9.31E-04	< 1.83E-03	49.14
Isopropyl Mercaptan	< 6.14E-04	< 1.21E-03	49.14
tert-Butyl Mercaptan	< 7.53E-04	< 1.48E-03	49.14
n-Propyl Mercaptan	< 8.91E-04	< 1.75E-03	49.14
Ethyl Methyl Sulfide	< 7.53E-04	< 1.48E-03	49.14
Thiophene	< 7.53E-04	< 1.48E-03	49.14
Isobutyl Mercaptan	< 8.32E-04	< 1.63E-03	49.14
Diethyl Sulfide	< 8.91E-04	< 1.75E-03	49.14
Butyl Mercaptan	< 8.91E-04	< 1.75E-03	49.14
Dimethyl Disulfide	< 8.91E-04	< 1.75E-03	49.14
3-Methylthiophene	< 9.70E-04	< 1.91E-03	49.14
Tetrahydrothiophene	< 8.71E-04	< 1.71E-03	49.14
2-Ethylthiophene	< 1.11E-03	< 2.18E-03	49.14
2,5-Dimethylthiophene	< 1.11E-03	< 2.18E-03	49.14
Diethyl Disulfide	< 1.21E-03	< 2.38E-03	49.14

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TABLE 6-14
CLARKSTOWN LANDFILL, CLARKSTOWN NY
RUN 3
SUMMARY OF SULFUR COMPOUNDS TEST DATA AND TEST RESULTS

TEST DATA:

Test run number	3	3	3
Test location	FLARE STACK OUTLET	FLARE STACK INLET	FLARE STACK
Test date	02-17-99	02-17-99	02-17-99
Test time	1546-1646	1546-1646	%DRE

SULFUR EMISSIONS (lbs/hr):

Hydrogen Sulfide	< 3.16E-04	8.15E-02	99.61
Carbonyl Sulfide	9.02E-04	3.59E-03	74.88
Methyl Mercaptan	< 4.46E-04	< 9.35E-04	52.31
Ethyl Mercaptan	< 5.76E-04	< 1.21E-03	52.31
Dimethyl Sulfide	< 7.06E-04	< 1.48E-03	52.31
Carbon Disulfide	< 8.73E-04	< 1.83E-03	52.31
Isopropyl Mercaptan	< 5.76E-04	< 1.21E-03	52.31
tert-Butyl Mercaptan	< 7.06E-04	< 1.48E-03	52.31
n-Propyl Mercaptan	< 8.36E-04	< 1.75E-03	52.31
Ethyl Methyl Sulfide	< 7.06E-04	< 1.48E-03	52.31
Thiophene	< 7.06E-04	< 1.48E-03	52.31
Isobutyl Mercaptan	< 7.80E-04	< 1.63E-03	52.31
Diethyl Sulfide	< 8.36E-04	< 1.75E-03	52.31
Butyl Mercaptan	< 8.36E-04	< 1.75E-03	52.31
Dimethyl Disulfide	< 8.36E-04	< 1.75E-03	52.31
3-Methylthiophene	< 9.10E-04	< 1.91E-03	52.31
Tetrahydrothiophene	< 8.17E-04	< 1.71E-03	52.31
2-Ethylthiophene	< 1.04E-03	< 2.18E-03	52.31
2,5-Dimethylthiophene	< 1.04E-03	< 2.18E-03	52.31
Diethyl Disulfide	< 1.13E-03	< 2.38E-03	52.31

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APPENDIX A
PROCESS DATA

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PAGE ①

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94L1 001.03
92L1 001.02
94L1 001.02

PAGE ①

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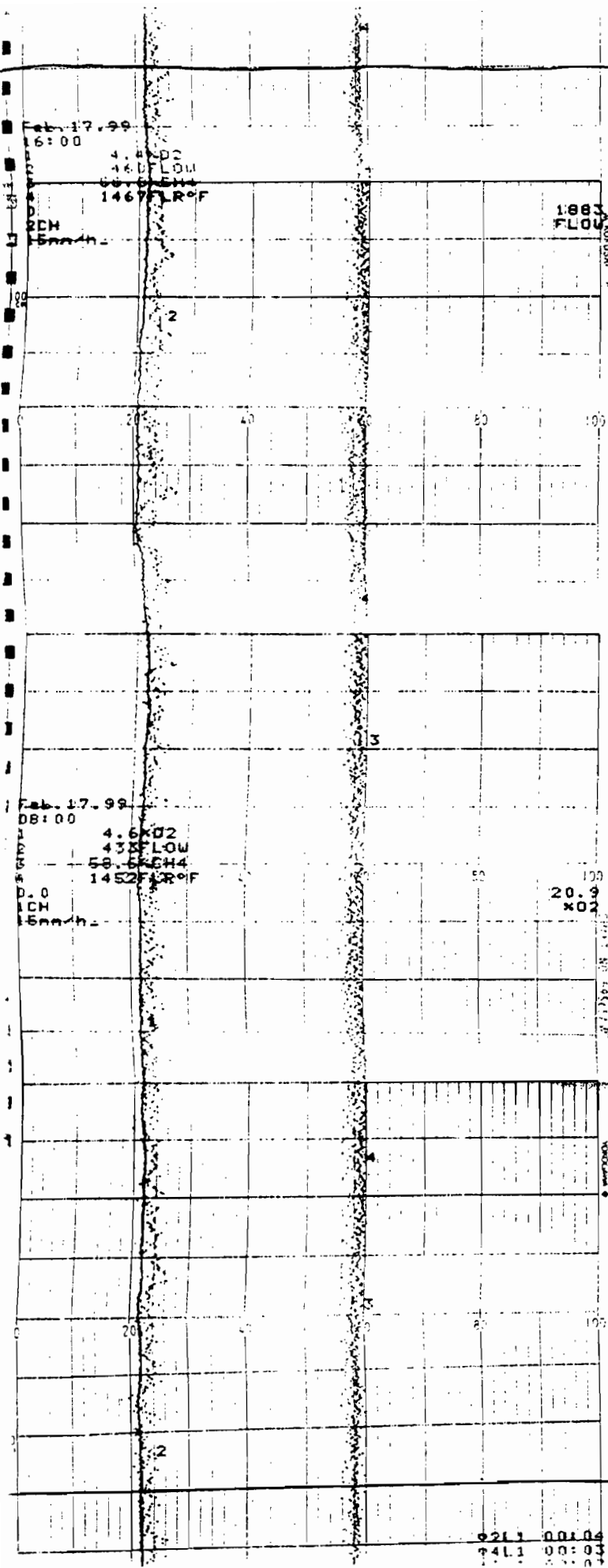
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1444 FLOW
D.O.
HCH
15mm/h

20.9
x02

PAGE ③

PAGE ②



PAGE

②

Feb 17th

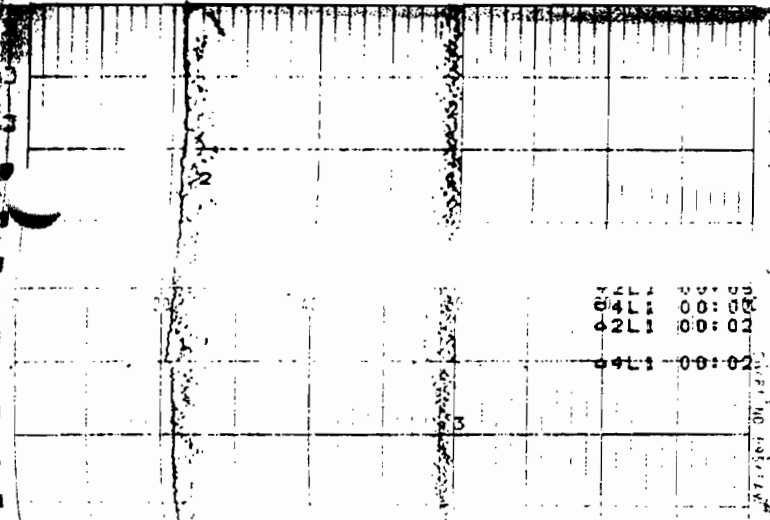
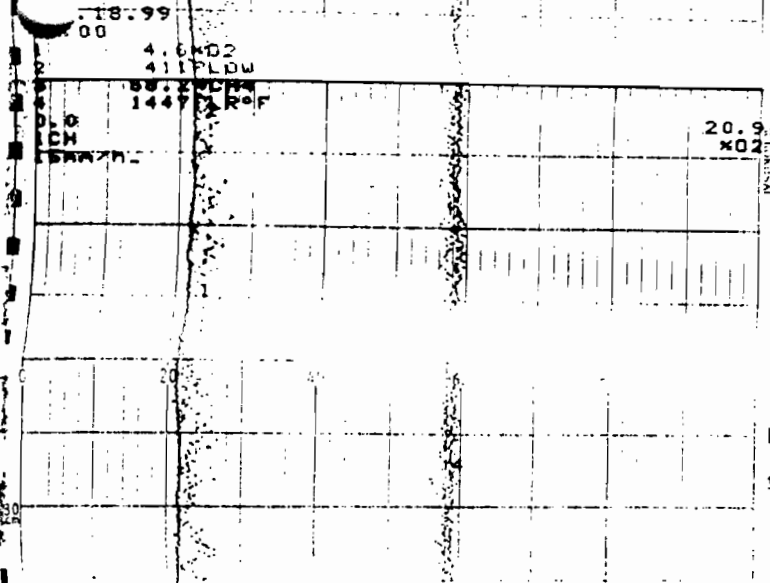
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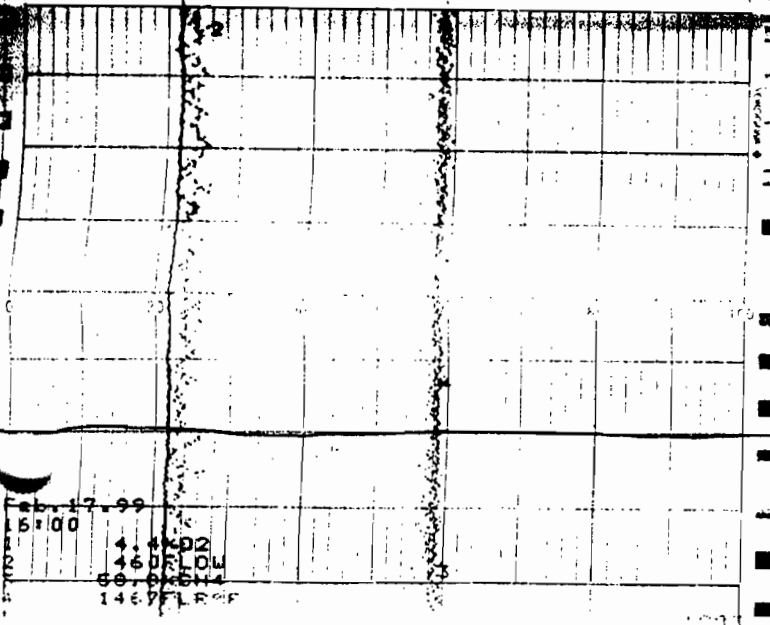
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Feb 18 th



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 44L1 00:02

PAGE ④

Feb 18 th

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 59.5 KCH4
 1412 ROP
 2CH
 18MM/H

1883
 FLOW

PAGE ④

PAGE ③

Feb-18-99
 DB100
 4.6A02
 41 FLOW
 58.2 KCH4
 1447 ROP
 D.O
 2CH
 18MM/H

20.9
 x02

APPENDIX B
RAW TEST DATA

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CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK OUTLET
PARTICULATE TEST DATA INPUTS

Test Data

Run number	1	2	3
Location		FLARE STACK	
Date	2/17/99	2/17/99	2/17/99
Time period	1112-1248	1331-1511	1546-1724
Operator	RE/TB	RE/TB	RE/TB

Inputs For Calcs.

Sq. rt. delta P	0.08694	0.07803	0.07925
Delta H	1.1721	0.9238	0.9029
Stack temp. (deg.F)	1093.60	1098.90	1076.20
Meter temp. (deg.F)	59.83	62.83	66.96
Sample volume (act.)	40.393	36.231	35.929
Barometric press. (in.Hg)	30.07	30.04	29.98
Volume H ₂ O imp. (ml)	35.0	52.0	40.0
Weight chnge sil. gel (g)	11.2	7.9	9.3
% CO ₂	4.8	4.5	4.5
% O ₂	15.6	16.0	15.0
% N	79.6	79.5	80.5
Area of stack (sq.ft.)	69.64	69.64	69.64
Sample time (min.)	72.0	72.0	72.0
Static pressure (in.H ₂ O)	-0.04	-0.04	-0.04
Nozzle dia. (in.)	0.800	0.800	0.800
Meter box cal.	1.0116	1.0116	1.0116
Cp of pitot tube	0.84	0.84	0.84
Traverse points	24	24	24

Particulate Laboratory Report Data

Front half acetone rinse, g	0.0012	0.0022	0.0027
Filter, g	0.0009	0.0006	0.0005
Total catch, g	0.0021	0.0028	0.0032

CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK INLET
VOLATILE ORGANIC COMPOUNDS TEST DATA INPUTS

TEST DATA:

	1	2	3
Test run number			
Test location	FLARE STACK INLET	FLARE STACK INLET	FLARE STACK INLET
Test date	02-17-99	02-17-99	02-17-99
Test time	1116-1216	1331-1431	1546-1646

SAMPLING DATA:

Duration, minutes	60.0	60.0	60.0
Barometric pressure, in. Hg	30.07	30.07	30.07
Volumetric flow rate, dscf/min ⁽¹⁾	428	423	435

LABORATORY DATA, ug/dscm

Chloromethane	31 U	23 U	28 U
Vinyl chloride	1400	1200	35 U
Bromomethane	58 U	42 U	53 U
Chloroethane	220	340	350
Freon 11	83 U	81 J	88 J
1,1-Dichloroethene	59 U	43 U	54 U
Carbon disulfide	180 U	140 U	170 U
Acetone	360	330	350
Methylene chloride	52 U	38 U	47 U
trans-1,2-Dichloroethene	240 U	170 U	220 U
1,1-Dichloroethane	60 U	100 J	54 U
Vinyl acetate	210 U	150 U	190 U
2-Butanone	190 J	340	400 J
Chloroform	72 U	53 U	67 U
1,1,1-Trichloroethane	81 U	60 U	74 U
Carbon tetrachloride	93 U	69 U	86 U
Benzene	570	960	1100
1,2 Dichloroethane	60 U	44 U	55 U
Trichloroethene	190 J	280	320
1,2-Dichloropropane	69 U	50 U	63 U
Bromodichloromethane	400 U	290 U	370 U
trans-1,3-Dichloropropene	67 U	50 U	62 U
4-Methyl-2-pentanone	240 U	180 U	220 U
Toluene	3600	6500	7200
cis 1,3 Dichloropropene	67 U	50 U	62 U
1,1,2-Trichloroethane	81 U	60 U	74 U
Tetrachloroethene	100 U	150 J	170 J
2-Hexanone	240 U	180 U	220 U
Dibromochloromethane	510 U	370 U	460 U
Chlorobenzene	1300	2300	2500
Ethylbenzene	4700	8100	8800
m-/p-Xylene	5400	9700	11000
o-Xylene	2700	4900	5400
Styrene	200 J	390	440
Bromoform	610 U	450 U	560 U
1,1,2,2-Tetrachloroethane	100 U	75 U	94 U
1,3-Dichlorobenzene	89 U	70 J	87 J
1,4-Dichlorobenzene	2900	5400	6200
1,2-Dichlorobenzene	240 J	380	430

Total Organics ug/dscm.(1)	23970	41521	44835
NMOC as methane ppm/v	880	1000	1000
NMOC as hexane ppm/v	146.67	166.67	166.67
NMOC as hexane ppm/v corr. @3% O ₂ .	170	186	188
Methane, ppm/v	46000	48000	48000

U = Detection limit value.

(1) Total Organics is a summation of all the detected quantities in the target compound list.

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CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK OUTLET-RUN 1
VOLATILE ORGANIC COMPOUNDS TEST DATA INPUTS

TEST DATA:

Test run number	1	1	1
Test location	FLARE STACK	FLARE STACK	FLARE STACK
Test date	02-17-99	02-17-99	02-17-99
Test time	1112-1133	1143-1203	1212-1232
Test tube pair	1	2	3

SAMPLING DATA:

Duration, minutes	20.0	20.00	20.00
Average dry gas meter press. in. H ₂ O	1.600	1.600	1.600
Average dry gas meter temp. deg. C	16.875	16.250	16.625
Average dry gas meter temp. deg. F	62.38	61.25	61.93
Average absolute meter temp. deg. R	522.38	521.25	521.93
Actual sample volume, liters	20.580	18.550	18.160
Meter box calibration, Y	1.0181	1.0181	1.0181
Barometric pressure, in. Hg	30.07	30.07	30.07
Sample volume, dscf	21.359	19.294	18.864
Sample volume, dscf	0.7543	0.6814	0.6662
Volumetric flow rate, dscf/min ⁽¹⁾	11335	11335	11335

LABORATORY DATA, ug:

Chloromethane	0.020	0.026	0.010 U
Vinyl chloride	0.010 U	0.010 U	0.010 U
Bromomethane	0.028 B	0.030 B	0.010 U B
Chloroethane	0.010 U	0.010 U	0.010 U
Freon 11	0.010 U B	0.010 U B	0.010 U B
1,1-Dichloroethene	0.010 U	0.010 U	0.010 U
Carbon disulfide	0.010 U	0.010 U	0.010 U
Acetone	0.280	0.078	0.068
Methylene chloride	0.010 U B	0.010 U B	0.010 U B
trans-1,2-Dichloroethene	0.010 U	0.010 U	0.010 U
1,1-Dichloroethane	0.010 U	0.010 U	0.010 U
Vinyl acetate	0.050 U	0.050 U	0.050 U
2-Butanone	0.050 U	0.050 U	0.050 U
Chloroform	0.010 U B	0.010 U B	0.010 U B
1,1,1-Trichloroethane	0.010 U	0.010 U	0.010 U
Carbon tetrachloride	0.010 U	0.010 U	0.010 U
Benzene	10.000	0.660	0.230
1,2 Dichloroethane	0.010 U	0.010 U	0.010 U
Trichloroethene	0.010 U	0.010 U	0.010 U
1,2-Dichloropropane	0.010 U	0.010 U	0.010 U
Bromodichloromethane	0.010 U	0.010 U	0.010 U
trans-1,3-Dichloropropene	0.010 U	0.010 U	0.010 U
4-Methyl-2-pentanone	0.050 U	0.050 U	0.050 U
Toluene	0.610	0.035	0.017
cis 1,3 Dichloropropene	0.010 U	0.010 U	0.010 U
1,1,2-Trichloroethane	0.010 U	0.010 U	0.010 U
Tetrachloroethene	0.010 U	0.010 U	0.010 U
2-Hexanone	0.050 U	0.050 U	0.050 U
Dibromochloromethane	0.010 U	0.010 U	0.010 U
Chlorobenzene	0.010 U	0.043	0.010 U
Ethylbenzene	0.010 U	0.010 U	0.010 U
m-/p-Xylene	0.015	0.010 U	0.010 U
o-Xylene	0.010 U	0.010 U	0.010 U
Styrene	0.010 U	0.010 U	0.010 U
Bromoform	0.010 U	0.010 U	0.010 U
1,1,2,2-Tetrachloroethane	0.010 U	0.010 U	0.010 U
1,3-Dichlorobenzene	0.010 U	0.010 U	0.010 U
1,4-Dichlorobenzene	0.010 U	0.010 U	0.010 U
1,2-Dichlorobenzene	0.010 U	0.018	0.010 U
Total Organics ug.(1)	10.953	0.890	0.315
NMOC as methane ppm/v	72		
NMOC as hexane ppm/v	12		
NMOC as hexane ppm/v corr. @3% O ₂	54		
Methane, ppm/v	< 1400		

U = Detection limit value.

B = Corrected for field blank values.

(1) Total Organics is a summation of all the detected quantities in the target compound list.

CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK OUTLET-RUN 2
VOLATILE ORGANIC COMPOUNDS TEST DATA INPUTS

TEST DATA:

Test run number	2	2	2
Test location	FLARE STACK	FLARE STACK	FLARE STACK
Test date	02-17-99	02-17-99	02-17-99
Test time	1330-1517	1357-1417	1429-1459
Test tube pair	1	2	3

SAMPLING DATA:

Duration, minutes	20.0	20.00	20.00
Average dry gas meter press. in. H ₂ O	1.600	1.600	1.600
Average dry gas meter temp. deg. C	17.875	18.125	16.500
Average dry gas meter temp. deg. F	64.18	64.63	61.70
Average absolute meter temp. deg. R	524.18	524.63	521.70
Actual sample volume, liters	19.660	18.550	18.190
Meter box calibration, Y	1.0181	1.0181	1.0181
Barometric pressure, in. Hg	30.04	30.04	30.04
Sample volume, dscf	20.314	19.151	18.884
Sample volume, dscf	0.7174	0.6763	0.6669
Volumetric flow rate, dscf/min ⁽¹⁾	9947	9947	9947

LABORATORY DATA, ug:

Chloromethane	0.010 U	0.010 U	0.026
Vinyl chloride	0.010 U	0.010 U	0.010 U
Bromomethane	0.010 U B	0.010 U B	0.019 B
Chloroethane	0.010 U	0.010 U	0.010 U
Freon 11	0.011 B	0.004 B	0.007 B
1,1-Dichloroethene	0.010 U	0.010 U	0.010 U
Carbon disulfide	0.010 U	0.010 U	0.010 U
Acetone	0.050 U	0.050 U	0.055
Methylene chloride	0.002 B	0.007 B	0.021 B
trans-1,2-Dichloroethene	0.010 U	0.010 U	0.010 U
1,1-Dichloroethane	0.010 U	0.010 U	0.010 U
Vinyl acetate	0.050 U	0.050 U	0.050 U
2-Butanone	0.050 U	0.050 U	0.050 U
Chloroform	0.023 B	0.010 U B	0.010 U B
1,1,1-Trichloroethane	0.010 U	0.010 U	0.010 U
Carbon tetrachloride	0.010 U	0.010 U	0.010 U
Benzene	0.080	0.043	0.070
1,2 Dichloroethane	0.010 U	0.010 U	0.010 U
Trichloroethene	0.010 U	0.010 U	0.010 U
1,2-Dichloropropane	0.010 U	0.010 U	0.010 U
Bromodichloromethane	0.010 U	0.010 U	0.010 U
trans-1,3-Dichloropropene	0.010 U	0.010 U	0.010 U
4-Methyl-2-pentanone	0.050 U	0.050 U	0.050 U
Toluene	0.013	0.010	0.013
cis 1,3 Dichloropropene	0.010 U	0.010 U	0.010 U
1,1,2-Trichloroethane	0.010 U	0.010 U	0.010 U
Tetrachloroethene	0.010 U	0.010 U	0.010 U
2-Hexanone	0.050 U	0.050 U	0.050 U
Dibromochloromethane	0.010 U	0.010 U	0.010 U
Chlorobenzene	0.010 U	0.010 U	0.010 U
Ethylbenzene	0.010 U	0.010 U	0.010 U
m-/p-Xylene	0.010 U	0.010 U	0.010 U
o-Xylene	0.010 U	0.010 U	0.010 U
Styrene	0.010 U	0.010 U	0.010 U
Bromoform	0.010 U	0.010 U	0.010 U
1,1,2,2-Tetrachloroethane	0.010 U	0.010 U	0.010 U
1,3-Dichlorobenzene	0.010 U	0.010 U	0.010 U
1,4-Dichlorobenzene	0.010 U	0.010 U	0.010 U
1,2-Dichlorobenzene	0.010 U	0.010 U	0.010 U
Total Organics ug.(1)	0.129	0.064	0.211
NMOC as methane	58		
NMOC as hexane	10		
NMOC as hexane ppm/v corr. @3% O ₂ .	44		
Methane, ppm/v	< 1500		

U = Detection limit value.

B = Corrected for field blank values.

(1) Total Organics is a summation of all the detected quantities in the target compound list.

CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK OUTLET - RUN 3
VOLATILE ORGANIC COMPOUNDS TEST DATA INPUTS

TEST DATA:

Test run number	3	3	3
Test location	FLARE STACK	FLARE STACK	FLARE STACK
Test date	02-17-99	02-17-99	02-17-99
Test time	1546-1606	1613-1633	1642-1702
Test tube pair	1	2	3

SAMPLING DATA:

Duration, minutes	20.0	20.00	20.00
Average dry gas meter press. in. H ₂ O	1.600	1.600	1.600
Average dry gas meter temp. deg. C	21.000	18.500	19.875
Average dry gas meter temp. deg. F	69.80	65.30	67.78
Average absolute meter temp. deg. R	529.80	525.30	527.78
Actual sample volume, liters	18.400	18.317	19.720
Meter box calibration, Y	1.0181	1.0181	1.0181
Barometric pressure, in. Hg	29.98	29.98	29.98
Sample volume, dscf	18.773	18.848	20.197
Sample volume, dscf	0.6630	0.6656	0.7133
Volumetric flow rate, dscf/min ⁽¹⁾	10262	10262	10262

LABORATORY DATA, ug:

Chloromethane	0.010 U	0.010 U	0.010 U
Vinyl chloride	0.010 U	0.010 U	0.010 U
Bromomethane	0.010 U B	0.010 U B	0.010 U B
Chloroethane	0.010 U	0.010 U	0.010 U
Freon 11	0.029 B	0.026 B	0.056 B
1,1-Dichloroethene	0.010 U	0.010 U	0.010 U
Carbon disulfide	0.010 U	0.010 U	0.010 U
Acetone	0.050 U	0.050 U	0.050 U
Methylene chloride	0.045 B	0.013 B	0.095 B
trans-1,2-Dichloroethene	0.010 U	0.010 U	0.010 U
1,1-Dichloroethane	0.010 U	0.010 U	0.010 U
Vinyl acetate	0.050 U	0.050 U	0.050 U
2-Butanone	0.050 U	0.050 U	0.050 U
Chloroform	0.010 U B	0.010 U B	0.010 U B
1,1,1-Trichloroethane	0.010 U	0.010 U	0.010 U
Carbon tetrachloride	0.010 U	0.010 U	0.010 U
Benzene	0.023	0.021	0.024
1,2 Dichloroethane	0.010 U	0.010 U	0.010 U
Trichloroethene	0.010 U	0.010 U	0.010 U
1,2-Dichloropropane	0.010 U	0.010 U	0.010 U
Bromodichloromethane	0.010 U	0.010 U	0.010 U
trans-1,3-Dichloropropene	0.010 U	0.010 U	0.010 U
4-Methyl-2-pentanone	0.050 U	0.050 U	0.050 U
Toluene	0.012	0.012	0.020
cis 1,3 Dichloropropene	0.010 U	0.010 U	0.010 U
1,1,2-Trichloroethane	0.010 U	0.010 U	0.010 U
Tetrachloroethene	0.010 U	0.010 U	0.010 U
2-Hexanone	0.050 U	0.050 U	0.050 U
Dibromochloromethane	0.010 U	0.010 U	0.010 U
Chlorobenzene	0.010 U	0.010 U	0.010 U
Ethylbenzene	0.010 U	0.010 U	0.010 U
m-/p-Xylene	0.010 U	0.010	0.018
o-Xylene	0.010 U	0.010 U	0.010 U
Styrene	0.010 U	0.010 U	0.010 U
Bromoform	0.010 U	0.010 U	0.010 U
1,1,2,2-Tetrachloroethane	0.010 U	0.010 U	0.010 U
1,3-Dichlorobenzene	0.010 U	0.010 U	0.010 U
1,4-Dichlorobenzene	0.010 U	0.010 U	0.010 U
1,2-Dichlorobenzene	0.010 U	0.010 U	0.010 U

Total Organics ug.(1)	0.109	0.082	0.213
NMOC as methane	140		
NMOC as hexane	23		
NMOC as hexane ppm/v corr. @3% O ₂	140		
Methane, ppm/v	< 1500		

U = Detection limit value.

B = Corrected for field blank values.

(1) Total Organics is a summation of all the detected quantities in the target compound list.

**CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK INLET
SULFUR COMPOUNDS TEST DATA INPUTS**

TEST DATA:

	1	2	3
Test run number			
Test location	FLARE STACK INLET	FLARE STACK INLET	FLARE STACK INLET
Test date	02-17-99	02-17-99	02-17-99
Test time	1116-1216	1331-1431	1546-1646

SAMPLING DATA:

Duration, minutes	60.0	20.00	20.00
Barometric pressure, in. Hg	30.07	30.07	30.07
Volumetric flow rate, dscf/min ⁽¹⁾	480	480	480

LABORATORY DATA, ppb/v

Hydrogen Sulfide	22000	33000	32000
Carbonyl Sulfide	470	800	800
Methyl Mercaptan	230 U	260 U	260 U
Ethyl Mercaptan	230 U	260 U	260 U
Dimethyl Sulfide	230 U	260 U	260 U
Carbon Disulfide	230 U	260 U	260 U
Isopropyl Mercaptan	230 U	260 U	260 U
tert-Butyl Mercaptan	230 U	260 U	260 U
n-Propyl Mercaptan	230 U	260 U	260 U
Ethyl Methyl Sulfide	230 U	260 U	260 U
Thiophene	230 U	260 U	260 U
Isobutyl Mercaptan	230 U	260 U	260 U
Diethyl Sulfide	230 U	260 U	260 U
Butyl Mercaptan	230 U	260 U	260 U
Dimethyl Disulfide	230 U	260 U	260 U
3-Methylthiophene	230 U	260 U	260 U
Tetrahydrothiophene	230 U	260 U	260 U
2-Ethylthiophene	230 U	260 U	260 U
2,5-Dimethylthiophene	230 U	260 U	260 U
Diethyl Disulfide	230 U	260 U	260 U

U = Detection limit value.

**CLARKSTOWN LANDFILL, CLARKSTOWN NY
FLARE STACK OUTLET
SULFUR COMPOUNDS TEST DATA INPUTS**

TEST DATA:

Test run number	1	2	3
Test location	FLARE STACK OUTLET	FLARE STACK OUTLET	FLARE STACK OUTLET
Test date	02-17-99	02-17-99	02-17-99
Test time	1116-1216	1332-1432	1546-1646

SAMPLING DATA:

Duration, minutes	60.0	20.00	20.00
Barometric pressure, in. Hg	30.07	30.07	30.07
Volumetric flow rate, dscf/min ⁽¹⁾	11335	9947	10262

LABORATORY DATA, ppb/v

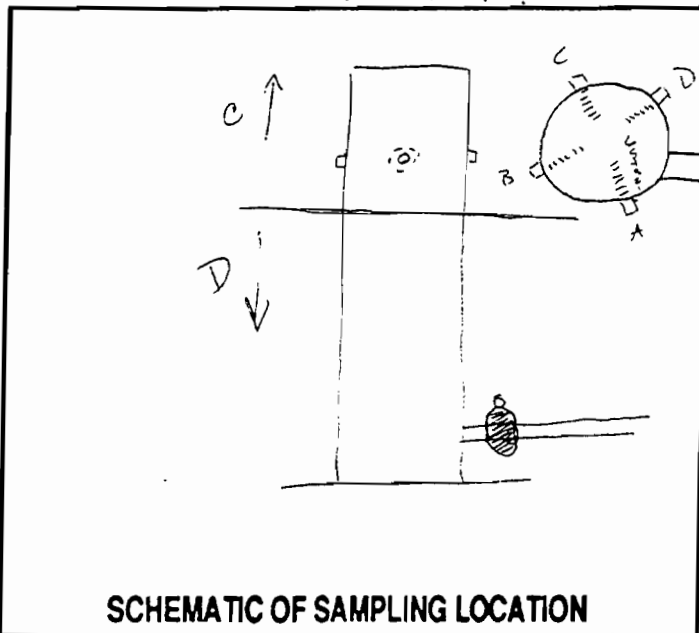
Hydrogen Sulfide	5.6 U	5.8 U	5.8 U
Carbonyl Sulfide	10.0	11.0	9.4
Methyl Mercaptan	5.6 U	5.8 U	5.8 U
Ethyl Mercaptan	5.6 U	5.8 U	5.8 U
Dimethyl Sulfide	5.6 U	5.8 U	5.8 U
Carbon Disulfide	5.6 U	5.8 U	5.8 U
Isopropyl Mercaptan	5.6 U	5.8 U	5.8 U
tert-Butyl Mercaptan	5.6 U	5.8 U	5.8 U
n-Propyl Mercaptan	5.6 U	5.8 U	5.8 U
Ethyl Methyl Sulfide	5.6 U	5.8 U	5.8 U
Thiophene	5.6 U	5.8 U	5.8 U
Isobutyl Mercaptan	5.6 U	5.8 U	5.8 U
Diethyl Sulfide	5.6 U	5.8 U	5.8 U
Butyl Mercaptan	5.6 U	5.8 U	5.8 U
Dimethyl Disulfide	5.6 U	5.8 U	5.8 U
3-Methylthiophene	5.6 U	5.8 U	5.8 U
Tetrahydrothiophene	5.6 U	5.8 U	5.8 U
2-Ethylthiophene	5.6 U	5.8 U	5.8 U
2,5-Dimethylthiophene	5.6 U	5.8 U	5.8 U
Diethyl Disulfide	5.6 U	5.8 U	5.8 U

U = Detection limit value.



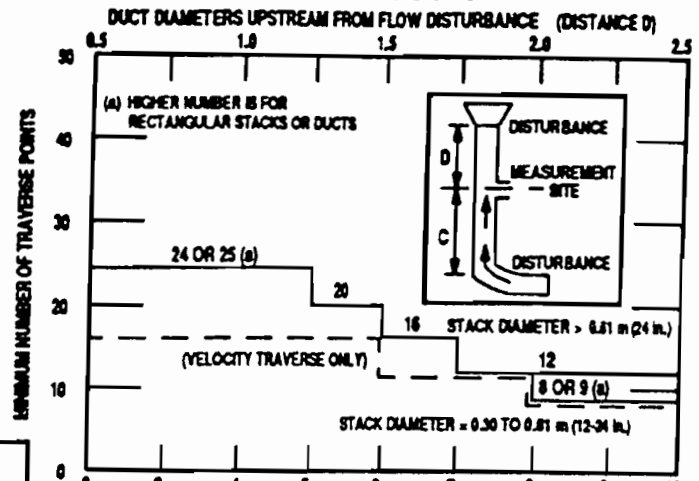
TRAVERSE POINT LOCATION FOR CIRCULAR AND RECTANGULAR DUCTS

PLANT Chickadee Landfill
 DATE 16 FEB 99
 SAMPLING LOCATION Flare
 INSIDE OF FAR WALL TO
 OUTSIDE OF PORT (DISTANCE A) 121 in
 INSIDE OF NEAR WALL TO
 OUTSIDE OF PORT (DISTANCE B) 8 in
 STACK LD. (DISTANCE A - DISTANCE B) 113 in
 NEAREST UPSTREAM DISTURBANCE (C) 20 ft
 NEAREST DOWNSTREAM DISTURBANCE (D) 9 ft
 CALCULATOR TI-82 (RE)
 $AREA = 69.644 \text{ ft}^2$



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	1	2	3	4	5
	FRACTION OF STACK LD.	STACK LD.	PRODUCT OF COLUMNS 1 AND 2 (TO NEAREST 1/8 INCH)	DISTANCE B (PORT DEPTH)	TRAVERSE POINT LOCATION FROM OUTSIDE OF PORT (SUM OF COLUMNS 3 AND 4)
1	2.1	113.0	2.37	8.0	10.37
2	6.7		7.57		15.57
3	11.8		13.33		21.33
4	17.7		20.00		28.00
5	25.0		28.25		36.25
6	35.6	✓	40.23	✓	48.23
7					
8					
9					
10					
11					
12					



DUCT DIAMETERS DOWNSTREAM FROM FLOW DISTURBANCE (DISTANCE C)
 * FROM POINT OF ANY TYPE DISTURBANCE (BEND, CONTRACTION, ETC.)

RECTANGULAR DUCT EQUIVALENT DIAMETER DETERMINATION
 FOR THE MINIMUM NUMBER OF TRAVERSE POINTS = $\frac{21 \cdot W}{L \cdot W}$

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.8	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			88.5	77.4	64.4	38.8	28.3	23.6	20.4	18.0	16.1
8			96.8	86.4	75.0	63.4	37.5	29.8	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.6
10					97.4	88.2	78.9	71.7	61.8	38.8	31.5
11						93.3	85.4	78.0	70.4	61.2	38.3
12							97.9	88.1	83.1	78.4	68.7
13								94.3	87.5	81.2	75.0
14									98.2	91.5	85.4
15										95.1	88.1
16											98.4
17											
18											
19											
20											
21											
22											
23											
24											

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	76.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	58.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

GAS VELOCITY AND VOLUME DATA FORM

Company:	<u>Clarkstown Landfill</u>	Stack Diameter, In.:	<u>113</u>
Plant:	" "	Cross Sectional Area (AS), ft ² :	
Location:	<u>Clarkstown NY</u>	Pilot Tube ID No.:	<u>P71</u> Cp: <u>0.84</u>
Date:	<u>2-17-99</u> Run No.: <u>Pre 1</u>	Pilot Tube Leak Check:	<u>✓</u>
Operators:	<u>ERGA Briggs</u>	Notes:	
Barometric Pressure, in. Hg:			

[illegible]

MOISTURE DETERMINATION FORM

Plant Charkestown Landfill Date 2.16.99
 Sample Location Flare Run No. Prelim
 Operator ERG A Barometric Pressure (P_b), in. Hg 29.97
 Initial Leak Rate 0.000 CFM @ 15 in. Hg
 Final Leak Rate 0.000 CFM @ 16 in. Hg
 Comments: _____

	24-hr Clock Time	Gas Meter Reading ft. ³	Orifice meter pressure differential (ΔH) in. H ₂ O	Dry gas meter temperature (T_m)	
				Inlet °F	Outlet °F
Stop	1536	646.880	1.5	78	76
Start	1506	627.852	1.5	78	76
	30	Total V_m	Ave. ΔH	Avg. T_m	
		19.028	1.5	77	

Impinger volume

Final, ml 210
 Initial, ml 200 ml
 Net, ml _____

Silica gel weight

Final, g 305.5
 Initial, g _____
 Net, g. _____

CALCULATIONS

- (1) $P_b = 29.97$ (4) Avg. $T_m = 77$
 (2) Total $V_m =$ (5) Net ml =
 (3) Avg. $\Delta H = 1.5$ (6) Net g =
 (7) Meter box cal. (Y) = 1.0116
 (8)
$$V_{m(std)} = \frac{Y \times 17.64 \times V_m (P_b + \frac{\Delta H}{13.6})}{(T_m + 460)} = \frac{17.64 \times \quad \times (\quad + \frac{\quad}{13.6})}{(\quad + 460)}$$

 (9)
$$V_{w(std)} = \frac{(.04707 \times \text{Net ml}) + (.04715 \times \text{Net g})}{(.04707 \times \quad) + (.04715 \times \quad)} =$$

 (10)
$$\% M = \frac{100 \times V_{w(std)}}{V_{w(std)} + V_{m(std)}} = \frac{100 \times \quad}{\quad + \quad} = 4.15$$

ISOKINETIC FIELD DATA SHEET

EPA Method 5 - Particulate

Page 1 of 2

Client	CLARKSTOWN LANDFILL	Stack Conditions	Meter Box ID	Thermo ID
W.O.#	03228-018-001-1500-00	Assumed	Meter Box Y	Ambient Temp (°F)
Project ID	CL	4.1	Meter Box Del H	Sample Time
Mode/Source ID	FL		Probe ID/Length	Total Traverse Pts
Sample Loc ID	STK		Probe Material	
Run No ID	1	5.5	Pitot ID	
Test Method ID	M5	14.0	Pitot Coefficient	
Date ID	17FEB1999	104.3	Nozzle ID	
Source/Location	Flare Stack	55	Avg Nozzle Dia (in)	
Sample Date	9-11-98	-0.04	Area of Stack (ft²)	
Baro. Press (in Hg)	30.07	Filter W-78	Operator	

Run No	Sample Time (min)	Flow Rate (ft³/min)	Pressure (in Hg)	Temperature (°F)	Humidity (%)	Stack Temp (°F)	Filter Temp (°F)	Outlet Temp (°F)	Exhaust Temp (°F)	Train Temp (°F)	Comments
B-1	0	1112	0.010	1.63	649.9	944	736	751	51	56	2
2	3		0.005	0.76	651.3	1044	240	252	50	57	2
3	9		0.005	0.76	652.9	1145	240	242	49	59	1
4	12		0.005	0.76	654.1	1080	236	242	49	61	1
5	15		0.005	0.76	655.4	1151	235	258	48	61	1
6	18	1130	0.010	1.48	657.482	1086	230	255	48	62	2
C-1	0	1140	0.005	0.76	657.600	1086	230	255	48	62	2
2	3		0.005	0.74	659.000	1034	232	265	48	57	1
3	9		0.005	0.74	660.4	1088	233	261	48	60	1
4	12		0.005	0.69	661.7	1027	236	262	48	60	1
5	15		0.015	2.22	663.1	1197	231	261	48	63	3
6	18	1158	0.010	1.48	666.1	1121	236	262	48	61	3
A-1	0	1205	0.005	0.82	667.400	1100	236	265	48	64	2
2	3		0.005	0.74	668.9	930	229	258	49	59	2
3	9		0.005	0.70	670.4	1014	229	257	46	61	2
4	12		0.005	0.73	671.2	1164	228	257	47	59	2
5	15		0.010	1.45	673.0	1134	215	254	46	58	2
6	18	1223	0.010	1.48	674.9	1119	218	252	46	59	1
					676.650	1095	224	248	46	59	1
						(9.2500)		LKOK	0.003	5	

WESTON
LABORATORY

Comments: 944-163 1197-139
1044-152 1134-145
1080 148

ERG A/Bigs
1

[illegible]

WESTON[®]
AVALON 117
DI SEAT HELICOPTERS AVAILABLE

Comments:

EPA Method 5 - Particulate

Page 1 of 2

TRAVELER POINT No.	SAMPLE TIME (min)	CLOCK TIME (min)	VELOCITY PRESSURE (in H ₂ O)	PRIME PRESSURE Dens H (in H ₂ O)	WATER READING (ft)	STACK TEMP (°F)	INLET TEMP (°F)	ROOM TEMP (°F)	INLET BOX TEMP (°F)	IMPING EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
	0	1331			686.805							
B 1	3		0.005	0.74	690.4	1114	212	248	51	56	1	
2	6		0.005	0.74	692.0	1098	220	248	50	58	1	
3	9		0.005	0.74	692.9	1099	236	248	51	57	1	
4	12		0.005	0.72	694.3	1148	230	258	49	60	1	
5	15		0.005	0.70	695.5	1211	230	248	49	61	1	
6	18	1349	0.005	0.73	696.848	1136	220	260	48	62	1	
	0	1358			696.920	1080	0.006	4 in				
C 1	3		0.005	0.74	698.3	1080	228	249	48	62	2	
2	6		0.005	0.74	699.8	1174	229	257	48	62	2	
3	9		0.005	0.70	701.1	1226	228	247	47	62	2	
4	12		0.005	0.74	702.5	1104	228	246	48	62	2	
5	15		0.010	1.48	704.3	1088	233	260	48	63	2	
6	18	1416	0.010	1.48	706.128	1067	234	261	48	64	2	
A	0	1427			706.300	9208	0.005	6 in				
A 1	3		0.005	0.82	707.7	944	229	248	50	61	2	
2	6		0.005	0.82	709.3	934	230	252	50	64	2	
3	9		0.005	0.76	710.6	1062	231	248	48	65	2	
4	12		0.005	0.76	712.0	1043	231	249	49	65	2	
5	15		0.010	1.52	713.9	1047	229	253	49	66	2	
6	18	1445	0.010	1.39	715.757	1162	229	254	49	67	2	
						(9.452)	LOCK	0.004	5 in			

WESTON[®]
IN SEAL ESCORTS TRAILS
AVAILABLE

Comments: 9/14/163
10/44-152
1080 148

ISOKINETIC FIELD DATA SHEET

Client	CLARKSTOWN LANDFILL	Operator	ERGA
Source	Flare	Run No.	2
Sample Loc.	Stack	Date	10-Jan-98

[illegible]

WESTON
MANAGING
DESIGN • PROJECTS • FINANCE

Comments:

EPA Method 5 - Particulate

Page 1 of 2

INTEGRITY TEST NO.	SAMPLE TIME (min)	CLOCK TIME (plan) (time)	VELOCITY PRESSURE Delta P (in H ₂ O)	ORIFICE PRESSURE Delta H (in H ₂ O)	PITOT-STATIC METER READING (in")	B (deg) TEMP (°F)	PIPE TEMP (°F)	OUTLET TEMP (°F)	FILTERED BOX TEMP (F)	INFILTRATION EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
D	0	1546			735.200							
1	3		0.005	0.70	736.6	1066	226	249	55	64	1	
2	6		0.005	0.70	738.0	1084	231	248	54	64	1	
3	9		0.010	1.38	740.0	1126	232	250	54	66	1	
4	12		0.010	1.38	741.6	1127	233	249	55	67	1	
5	15		0.005	0.69	742.9	1121	234	256	52	69	1	
6	18	1604	0.010	1.40	744.842	1065	231	253	53	69	1	
C	0	1616	0.012		744.950	(9.640)	LK OK 0.004(0)					
1	3		0.005	0.70	746.4	1069	228	256	53	65	1	
2	6		0.005	0.70	747.9	1068	229	251	51	66	1	
3	9		0.010	1.40	749.6	1099	230	252	52	66	1	
4	12		0.010	1.40	751.3	1140	231	253	52	68	2	
5	15		0.010	1.40	753.2	1093	230	249	50	68	2	
6	18	1630	0.005	0.69	754.482	1147	231	250	50	69	2	
B	0	1636	0.01640		754.650	(9.530)	LK OK 0.004(0)					
B/1	3		0.005	0.70	756.2	1068	226	248	52	68	2	
2	6		0.005	0.70	757.3	1030	229	249	52	68	2	
3	9		0.005	0.70	758.3	1053	230	248	52	68	2	
4	12		0.005	0.70	760.2	1020	231	250	53	67	2	
5	15		0.010	0.140	761.8	1041	230	258	53	67	2	
6	18	1658	0.005	0.69	763.300	1157	231	255	50	68	2	
						(8.650)	LK OK 0.003(0)					

WESTON
NATURAL GAS
URSA-MINORIS LIMITED

Comments:	944/-154	1197-133
	1044/-144	1134-138
	1080-140	

SAMPLE RECOVERY FIELD DATA

EPA Method 5 - Particulate

Client CLARKSTOWN LANDFILL W.O. # 03228-018-001-1500-00
 Location/Plant CLARKSTOWN NY Source & Location Flare Stack

Run No. 1 Sample Date 9-Jan-98 Recovery Date 17 FEB 99
 Sample I.D. CL - FL - STK - 1 - M5 - 17FEB1999 Analyst RE/TB Filter Number W-78

	Impinger						Imp.Total	7	Total
	1	2	3	4	5	6			
Contents	Di H2O	Di H2O	Empty					Silica Gel	
Final	128	107	0				235	311.2	
Initial	100	100	0				200	300	
Gain	28	7	0				35	11.2	46.2

Impinger Color Clear Labeled? Y
 Silica Gel Condition Good Sealed? Y

Run No. 2 Sample Date 10-Jan-98 Recovery Date 17 FEB 99
 Sample I.D. CL - FL - STK - 2 - M5 - 17FEB1999 Analyst RE/TB Filter Number W-79

	Impinger						Imp.Total	7	Total
	1	2	3	4	5	6			
Contents	Di H2O	Di H2O	Empty					Silica Gel	
Final	150	102	0					307.9	
Initial	100	100	0					300	
Gain	50	2	0				52	7.9	59.9

Impinger Color Clear Labeled? Y
 Silica Gel Condition Good Sealed? Y

Run No. 3 Sample Date 11-Jan-98 Recovery Date 17 FEB 99
 Sample I.D. CL - FL - STK - 3 - M5 - 17FEB1999 Analyst RE/TB Filter Number W-80

	Impinger						Imp.Total	7	Total
	1	2	3	4	5	6			
Contents	Di H2O	Di H2O	Empty					Silica Gel	
Final			0					309.3	
Initial	100	100	0					300	
Gain			0				40	9.3	49.3

Impinger Color Clear Labeled? Y
 Silica Gel Condition Good Sealed? Y

Check COC for Sample IDs of Blank Trains and/or Media Blanks



CANISTER FIELD DATA

CLIENT
PLANT
SOURCE
PARAMETER

CLARKSON LANDFILL
CLARKSON, N.Y.
OUTLET

METHOD
W.O. #

T0-14
03228-08-M1

DATE	2-17-99	2/17/99	2-17-99
RUN #	1	2	3
CAN #	3686	1191	1509
SAMPLE ID			
SAMPLE FLOW RATE, ml/min			
BAROMETRIC PRESS, Pb	30.07	30.07	30.07
START TIME			
END TIME			
TOTAL SAMPLE TIME			
FINAL VAC READING, in Hg	3.5	4	
INITIAL VAC READING, in Hg	28"	28"	28"
TOTAL VAC DROP, in Hg			

VAC READING (in Hg)/TIME			
1	28 1116	28 1332	28 1546
2			
3	22 1136	23 1342	20 1600
4			
5	15.5 1136	15 1357	17 1607
6			
7	12.5 1146	12 1405	11 1622
8			
9	8 1200	8.5 1417	9 1629
10			
11	6.5 1210		7 1639
12	3.5 1216	4 1432	5 1646

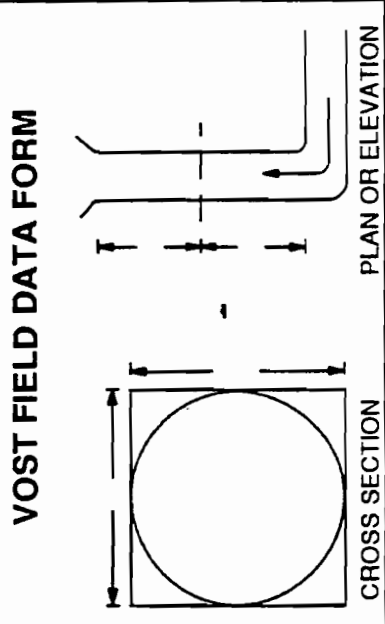
OPERATOR

M/S





CLIENT Chas. S. Stinson Landfill
PLANT PLANT
LOCATION PLANT
OPERATOR M. J. S. DATE 2/12/99
RUN NO. ONE
AMBIENT TEMP. (deg F) 40
BARO. PRESS. (in Hg) 30.07
METER BOX NO. WEST 2
METER BOX ΔH @ N/A
METER BOX CAL. (Y) 1.0181
PROBE LENGTH (ft) 3 FT
PROBE LINER MATERIAL OVEN
PROBE HEATER SETTING
K FACTOR



TENAX TUBE SAMPLE NUMBERS
SET ONE CL-R1-MW30-TP1 #8614
SET TWO CL-R1-MW30-TP2 #8612
SET THREE CL-R1-MW30-TP3 #8606
SET FOUR CL-R1-MW30-TP4 #8608
SET FIVE
SET SIX
STACK BLANK

LEAK CHECKS SET ONE: SET TWO: SET THREE: SET FOUR: SET FIVE: SET SIX:
INITIAL: 4024/2/99 1028/2/99 1028/2/99 1028/2/99 1028/2/99
FINAL: 4024/2/99 1028/2/99 1028/2/99 1028/2/99 1028/2/99

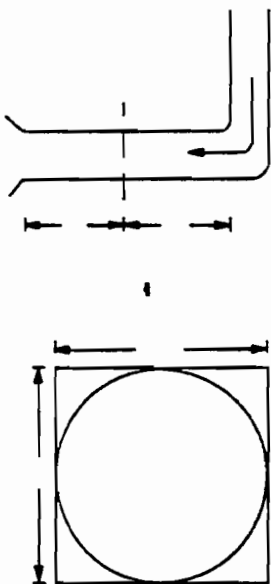
TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	ROTO-METER SETTING	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H2O)	GAS METER READING (liter)	DRY GAS METER TEMPERATURE INLET (deg C) OUTLET (deg C)	PROBE TEMP. (deg C)	PUMP VACUUM (in. Hg gauge)	FIRST CONDENS. EXIT GAS TEMP. (deg C)	SECOND CONDENS. EXIT GAS TEMP. (deg C)
1	0	1112	72	1.6	6535.990	17 17	145	3	10	12
2	5		72	1.6	6540.7	17 16	182	4	10	11
3	10		72	1.6	6545.5	17 17	193	4	10	12
4	15	1133	72	1.6	6550.2	17 17	195	4	11	13
5	20		72	1.6	6556.570	17 17		4		
6				1.60	6558.58	17 17				
7	0	1143			6556.940					
8	5		72	1.6	6561.2	16 16	176	4	8	9
9	10		72	1.6	6566.4	16 16	184	4	8	9
10	15		72	1.6	6570.9	16 16	210	4	8	9
11	20	1203	72	1.6	6575.490	17 17	209	4.5	8	9
12				1.60	6575.490	17 17				
13	0	1212			6576.040					
14	5	1212	72	1.6	6580.6	16 16	143	4	8	9
15	10		72	1.6	6585.2	17 17	163	4	8	9
16	15		72	1.6	6589.8	17 17	172	4	9	10
17	20	1232	72	1.6	6594.200	17 16	157	4	9	10
18	TOTAL			1.60	6594.200	17 16	157	4	9	10
19				1.60	18.16	16.625				

COMMENTS:



CLIENT Chickadee Landfill
PLANT Chickadee NY
LOCATION From State
OPERATOR Mills
RUN NO. Two DATE 2/12/98
AMBIENT TEMP. (deg F) 40
BARO. PRESS. (in Hg) 30.04
METER BOX NO. 10512
METER BOX ΔH@ N/A
METER BOX CAL. (Y) 1.0181
PROBE LENGTH (in) 3.5
PROBE LINER MATERIAL Q-2
PROBE HEATER SETTING
K FACTOR

VOST FIELD DATA FORM



CROSS SECTION

PLAN OR ELEVATION

LEAK CHECKS SET ONE: SET TWO: SET THREE: SET FOUR: SET FIVE: SET SIX:
INITIAL: 402 4/10/95 402 4/10/95 402 4/10/95 402 4/10/95 402 4/10/95 402 4/10/95
FINAL: 402 4/10/95 402 4/10/95 402 4/10/95 402 4/10/95 402 4/10/95 402 4/10/95

TENAX TUBE SAMPLE NUMBERS
SET ONE Q-2-10030-TP1 #8605
SET TWO Q-2-10030-TP2 #8617
SET THREE Q-2-10030-TP3 #8602
SET FOUR Q-2-10030-TP4 #8604
SET FIVE
SET SIX
STACK BLANK Q-2-10030-TP5 #8607

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	ROTO-METER SETTING	ORIFICE PRESSURE DIFFERENTIAL (delta H) (in. H ₂ O)	GAS METER READING (liter)	DRY GAS METER TEMPERATURE		PROBE TEMP. (deg C)	PUMP VACUUM (in. Hg gauge)	FIRST CONDENS. EXIT GAS TEMP. (deg C)	SECOND CONDENS. EXIT GAS TEMP. (deg C)
						INLET (deg C)	OUTLET (deg C)				
AX	0	1330	74	1.6	6616.890	18	16	230	4	12	13
	5		72	1.6	6622.0	17	16	205	4	11	11
	10		72	1.6	6631.7	17	17	234	4	12	13
	15		72	1.6	6636.550	22	20	250	4	11	11
	20	1350	72	1.60	19.66	17.875					
AX	0	1357			6636.850						
	5		74	1.6	6641.5	21	22	142	4	16	17
	10		74	1.6	6646.2	17	18	139	4	12	13
	15		72	1.6	6650.8	17	17	149	4	10	9
	20	1417	72	1.60	6655.40	16	17	215	4	10	10
AX	0			1.60	18.53	18.105					
	5	1420	72	1.6	6655.980	16	16	207	4	10	9
	10		72	1.6	6660.5	16	16	149	4	10	9
	15		72	1.6	6665.3	17	17	228	4	10	10
	20	1459	72	1.60	6669.8	17	17	222	4	10	9
TOTAL				AVG. ΔH	TOTAL V _m	AVG. T _m		AVG. T _s	MAX. VAC.	MAX. TEMP.	MAX. TEMP.

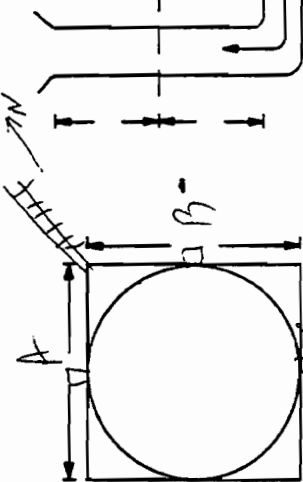
COMMENTS:



SHEET

OF

VOST FIELD DATA FORM



CROSS SECTION PLAN OR ELEVATION

CLIENT <u>Chickston</u>	TENAX TUBE SAMPLE NUMBERS
PLANT <u>Flare</u>	SET ONE <u>Q-13-mw30-771</u> #8613
OPERATOR <u>Willis</u>	SET TWO <u>Q-13-mw30-772</u> #8609
RUN NO. <u>3</u>	SET THREE <u>Q-13-mw30-773</u> #8601
DATE <u>11/2/99</u>	SET FOUR <u>Q-13-mw30-774</u> #8615
AMBIENT TEMP. (deg F) <u>40</u>	SET FIVE
BARO. PRESS. (in Hg) <u>29.98</u>	SET SIX
METER BOX NO. <u>40512</u>	STACK BLANK <u>Q-23-mw30-779</u> #8610
METER BOX A/H @ <u>N/A</u>	
METER BOX CAL. (Y) <u>10/8/1</u>	
PROBE LENGTH (ft) <u>3.75</u>	
PROBE LINER MATERIAL <u>Quartz</u>	
PROBE HEATER SETTING	
K FACTOR	

LEAK CHECKS SET ONE: SET TWO: SET THREE: SET FOUR: SET FIVE: SET SIX:

INITIAL: 902-4740-13 4024013 4024012 4024010 4024007

FINAL: 4024708 4024706 4024707 4024707

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	ROTO-METER SETTING	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H ₂ O)	GAS METER READING (liter)	DRY GAS METER TEMPERATURE INLET (deg C) OUTLET (deg C)	PROBE TEMP. (deg C)	PUMP VACUUM (in. Hg gauge)	FIRST CONDENS. EXIT GAS TEMP. (deg C)	SECOND CONDENS. EXIT GAS TEMP. (deg C)
0	0	1546	72	1.6	6695.60	20	165	3	13	13
5	5		72	1.6	6704.6	22	179	3	10	10
10	10		72	1.6	6709.0	24	232	3	15	16
15	15		72	1.6	6713.560	17	191	3	11	10
20	20			1.60	18.40	210				
0	0	1613			6714.003					
5	5		73	1.6	6718.7	17	150	3	11	11
10	10		72	1.6	6723.2	19	162	3	14	13
15	15		72	1.6	6728.0	19	165	3	12	11
20	20	1633	72	1.6	6732.320	19	194	3	13	12
				1.60	18.37	18.50				
0	0	1642			6732.750					
5	5		72	1.6	6737.8	19	153	3	14	13
10	10		72	1.6	6742.8	20	146	3	14	13
15	15		73	1.6	6747.7	20	154	3	13	16
20	20	1702	73	1.6	6752.470	20	166	3	12	13
TOTAL				1.60	19.72	19.875				

COMMENTS:



**CLARKSTOWN LANDFILL
GAS FLOW DATA SUMMARY
FLARE STACK
18-Feb-99**

RUN NUMBER	1			2			3		
TIME	0942-1026			1051-1138			1204-1253		
LOCATION	FLARE STACK			FLARE STACK			FLARE STACK		
Traverse Point No.	Velocity Head in. H ₂ O	Stack Temp. deg F	Static Press. in. H ₂ O	Velocity Head in. H ₂ O	Stack Temp. deg F	Static Press. in. H ₂ O	Velocity Head in. H ₂ O	Stack Temp. deg F	Static Press. in. H ₂ O
Point 1	0.0075	1052		0.0100	1218		0.0075	1060	
Point 2	0.0075	1040		0.0050	1223		0.0075	1120	
Point 3	0.0050	1033		0.0050	1080		0.0050	1135	
Point 4	0.0050	1029		0.0050	1040		0.0050	1142	
Point 5	0.0050	1006		0.0050	1034		0.0050	1089	
Point 6	0.0050	972		0.0050	1005		0.0050	1020	
Point 7	0.0050	1040		0.0075	1131		0.0050	1077	
Point 8	0.0075	1045	-0.05	0.0100	1147	-0.06	0.0050	1133	-0.06
Point 9	0.0100	1056		0.0125	1185		0.0100	1145	
Point 10	0.0100	1055		0.0100	1193		0.0100	1180	
Point 11	0.0075	982		0.0075	1114		0.0100	1068	
Point 12	0.0050	870		0.0050	1049		0.0050	1027	
Point 13	0.0100	1052		0.0100	1082		0.0100	1068	
Point 14	0.0100	1110		0.0100	1132		0.0100	1142	
Point 15	0.0075	1063		0.0075	1172		0.0075	1186	
Point 16	0.0050	1054		0.0050	1206		0.0050	1193	
Point 17	0.0050	1037		0.0050	1145		0.0050	1159	
Point 18	0.0050	975		0.0050	1072		0.0050	1093	
Point 19	0.0050	1020		0.0050	1054		0.0050	1030	
Point 20	0.0100	1035		0.0100	1132		0.0125	1147	
Point 21	0.0125	1042		0.0125	1150		0.0100	1162	
Point 22	0.0100	1031		0.0100	1130		0.0075	1184	
Point 23	0.0075	1016		0.0075	1058		0.0050	1192	
Point 24	0.0075	976		0.0050	1007		0.0050	1091	
Averages	0.0073	1024.6	-0.050	0.0075	1115.0	-0.06	0.0070	1118.5	-0.06
Velocity Inputs									
Avg. Square Root of Delta P, in. H ₂ O		0.08438			0.08533			0.08239	
Pitot Tube Coefficient		0.84			0.84			0.84	
Barometric Pressure, in. Hg		29.96			29.96			29.96	
Static Pressure, in. H ₂ O		-0.050			-0.06			-0.06	
Stack Pressure, in. Hg		29.96			29.96			29.96	
Stack Cross-sectional Area, ft ²		69.644			69.644			69.644	
Moisture Inputs									
Avg. orifice press. diff., in. H ₂ O		1.80			1.80			1.80	
Avg. dry gas meter temp., deg F		60.8			58.8			58.3	
Dry gas meter calibration factor		1.0116			1.0116			1.0116	
Sample vol. at meter cond., dcf		30.135			31.698			34.302	
Volume H ₂ O imp. (ml)		41.0			39.0			42.0	
Weight chnge sil. gel (g)		6.1			7.6			2.5	
Sample vol. at std. cond., dscf (1)		31.075			32.812			35.542	
Std. vol. of H ₂ O vapor coll., cu.ft		2.217			2.194			2.095	
H ₂ O vapor in gas stream, prop. by vol.		0.067			0.063			0.056	
Stack Gas Composition									
Temperature, deg F		1024.6			1115.0			1118.5	
Moisture, %		6.7			6.3			5.6	
CO ₂ Concentration, %		4.7			4.6			4.6	
O ₂ Concentration, %		15.5			15.4			16.0	
Molecular Weight, lb/lb-mole		28.6			28.6			28.7	
Volumetric Flow Rate									
Velocity, ft/sec		8.0			8.3			8.0	
At Stack Conditions, ACFM		33323			34691			33476	
At Standard Conditions, DSCFM		11071			10910			10583	
Wet SCFM		11861			11639			11207	

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 inches Hg (760mm Hg).

Determination of Stack Gas Velocity - Method 2

Client CLARKSTOWN LANDELL
 Location/Plant CLARKSTOWN, NY
 Source OUTLET

Operator TB-JM
 Date 2-18-99
 Pitot Tube/Thermo ID P71

Pitot Coeff (Cp) .84
 Stack Area, ft² (As) 69.64

Run Number	1	2	3
Time	<u>0950-1015</u>	<u>1051-1120-1136</u>	<u>1231-1248</u>
Barometric Press, in Hg (Pb)	<u>29.96</u>	<u>29.96</u>	<u>29.96</u>
Static Press, in H ₂ O (Pstatic)	<u>- .05</u>	<u>- .06</u>	<u>- .06</u>
Source Moisture, % (BWS)			
O ₂ , %			
CO ₂ , %			

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y/N		Leak Check good ? Y/N		Leak Check good ? Y/N	
Delta P at 0°	Angle yielding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
		A	1	0.0075	1052	0.010	1218	0.0075	1060
			2	0.0075	1040	0.005	1223	0.0075	1120
			3	0.005	1033	0.005	1090	0.005	1135
			4	0.005	1029	0.005	1040	0.005	1142
			5	0.005	1006	0.005	1074	0.005	1089
			6	0.005	972	0.005	1005	0.005	1020
		B	1	.005	1040	0.0075	1131	0.005	1072
			2	.0075	1045	0.01	1147	0.005	1133
			3	.010	1056	0.0125	1185	0.01	1145
			4	.010	1085	0.01	1193	0.01	1180
			5	0.0075	982	0.0075	1114	0.0075	1068
			6	0.005	870	0.005	1049	0.005	1027
		C	1	0.01	1052	0.01	1082	0.01	1068
			2	0.01	1110	0.01	1132	0.01	1142
			3	0.0075	1063	0.0075	1172	0.0075	1186
			4	0.005	1054	0.005	1206	0.005	1193
			5	0.005	1037	0.005	1145	0.005	1159
			6	0.005	975	0.005	1072	0.005	1093
		D	1	0.005	1020	0.005	1054	0.005	1030
			2	0.01	1035	0.01	1132	0.0125	1147
			3	0.0125	1042	0.0125	1150	0.01	1162
			4	0.01	1031	0.01	1130	0.0075	1184
			5	0.0075	1016	0.0075	1052	0.005	1192
			6	0.0075	976	0.005	1007	0.005	1210
Avg Angle		avg. Delta P & Temp							
Average gas stream velocity, ft/sec.									
Vol. flow rate @ actual conditions, wacf/min									
Vol. flow rate at standard conditions, dscf/min									

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * \sqrt{\Delta P * Ts / (Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:

MWd = Dry molecular weight source gas, lb/lb-mole.

MWs = Wet molecular weight source gas, lb/lb-mole.

Tsa = Source Temperature, absolute (°R)

Ps = Absolute stack static pressure, inches Hg.

Vs = Average gas stream velocity, ft/sec.

Qs(act) = Volumetric flow rate of wet stack gas at actual,

Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

WESTON
 MANAGERS DESIGNERS/CONSULTANTS

Comments _____

Determination of Moisture Content in Stack Gases - Method 4

Client CLARKSTOWN LANDFILL

Operator TB

Date 2-18-99

Location/Plant CLARKSTOWN, NY

Meter Box ID 14

Meter Box Y 1,907.4/1,011.6

Source OUTLET

Temperature C° or F° F

Sample Volume, ft³ or L FT3

Run Number	Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H ₂ O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
1			Inlet	Outlet					Initial <u>1002015</u>
	End Test	<u>1026</u>	<u>801.760</u>	<u>52</u>	<u>58</u>	<u>1.8</u>	<u>241</u>	<u>306.1</u>	Final <u>1002015</u>
Baro Press., Pb (in Hg)	Start Test	<u>0942</u>	<u>771.625</u>	<u>66</u>	<u>67</u>	<u>1.8</u>	<u>200</u>	<u>300</u>	Moisture Volume, Vw(std)
<u>29.96</u>	Avg. or Total	<u>43</u>	<u>301.35</u>	<u>60.75</u>	<u>1.8</u>	<u>41</u>	<u>6.1</u>		Percent Moisture (%), BWS <u>6.66</u>

Run Number	Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H ₂ O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
2			Inlet	Outlet					Initial <u>1002015</u>
	End Test	<u>1138</u>	<u>833.498</u>	<u>67</u>	<u>57</u>	<u>1.8</u>	<u>239</u>	<u>313.7</u>	Final <u>1002015</u>
Baro Press., Pb (in Hg)	Start Test	<u>1051</u>	<u>801.800</u>	<u>56</u>	<u>55</u>	<u>1.8</u>	<u>200</u>	<u>306.1</u>	Moisture Volume, Vw(std)
<u>29.96</u>	Avg. or Total	<u>47</u>	<u>31.698</u>	<u>58.75</u>	<u>1.8</u>	<u>39</u>	<u>7.6</u>		Percent Moisture (%), BWS <u>6.27</u>

Run Number	Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H ₂ O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
3			Inlet	Outlet					Initial <u>1002012</u>
	End Test	<u>1253</u>	<u>867.928</u>	<u>67</u>	<u>56</u>	<u>1.8</u>	<u>242</u>	<u>316.2</u>	Final
Baro Press., Pb (in Hg)	Start Test	<u>1204</u>	<u>833.626</u>	<u>56</u>	<u>54</u>	<u>1.8</u>	<u>200</u>	<u>313.7</u>	Moisture Volume, Vw(std)
<u>29.96</u>	Avg. or Total		<u>34.302</u>	<u>58.25</u>	<u>1.8</u>	<u>42</u>	<u>2.5</u>		Percent Moisture (%), BWS

$$Vm(std) = \frac{17.64 \cdot Y \cdot Vm \cdot (Pb + (\Delta H / 13.6))}{(Tm + 460)}$$

If Tm is C° than Tm = (Tmc * 1.8) + 32

If Vm is liters than Vm = Vml * 28.32

$$Vw(std) = (0.04707 \cdot Vwc) + (0.04715 \cdot Wwsg)$$

$$BWS = \left(\frac{Vw(std)}{Vw(std) + Vm(std)} \right) \cdot 100$$

WHERE:

Vm(std) = Sample volume corrected to standard temp and pressure, scf or L

Vm = Actual sample volume, calculated, scf

Vml = Actual sample volume, calculated, Liters

Y = Dry gas meter calibration factor.

Pb = Barometric pressure, in. Hg

Delta H = Meter pressure, in H₂O

Tm = Average temperature of meter (DGM is used) or rotometer, degrees °

Tmc = Average temperature of meter (DGM is used) or rotometer, degrees °

Vw(std) = Volume of water vapor at standard conditions, scf or L

Vwc = Volume of water condensed, mL

Wwsg = Weight of Silica Gel, g

Bws = Water vapor in gas stream, percent

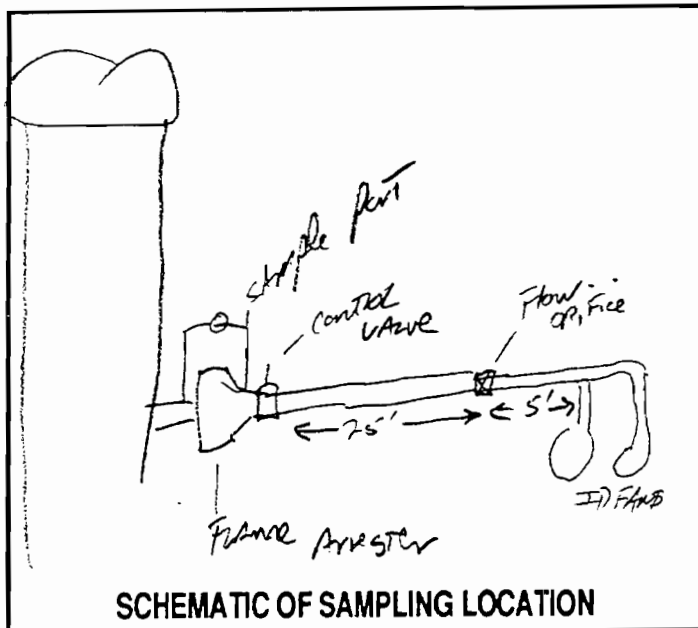
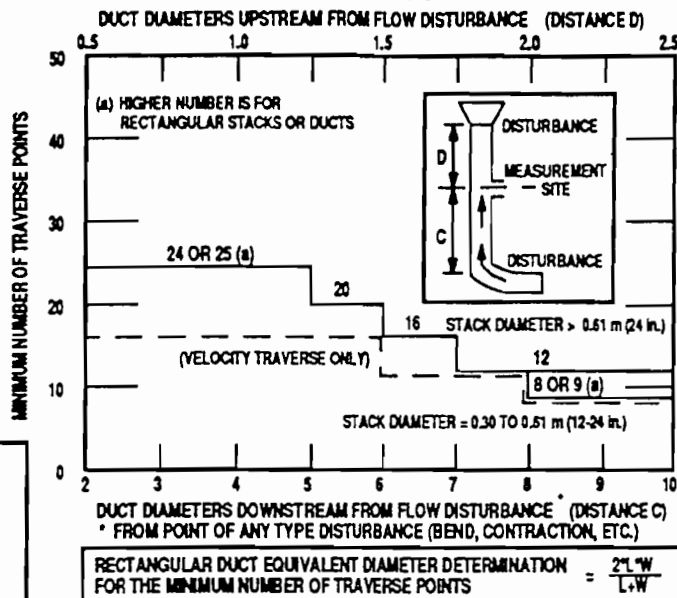
WESTON

Use either ft³ or liters in calculations. DO NOT MIX CUBIC FEET AND LITERS IN ANY CALCULATION.



TRAVERSE POINT LOCATION FOR CIRCULAR AND RECTANGULAR DUCTS

PLANT CLARKSON LANDFILL
 DATE 2/17/99
 SAMPLING LOCATION Fine Stack Inlet
 INSIDE OF FAR WALL TO _____
 OUTSIDE OF PORT (DISTANCE A) _____
 INSIDE OF NEAR WALL TO _____
 OUTSIDE OF PORT (DISTANCE B) _____
 STACK I.D. (DISTANCE A - DISTANCE B) 8"
 NEAREST UPSTREAM DISTURBANCE (C) _____
 NEAREST DOWNSTREAM DISTURBANCE (D) _____
 CALCULATOR _____



LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.8	12.9	11.8	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.8	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

CANISTER FIELD DATA

CLIENT
PLANT
SOURCE
PARAMETER

CLARKSON L.F.
CLARKSON, N.Y.
INLET

METHOD
W.O. #

TO-14
03228-018-001

DATE	2-17-99	2/17/99	2/17/99
RUN #	1	2	3
CAN #	1189	3628	1193
SAMPLE ID			
SAMPLE FLOW RATE, ml/min	8		
BAROMETRIC PRESS, Pb	30.07	30.07	
START TIME	1116	1331	1546
END TIME	1216	1431	
TOTAL SAMPLE TIME			

FINAL VAC READING, in Hg	3"	4.0	
INITIAL VAC READING, in Hg	28"	28.0	27.5
TOTAL VAC DROP, in Hg	25"	24.0	

VAC READING (in Hg)/TIME

1	28" 1116	28" 1331	27.5 1546
2			
3	22" 1126	22.5 1341	20.5 1601
4			
5	18" 1136	15" 1356	15" 1611
6			
7	12.5" 1146	11.5 1406	11" 1621
8			
9	8" 1201	7.0 1418	8.5 1630
10			
11	4.5 1212	4.0 1431	4.0 1639
12			4" 1646

OPERATOR _____

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Client CLARKSTOWN LANDFILL Operator KIT Pitot Coeff (Cp)
Location/Plant CLARKSTOWN, NY Date 2/17/99 Stack Area, ft² (As)
Source FLARE INLET Pitot Tube/Thermo ID

Run Number	1	2	3
Time	1112-1247	1331-1516	1546-1731
Barometric Press, in Hg (Pb)	~~30.05~~ (11)	30.07	30.07
Static Press, in H ₂ O (Pstatic)	30.07	~~30.07~~	30.07 (12)
Source Moisture, % (BWS)	_____	_____	_____
O ₂ , %	_____	_____	_____
CO ₂ , %	_____	_____	_____

Cyclonic Flow Determination		Traverse Location		Leak Check good? $\sim 40^\circ\text{F}$ Y/N		Leak Check good? $\sim 50^\circ\text{F}$ Y/N	
Delta P at 0°	Angle yielding zero Delta P	Port	Point	Delta P	Source Temp, $^\circ\text{F}$ (Ts)	Delta P	Source Temp, $^\circ\text{F}$ (Ts)
				TIME	FLW-CFM	TIME	FLW-CFM
				1112	411	1331	455
				1117	419	1346	404
				1132	420	1401	416
				1147	443	1416	406
				1202	450	1431	380
				1217	458	1446	419
				1232	419	1501	451
				1247	407	1516	456
					428		423
				2/18/99	(0958-1043) 29.96	(1056-1148) 29.96	(1206-1263) 29.96
				0958	442	1056	441
				1010	444	1104	457
				1016	465	1110	452
				1023-1021	423	1119	453
				1026	442	1122	450
				1036	445	1124	456
				1043	439	1142	468
						1178	443
					440		442
							442
Avg Angle		Avg Delta P & Temp avg $\sqrt{\text{Delta P}}$					
Average gas stream velocity, ft/sec.							
Vol. flow rate @ actual conditions, wact/min							
Vol. flow rate at standard conditions, dscf/min							

Comments Readings taken from flame control panel.

$Q_s(\text{std})$ = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

WESTON
MANAGI E PIÙ
CONSERVARE IL COMPLESSIVO



CLIENT: CLARKSTOWN LANDFILL CEM CALIBRATION
PLANT: CLARKSTOWN, NY DATA SHEET
LOCATION: CLARKSTOWN, NY (KB) FLARE STACK
OPERATOR: KIT

DATE: 2/17/99
RUN NO.: ONE
START: 1112
STOP: 1212

		INTERNAL CALIBRATION			SYSTEM BIAS					
		TIME			PRE-TEST			POST-TEST		
			ANAL	%	ANAL	%	ANAL	%	%	AVG
		KNOWN	RESP.	DIFF.	RESP.	DIFF.	RESP.	DIFF.	DRIFT	BIAS
CO	ZERO	0.0	0.1		0.2	0.2	0.2			0.2
	LOW	25.17	25.1		25.4	25.0	24.9			24.95
	MID	54.76	54.0							
	HIGH	86.09	87.3							
		100								
CO2	ZERO	0.0	0.0		0.1	0.0	0.2			0.1
	LOW	3.95	4.1							
	MID	7.95	8.0		8.0	8.1	8.0			8.05
	HIGH	16.97	17.0							
		20								
O2	ZERO	0.0	0.0		0.0	0.1	0.1			0.1
	LOW	6.95	7.0							
	MID	14.07	14.0		14.0	14.0	14.0			14.0
	HIGH	21.08	20.9							
		25								
NOx	ZERO	0.0								
	LOW	28.76								
	MID	54.08								
	HIGH	88.22								
		100								
THC	ZERO	0.0								
	LOW									
	MID									
	HIGH									
SO2	ZERO	0.0	0.1		0.2	0.3	0.1			0.2
	LOW	40.8	40.4		39.1	38.4	39.2			38.8
	MID									
	HIGH	88.06	87.0							
		100								
	ZERO	0.0								
	LOW									
	MID									
	HIGH									

* API NOx ANALYZER DOWN. WITH PERSONAL NOx TESTING 2/18.



CLIENT: CLARKSTOWN LANDFILL CEM CALIBRATION
PLANT: CLARKSTOWN, NY DATA SHEET
LOCATION: FLAME STACK
OPERATOR: KH

DATE: 2/17/98
RUN NO.: TWO
★ START: 1405
STOP: 1511

		INTERNAL CALIBRATION			SYSTEM BIAS					
		TIME			PRE-TEST			POST-TEST		
			ANAL	%	ANAL	%		ANAL	%	
		KNOWN	RESP.	DIFF.	RESP.	DIFF.		RESP.	DIFF.	DRIFT
CO ppm range 100	ZERO	0.0			0.2			0.2		0.2
	LOW	25.17			24.9			24.8		24.85
	MID									
	HIGH									
CO2 % range 20	ZERO	0.0			0.2			0.2		0.2
	LOW									
	MID	7.95			7.9			8.0		7.95
	HIGH									
O2 % range 25	ZERO	0.0			0.1			0.1		0.1
	LOW									
	MID	14.07			14.0			13.9		13.95
	HIGH									
NOx ppm range	ZERO	0.0								
	LOW									
	MID									
	HIGH									
THC ppm range	ZERO	0.0								
	LOW									
	MID									
	HIGH									
SO2 ppm range 100	ZERO	0.0			0.2			0.2		0.2
	LOW	40.8			39.1			40.1		39.6
	MID									
	HIGH									
range	ZERO	0.0								
	LOW									
	MID									
	HIGH									

★ Note ccm probe @ 1443 - MS Train traversing each point. Back end @ 1447



CLIENT: CLARKSTOWN LANDFILL CEM CALIBRATION
PLANT: CLARKSTOWN, NY DATA SHEET
LOCATION: FLAME STACK
OPERATOR: 124/TB

DATE: 2/18/99
RUN NO.: ONE
START: 0937
STOP: 1037

INTERNAL CALIBRATION PRE-TEST POST-TEST
TIME 0858 0833 1038
ANAL % ANAL % ANAL %
KNOWN RESP. DIFF. RESP. DIFF. RESP. DIFF. DRIFT BIAS

CO	ZERO	0.0								
ppm	LOW	25.17								
range	MID	54.26								
100	HIGH	86.09								

CO2	ZERO	0.0	0.0		0.1		0.2			0.15
%	LOW	3.95	4.0							
range	MID	7.95	7.9	8.0	7.9		8.0			7.95
20	HIGH	16.97	16.7							

O2	ZERO	0.0	0.0		0.0		0.1			0.05
%	LOW	6.95	7.0							
range	MID	14.07	14.0		13.9		13.9			13.9
25	HIGH	21.08	20.9							

NOx	ZERO	0.0	0.0		0.1	0.3	0.3			0.1
ppm	LOW	25.76	25.8		25.7		25.5			25.6
range	MID	54.08	56.0							
100	HIGH	88.27	90.0							

THC	ZERO	0.0								
ppm	LOW									
range	MID									
	HIGH									

SO2	ZERO	0.0								
ppm	LOW	40.8								
range	MID									
100	HIGH	88.06								

	ZERO	0.0								
	LOW									
range	MID									
	HIGH									

* NOx, CO2/O2 ONLY TODAY.

[illegible]

APPENDIX C
ANALYTICAL LABORATORY DATA

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INDUSTRIAL HYGIENE

- EPA/NVLAP 101262-0
- AIHA ACCREDITATION NO. 8707

ENVIRONMENTAL TESTING

- NY DOH 10903
- PA DER 06-353
- NJ DEP 77678

March 8, 1999

Jack Mills
Roy F. Weston, Inc.
Weston Way
West Chester PA 19380-1499

Laboratory Project: 179268
Client Reference: Clarkstown Landfill, Clarkstown NY
WO #03228-018-001-1500-00

Dear Mr. Mills:

The samples which were logged in on 19-FEB-99 have been analyzed as requested.
The analytical results are enclosed in the attached report.

Please note that any unused portion of the samples will be disposed after 02-APR-99,
unless you have requested otherwise.

Thank you for the opportunity to provide these services to you. If you have any questions
concerning this report, please contact a Client Services representative at 610/921-8833.

Sincerely,

A handwritten signature in cursive script, appearing to read "Fred Usbeck".

Fred Usbeck, CIH
Director, Laboratory Services



INDUSTRIAL HYGIENE

ENVIRONMENTAL TESTING

- EPA/NVLAP 101262-0
- AIHA ACCREDITATION NO. 8707

- NY DOH 10903
- PA DER 06-353

- NJ DEP 77678

ANALYTICAL REPORT

Client: Roy F. Weston, Inc.
Report to: Jack Mills
Roy F. Weston, Inc.
Weston Way
West Chester PA 19380-1499

Project: 179268
Received: 19-FEB-99
Reported: 08-MAR-99

PURCHASE ORDER: 130541

Project Description: Clarkstown Landfill, Clarkstown NY
WO #03228-018-001-1500-00

Sampled: 17-FEB-99

	<u>RESULT</u>	<u>UNITS</u>	<u>METHOD</u>	<u>DATE</u>	<u>ANALYST</u>
<u>CL-FL-STK-1-M5-17FEB1999-FHA/FILT (W-78)</u>					
Lab Sample: 1347196					
Wt - Acetone Probe	1.2	mg	EPA 5	24-FEB-99	VJO
Particulate Weight - Filter	0.9	mg	EPA 5	24-FEB-99	VJO
<u>CL-FL-STK-2-M5-17FEB1999-FHA/FILT (W-79)</u>					
Lab Sample: 1347197					
Wt - Acetone Probe	2.2	mg	EPA 5	24-FEB-99	VJO
Particulate Weight - Filter	0.6	mg	EPA 5	24-FEB-99	VJO
<u>CL-FL-STK-3-M5-17FEB1999-FHA/FILT (W-80)</u>					
Lab Sample: 1347198					
Wt - Acetone Probe	2.7	mg	EPA 5	24-FEB-99	VJO
Particulate Weight - Filter	0.5	mg	EPA 5	24-FEB-99	VJO
<u>CL-FL-STK-SB-M5-17FEB1999-ACE/FILT (W-81)</u>					
Lab Sample: 1347199					
Wt - Acetone Probe	0.4	mg	EPA 5	24-FEB-99	VJO
Particulate Weight - Filter	< 0.1	mg	EPA 5	24-FEB-99	VJO

REVISED REPORT

< Indicates less than the limit of quantitation.

@AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9902275

Work Order Summary

CLIENT: Mr. Peter Virag
Roy F. Weston, Inc.
One Weston Way
West Chester, PA 19380-1499

BILL TO: Same

PHONE: 610-701-3000
FAX: 610-701-7401
DATE RECEIVED: 2/19/99
DATE COMPLETED: 3/4/99

P.O. # NR
PROJECT # Charlestown Landfill

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>
01A/B	CI-R1-M0030-TP1	VOST 5041A/8260B
02A/B	CI-R1-M0030-TP2	VOST 5041A/8260B
03A/B	CI-R1-M0030-TP3	VOST 5041A/8260B
04A/B*	CI-R1-M0030-TP4	VOST 5041A/8260B
05A/B	CI-R2-M0030-TP1	VOST 5041A/8260B
06A/B	CI-R2-M0030-TP2	VOST 5041A/8260B
07A/B	CI-R2-M0030-TP3	VOST 5041A/8260B
08A/B*	CI-R2-M0030-TP4	VOST 5041A/8260B
09A/B	CI-R3-M0030-TP1	VOST 5041A/8260B
10A/B	CI-R3-M0030-TP2	VOST 5041A/8260B
11A/B	CI-R3-M0030-TP3	VOST 5041A/8260B
12A/B*	CI-R3-M0030-TP4	VOST 5041A/8260B
13A/B	CI-FB-M0030-TP	VOST 5041A/8260B
14A/B	CI-SB-M0030-TP	VOST 5041A/8260B
15A	CI-R1-M0030-COND	VOST 5041A/8260B
16A	CI-R2-M0030-COND	VOST 5041A/8260B
17A	CI-R3-M0030-COND	VOST 5041A/8260B
18A	CI-FB-M0030-COND	VOST 5041A/8260B
19A	CI-SB-M0030-COND	VOST 5041A/8260B
20A	Lab Blank	VOST 5041A/8260B
20B	Lab Blank	VOST 5041A/8260B

LAB NARRATIVE:

*Sample on hold per client's request.

CERTIFIED BY:

John Swanson for:
Laboratory Director

DATE: 3-5-99

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-TP1

ID#: 9902275-01A/B

Modified VOST 5041A/8260B

File Name:	9022608	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	20
Vinyl Chloride	10	Not Detected
Bromomethane	10	51 B
Chloroethane	10	Not Detected
Freon 11	10	25
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	280
Methylene Chloride	10	57
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	10000 E
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	610
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	15
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

E = Exceeds instrument calibration range.

Container Type: VOST Tube

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-TP1

ID#: 9902275-01A/B

Modified VOST 5041A/8260B

File Name:	9022608	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	88	70-130
1,2-Dichloroethane-d4	82	69-112
Toluene-d8	99	72-134
4-Bromofluorobenzene	100	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-TP2

ID#: 9902275-02A/B

Modified VOST 5041A/8260B

File Name:	9022609	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	26
Vinyl Chloride	10	Not Detected
Bromomethane	10	53 B
Chloroethane	10	Not Detected
Freon 11	10	23
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	78
Methylene Chloride	10	70
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	660
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	35
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	43
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	18

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	96	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-TP2

ID#: 9902275-02A/B

Modified VOST 5041A/8260B

File Name:	9022609	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	89	69-112
Toluene-d8	106	72-134
4-Bromofluorobenzene	113	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-TP3

ID#: 9902275-03A/B

Modified VOST 5041A/8260B

File Name:	9022610	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	11 B
Chloroethane	10	Not Detected
Freon 11	10	22
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	68
Methylene Chloride	10	49
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	230
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	17
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	97	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-TP3

ID#: 9902275-03A/B

Modified VOST 5041A/8260B

File Name:	9022610	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	93	69-112
Toluene-d8	90	72-134
4-Bromofluorobenzene	97	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-TP1

ID#: 9902275-05A/B

Modified VOST 5041A/8260B

File Name:	9022611	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	11 B
Chloroethane	10	Not Detected
Freon 11	10	44
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	77
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	71
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	80
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	13
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	98	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-TP1

ID#: 9902275-05A/B

Modified VOST 5041A/8260B

File Name:	9022611	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	91	69-112
Toluene-d8	94	72-134
4-Bromofluorobenzene	102	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-TP2

ID#: 9902275-06A/B

Modified VOST 5041A/8260B

File Name:	9022612	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	11 B
Chloroethane	10	Not Detected
Freon 11	10	37
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	82
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	43
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	10
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	98	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-TP2

ID#: 9902275-06A/B

Modified VOST 5041A/8260B

File Name:	9022612	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	95	69-112
Toluene-d8	93	72-134
4-Bromofluorobenzene	99	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-TP3

ID#: 9902275-07A/B

Modified VOST 5041A/8260B

File Name:	9022613	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	26
Vinyl Chloride	10	Not Detected
Bromomethane	10	42 B
Chloroethane	10	Not Detected
Freon 11	10	40
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	55
Methylene Chloride	10	96
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	70
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	13
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	98	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-TP3

ID#: 9902275-07A/B

Modified VOST 5041A/8260B

File Name:	9022613	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	96	69-112
Toluene-d8	101	72-134
4-Bromofluorobenzene	111	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-TP1

ID#: 9902275-09A/B

Modified VOST 5041A/8260B

File Name:	9022614	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	16 B
Chloroethane	10	Not Detected
Freon 11	10	62
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	120
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	30
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	23
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	12
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	99	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-TP1

ID#: 9902275-09A/B

Modified VOST 5041A/8260B

File Name:	9022614	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	94	69-112
Toluene-d8	95	72-134
4-Bromofluorobenzene	107	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-TP2

ID#: 9902275-10A/B

Modified VOST 5041A/8260B

File Name:	9022615	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	59
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	88
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	21
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	12
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	10
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	99	70-130
1,2-Dichloroethane-d4	95	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-TP2

ID#: 9902275-10A/B

Modified VOST 5041A/8260B

File Name:	9022615	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
Toluene-d8	96	72-134
4-Bromofluorobenzene	113	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-TP3

ID#: 9902275-11A/B

Modified VOST 5041A/8260B

File Name:	9022616	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	89
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	170
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	24
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	20
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	18
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	99	70-130
1,2-Dichloroethane-d4	94	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-TP3

ID#: 9902275-11A/B

Modified VOST 5041A/8260B

File Name:	9022616	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
Toluene-d8	94	72-134
4-Bromofluorobenzene	108	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-FB-M0030-TP

ID#: 9902275-13A/B

Modified VOST 5041A/8260B

File Name:	9022606	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	23 B
Chloroethane	10	Not Detected
Freon 11	10	33
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	75
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	48
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	95	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-FB-M0030-TP

ID#: 9902275-13A/B

Modified VOST 5041A/8260B

File Name:	9022606	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	92	69-112
Toluene-d8	95	72-134
4-Bromofluorobenzene	108	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-SB-M0030-TP

ID#: 9902275-14A/B

Modified VOST 5041A/8260B

File Name:	9022607	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	97	70-130
1,2-Dichloroethane-d4	91	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-SB-M0030-TP

ID#: 9902275-14A/B

Modified VOST 5041A/8260B

File Name:	9022607	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
Toluene-d8	100	72-134
4-Bromofluorobenzene	100	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-COND

ID#: 9902275-15A

Modified VOST 5041A/8260B

File Name:	9022512	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	370
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	98	70-130
1,2-Dichloroethane-d4	92	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-M0030-COND

ID#: 9902275-15A

Modified VOST 5041A/8260B

File Name:	9022512	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Surrogates	% Recovery	Method Limits
Toluene-d8	97	72-134
4-Bromofluorobenzene	98	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-COND

ID#: 9902275-16A

Modified VOST 5041A/8260B

File Name:	9022513	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	280
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	101	70-130
1,2-Dichloroethane-d4	88	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-M0030-COND

ID#: 9902275-16A

Modified VOST 5041A/8260B

File Name:	9022513	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Surrogates	% Recovery	Method Limits
Toluene-d8	95	72-134
4-Bromofluorobenzene	94	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-COND

ID#: 9902275-17A

Modified VOST 5041A/8260B

File Name:	9022514	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	310
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	100	70-130
1,2-Dichloroethane-d4	94	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-M0030-COND

ID#: 9902275-17A

Modified VOST 5041A/8260B

File Name:	9022514	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Surrogates	% Recovery	Method Limits
Toluene-d8	98	72-134
4-Bromofluorobenzene	99	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-FB-M0030-COND

ID#: 9902275-18A

Modified VOST 5041A/8260B

File Name:	9022511	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	410
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	103	70-130
1,2-Dichloroethane-d4	89	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-FB-M0030-COND

ID#: 9902275-18A

Modified VOST 5041A/8260B

File Name:	9022511	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Surrogates	% Recovery	Method Limits
Toluene-d8	95	72-134
4-Bromofluorobenzene	93	78-119

AIR TOXICS LTD.

SAMPLE NAME : C1-SB-M0030-COND

ID#: 9902275-19A

Modified VOST 5041A/8260B

File Name:	9022515	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	430
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	102	70-130
1,2-Dichloroethane-d4	93	69-112

AIR TOXICS LTD.

SAMPLE NAME : C1-SB-M0030-COND

ID#: 9902275-19A

Modified VOST 5041A/8260B

File Name:	9022515	Date of Collection: 2/17/99
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Surrogates	% Recovery	Method Limits
Toluene-d8	95	72-134
4-Bromofluorobenzene	95	78-119

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902275-20A

Modified VOST 5041A/8260B

File Name:	9022506	Date of Collection: NA
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	Not Detected
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: NA

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	104	70-130
1,2-Dichloroethane-d4	93	69-112

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902275-20A

Modified VOST 5041A/8260B

File Name:	9022506	Date of Collection: NA
Dil. Factor:	1.0	Date of Analysis: 2/25/99

Surrogates	% Recovery	Method Limits
Toluene-d8	95	72-134
4-Bromofluorobenzene	94	78-119

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902275-20B

Modified VOST 5041A/8260B

File Name:	9022604	Date of Collection: NA
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	24
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: NA

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	98	70-130
1,2-Dichloroethane-d4	93	69-112

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902275-20B

Modified VOST 5041A/8260B

File Name:	9022604	Date of Collection: NA
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
Toluene-d8	98	72-134
4-Bromofluorobenzene	106	78-119

Custody Transfer Record/Lab Work Request

WESTON Analytics Use Only

Client Charles Tenax Landfill

Est. Final Proj. Sampling Date _____

Work Order # _____

Project Contact/Phone # Joe Mills

AD Project Manager (and) 701-725-1960

QC Del TAT _____

Date Rec'd _____ Date Due _____

Account # _____

MATRIX CODES:	Lab ID	Client ID/Description	Matrix QC Chosen (✓)	Matrix	Date Collected	Time Collected	WESTON Analytics Use Only									
							MS	MSD	VOA	BNA	Pest/PCB	Herb	INORG	Metal	CN	
S - Soil	01A	CE-R1-MAX30-TP1			3/27/99	100-730										
SE - Segment	02A	CE-R1-MAX30-TP2														
SO - Solid	03A	CE-R1-MAX30-TP3														
SL - Sludge	04A	CE-R1-MAX30-TP4														
SW - Water																
OW - Oil																
PS - Drum																
PL - Drum																
L - Liquids																
EP/TCLEP																
Leachate																
WI - Wipe																
X - Other																
F - Fish																

FIELD PERSONNEL: COMPLETE ONLY SHADED AREAS

Special Instructions: ANALYZE TENAX - TENAX/CEMENT IN TARDON
8260 B LIST
HOLD TP4

DATE/REVISIONS:

Relinquished by	Received by	Date	Time
<u>John Mills</u>	<u>Joe Mills</u>	<u>2/27/99</u>	

Discrepancies Between Samples Labels and COC Record? Y or N

NOTES:

WESTON Analytics Use Only

Samples were:

COC Tape was:

1) Shipped _____ or _____

Hand Delivered _____

Airbill # _____

2) Unbroken on Outer Package Y or N

3) Present on Sample Condition Y or N

4) Labels Indicate Properly Preserved Y or N

5) Received Within Holding Times Y or N

6) Unbroken on Sample Y or N

COC Record Present Upon Sample Rec't Y or N

Custody Transfer Record/Lab Work Request



Client Clarkston Landfill

Est. Final Proj. Sampling Date _____

Work Order # _____

Project Contact/Phone # Jack Mills

AD Project Manager Jack Mills

QC Del TAT _____

Date Rec'd _____ Date Due _____

Account # _____

MATRIX CODES:	Lab ID	Client ID/Description	Matrix QC Chosen (✓)	Matrix	Date Collected	Time Collected	WESTON Analytics Use Only					
							VOA	BNA	Pest/PCB	Herb	INORG	Meta
S - Soil	08A13	02-R3-M0030-TP1	MS	MSD	2/17/99	1545-1800						
SE - Sediment	10A15	02-R3-M0030-TP2										
SO - Solid	11A13	02-R3-M0030-TP3										
SL - Sludge	12A16	02-R3-M0030-TP4										
W - Water												
O - Oil												
A - Air												
DS - Drum Solids												
DL - Drum Liquids												
L - EP/CLP Leachate												
WI - Wipe	13A14	02-R3-M0030-TP			2/17/99							
X - Other	14A16	02-R3-M0030-TP										
F - Fish												

FIELD PERSONNEL: COMPLETE ONLY SHADED AREAS

Special Instructions: Analyze Tenax-Tenax/Phenol in TAPB
8260 B LIST
10L1 TP4

DATE/REVISIONS: 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____

Relinquished by	Received by	Date	Time
Jack Mills	Jack Mills	2/18/99	945

Discrepancies Between Samples Labels and COC Record? Y or N

NOTES:

WESTON Analytics Use Only

[illegible]

Custody Seal Intact? Y N None

Unile

@AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9902273B

Work Order Summary

CLIENT: Mr. Peter Virag
Roy F. Weston, Inc.
One Weston Way
West Chester, PA 19380-1499

BILL TO: Same

PHONE: 610-701-3000

P.O. # NR

FAX: 610-701-7401

PROJECT # Clarkstown Landfill

DATE RECEIVED: 2/19/99

DATE COMPLETED: 3/5/99

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>RECEIPT VAC./PRES.</u>
01A	CI-R1-Inlet-Can	Mod. Method 3C/25C	64 mm Hg
02A	C1-R1-Outlet-Can	Mod. Method 3C/25C	38 mm Hg
03A	CI-R2-Inlet-Can	Mod. Method 3C/25C	130 mm Hg
04A	CI-R2-Outlet-Can	Mod. Method 3C/25C	64 mm Hg
05A	CI-R3-Inlet-Can	Mod. Method 3C/25C	130 mm Hg
06A	CI-R3-Outlet-Can	Mod. Method 3C/25C	64 mm Hg
07A*	CI-R4-Inlet-Can	Mod. Method 3C/25C	130 mm Hg
08A*	CI-R4-Outlet-Can	Mod. Method 3C/25C	110 mm Hg
09A	Lab Blank	Mod. Method 3C/25C	NA
09B	Lab Blank	Mod. Method 3C/25C	NA
09C	Lab Blank	Mod. Method 3C/25C	NA

LAB NARRATIVE:

*Sample on hold per client's request.

CERTIFIED BY:

John Suran for:
Laboratory Director

DATE: 3-5-99

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

ID#: 9902273B-01A

Modified EPA Method 3C GC/TCD

Sample Name: CI-R1-Inlet-Can
Dil. Factor: 1.46

Date of Collection: 2/17/99
Date of Analysis: 2/24/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.15	5.5
Nitrogen	0.15	21
Methane	0.15	46
Carbon Dioxide	0.15	40

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	15	880

Notes:

Initial Canister Pressure (P_{ti}) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_i) = 64 mm Hg (gauge)
Canister Pressure after Pressurization (P_H) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_H) = 23.0 C

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-02A

Modified EPA Method 3C GC/TCD

Sample Name: C1-R1-Outlet-Can
Dil. Factor: 1.41

Date of Collection: 2/17/99
Date of Analysis: 2/26/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.14	17
Nitrogen	0.14	75
Methane	0.14	Not Detected
Carbon Dioxide	0.14	4.0

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	14	72

Notes:

Initial Canister Pressure (P_i) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_s) = 38 mm Hg (gauge)
Canister Pressure after Pressurization (P_{it}) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_{it}) = 23.0 C

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-03A

Modified EPA Method 3C GC/TCD

Sample Name: CI-R2-Inlet-Can
Dil. Factor: 1.61

Date of Collection: 2/17/99
Date of Analysis: 2/26/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.16	4.9
Nitrogen	0.16	18
Methane	0.16	48
Carbon Dioxide	0.16	42

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	16	1000

Notes:

Initial Canister Pressure (P_i) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_t) = 130 mm Hg (gauge)
Canister Pressure after Pressurization (P_{it}) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_{it}) = 23.0 C

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-04A

Modified EPA Method 3C GC/TCD

Sample Name: CI-R2-Outlet-Can
Dil. Factor: 1.46

Date of Collection: 2/17/99
Date of Analysis: 2/26/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.15	17
Nitrogen	0.15	75
Methane	0.15	Not Detected
Carbon Dioxide	0.15	4.3

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	15	58

Notes:

Initial Canister Pressure (P_{ti}) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_t) = 64 mm Hg (gauge)
Canister Pressure after Pressurization (P_{tf}) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_{tf}) = 23.0 C

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-05A

Modified EPA Method 3C GC/TCD

Sample Name: CI-R3-Inlet-Can
Dil. Factor: 1.61

Date of Collection: 2/17/99
Date of Analysis: 2/25/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.16	5.0
Nitrogen	0.16	19
Methane	0.16	48
Carbon Dioxide	0.16	42

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	16	1000

Notes:

Initial Canister Pressure (P_{ti}) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_t) = 130 mm Hg (gauge)
Canister Pressure after Pressurization (P_{tt}) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_{tt}) = 23.0 C

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-06A

Modified EPA Method 3C GC/TCD

Sample Name: CI-R3-Outlet-Can
Dil. Factor: 1.46

Date of Collection: 2/17/99
Date of Analysis: 2/26/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.15	18
Nitrogen	0.15	76
Methane	0.15	Not Detected
Carbon Dioxide	0.15	4.2

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	15	140

Notes:

Initial Canister Pressure (P_{ti}) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_t) = 64 mm Hg (gauge)
Canister Pressure after Pressurization (P_{tr}) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_{tr}) = 23.0 C

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-09A

Modified EPA Method 3C GC/TCD

Sample Name:

Lab Blank

Date of Collection: NA

Dil. Factor:

1.00

Date of Analysis: 2/24/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.10	Not Detected
Nitrogen	0.10	Not Detected
Methane	0.10	Not Detected
Carbon Dioxide	0.10	Not Detected

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	10	Not Detected

Notes:

Initial Canister Pressure (P_i) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_f) = NA (gauge)
Canister Pressure after Pressurization (P_H) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_H) = NA

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-09B

Modified EPA Method 3C GC/TCD

Sample Name:

Lab Blank

Date of Collection: NA

Dil. Factor:

1.00

Date of Analysis: 2/25/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.10	Not Detected
Nitrogen	0.10	Not Detected
Methane	0.10	Not Detected
Carbon Dioxide	0.10	Not Detected

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	10	Not Detected

Notes:

Initial Canister Pressure (P_{ti}) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_t) = NA (gauge)
Canister Pressure after Pressurization (P_{tr}) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_{tr}) = NA

Canisters are leak-checked according to Section 4.1 of the method.

AIR TOXICS LTD.

ID#: 9902273B-09C

Modified EPA Method 3C GC/TCD

Sample Name:

Lab Blank

Date of Collection: NA

Dil. Factor:

1.00

Date of Analysis: 2/26/99

Compound	Det. Limit (%)	Amount (%)
Oxygen	0.10	Not Detected
Nitrogen	0.10	Not Detected
Methane	0.10	Not Detected
Carbon Dioxide	0.10	Not Detected

Modified EPA Method 25C GC/FID

Compound	Det. Limit (ppmvC)	Amount (ppmvC)
NMOC as Methane (Average)	10	Not Detected

Notes:

Initial Canister Pressure (P_{ti}) = 0.005 mm Hg (absolute)
Canister Pressure after Sampling (P_t) = NA (gauge)
Canister Pressure after Pressurization (P_{tr}) = 258 mm Hg (gauge)
Canister Temperature after Pressurization (T_{tr}) = NA

Canisters are leak-checked according to Section 4.1 of the method.

Form 1293 rev 06

@AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9902273A

Work Order Summary

CLIENT: Mr. Peter Virag
Roy F. Weston, Inc.
One Weston Way
West Chester, PA 19380-1499

BILL TO: Same

PHONE: 610-701-3000
FAX: 610-701-7401
DATE RECEIVED: 2/19/99
DATE COMPLETED: 3/4/99

P.O. # NR
PROJECT # Clarkstown Landfill

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>RECEIPT VAC./PRES.</u>
01A	Cl-R1-Inlet-Can	TO-14	2.5 "Hg
02A**	C1-R1-Outlet-Can	TO-14	1.5 "Hg
03A	Cl-R2-Inlet-Can	TO-14	5.0 "Hg
04A**	Cl-R2-Outlet-Can	TO-14	2.5 "Hg
05A	Cl-R3-Inlet-Can	TO-14	5.0 "Hg
06A**	Cl-R3-Outlet-Can	TO-14	2.5 "Hg
07A*	Cl-R4-Inlet-Can	TO-14	5.0 "Hg
08A*	Cl-R4-Outlet-Can	TO-14	4.5 "Hg
09A	Lab Blank	TO-14	NA

LAB NARRATIVE:

*Sample on hold per client's request.

**Sample cancelled per client's request 2/26/99 AK.

Sample C1-R1-Inlet-Can was diluted due to non-target compounds.

CERTIFIED BY:

John Swanson for:
Laboratory Director

DATE:

3-5-99

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-Inlet-Can

ID#: 9902273A-01A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022618	Date of Collection:	2/17/99
Dil. Factor:	29.2	Date of Analysis:	2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Freon 12	15	73	440	2200
Freon 114	15	100	130	940
Chloromethane	15	31	Not Detected	Not Detected
Vinyl Chloride	15	38	550	1400
Bromomethane	15	58	Not Detected	Not Detected
Chloroethane	15	39	82	220
Freon 11	15	83	Not Detected	Not Detected
1,1-Dichloroethene	15	59	Not Detected	Not Detected
Freon 113	15	110	Not Detected	Not Detected
Methylene Chloride	15	52	Not Detected	Not Detected
1,1-Dichloroethane	15	60	Not Detected	Not Detected
cis-1,2-Dichloroethene	15	59	250	1000
Chloroform	15	72	Not Detected	Not Detected
1,1,1-Trichloroethane	15	81	Not Detected	Not Detected
Carbon Tetrachloride	15	93	Not Detected	Not Detected
Benzene	15	47	180	570
1,2-Dichloroethane	15	60	Not Detected	Not Detected
Trichloroethene	15	80	35 J	190 J
1,2-Dichloropropane	15	69	Not Detected	Not Detected
cis-1,3-Dichloropropene	15	67	Not Detected	Not Detected
Toluene	15	56	940	3600
trans-1,3-Dichloropropene	15	67	Not Detected	Not Detected
1,1,2-Trichloroethane	15	81	Not Detected	Not Detected
Tetrachloroethene	15	100	Not Detected	Not Detected
Ethylene Dibromide	15	110	Not Detected	Not Detected
Chlorobenzene	15	68	280	1300
Ethyl Benzene	15	64	1100	4700
m,p-Xylene	15	64	1200	5400
o-Xylene	15	64	620	2700
Styrene	15	63	47 J	200 J
1,1,2,2-Tetrachloroethane	15	100	Not Detected	Not Detected
1,3,5-Trimethylbenzene	15	73	320	1600
1,2,4-Trimethylbenzene	15	73	1200	5900
1,3-Dichlorobenzene	15	89	Not Detected	Not Detected
1,4-Dichlorobenzene	15	89	480	2900
Chlorotoluene	15	77	Not Detected	Not Detected
1,2-Dichlorobenzene	15	89	40 J	240 J
1,2,4-Trichlorobenzene	15	110	Not Detected	Not Detected
Hexachlorobutadiene	15	160	Not Detected	Not Detected
Propylene	58	100	Not Detected	Not Detected
1,3-Butadiene	58	130	Not Detected	Not Detected
Acetone	58	140	150	360

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-Inlet-Can

ID#: 9902273A-01A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022618	Date of Collection: 2/17/99
Dil. Factor:	29.2	Date of Analysis: 2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Carbon Disulfide	58	180	Not Detected	Not Detected
2-Propanol	58	150	Not Detected	Not Detected
trans-1,2-Dichloroethene	58	240	Not Detected	Not Detected
Vinyl Acetate	58	210	Not Detected	Not Detected
2-Butanone (Methyl Ethyl Ketone)	58	180	63 J	190 J
Hexane	58	210	310	1100
Tetrahydrofuran	58	180	260	760
Cyclohexane	58	200	140 J	480 J
1,4-Dioxane	58	210	Not Detected	Not Detected
Bromodichloromethane	58	400	Not Detected	Not Detected
4-Methyl-2-pentanone	58	240	Not Detected	Not Detected
2-Hexanone	58	240	Not Detected	Not Detected
Dibromochloromethane	58	510	Not Detected	Not Detected
Bromoform	58	610	Not Detected	Not Detected
4-Ethyltoluene	58	290	680	3400
Ethanol	58	110	Not Detected	Not Detected
Methyl tert-Butyl Ether	58	210	Not Detected	Not Detected
Heptane	58	240	240	1000

J = Estimated value.

Container Type: 6 Liter Silco Canister

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	102	70-130
Toluene-d8	99	70-130
4-Bromofluorobenzene	129	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-Inlet-Can

ID#: 9902273A-03A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022619	Date of Collection:	2/17/99
Dil. Factor:	21.5	Date of Analysis:	2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Freon 12	11	54	400	2000
Freon 114	11	76	170	1200
Chloromethane	11	23	Not Detected	Not Detected
Vinyl Chloride	11	28	450	1200
Bromomethane	11	42	Not Detected	Not Detected
Chloroethane	11	29	120	340
Freon 11	11	61	14 J	81 J
1,1-Dichloroethene	11	43	Not Detected	Not Detected
Freon 113	11	84	Not Detected	Not Detected
Methylene Chloride	11	38	Not Detected	Not Detected
1,1-Dichloroethane	11	44	24 J	100 J
cis-1,2-Dichloroethene	11	43	440	1800
Chloroform	11	53	Not Detected	Not Detected
1,1,1-Trichloroethane	11	60	Not Detected	Not Detected
Carbon Tetrachloride	11	69	Not Detected	Not Detected
Benzene	11	35	300	960
1,2-Dichloroethane	11	44	Not Detected	Not Detected
Trichloroethene	11	59	50	280
1,2-Dichloropropane	11	50	Not Detected	Not Detected
cis-1,3-Dichloropropene	11	50	Not Detected	Not Detected
Toluene	11	41	1700	6500
trans-1,3-Dichloropropene	11	50	Not Detected	Not Detected
1,1,2-Trichloroethane	11	60	Not Detected	Not Detected
Tetrachloroethene	11	74	22 J	150 J
Ethylene Dibromide	11	84	Not Detected	Not Detected
Chlorobenzene	11	50	490	2300
Ethyl Benzene	11	47	1800	8100
m,p-Xylene	11	47	2200	9700
o-Xylene	11	47	1100	4900
Styrene	11	47	91	390
1,1,2,2-Tetrachloroethane	11	75	Not Detected	Not Detected
1,3,5-Trimethylbenzene	11	54	560	2800
1,2,4-Trimethylbenzene	11	54	2000	9800
1,3-Dichlorobenzene	11	66	11 J	70 J
1,4-Dichlorobenzene	11	66	890	5400
Chlorotoluene	11	57	Not Detected	Not Detected
1,2-Dichlorobenzene	11	66	62	380
1,2,4-Trichlorobenzene	11	81	Not Detected	Not Detected
Hexachlorobutadiene	11	120	Not Detected	Not Detected
Propylene	43	75	Not Detected	Not Detected
1,3-Butadiene	43	97	Not Detected	Not Detected
Acetone	43	100	140	330

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-Inlet-Can

ID#: 9902273A-03A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022619	Date of Collection: 2/17/99
Dil. Factor:	21.5	Date of Analysis: 2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Carbon Disulfide	43	140	Not Detected	Not Detected
2-Propanol	43	110	50 J	120 J
trans-1,2-Dichloroethene	43	170	Not Detected	Not Detected
Vinyl Acetate	43	150	Not Detected	Not Detected
2-Butanone (Methyl Ethyl Ketone)	43	130	110	340
Hexane	43	150	710	2500
Tetrahydrofuran	43	130	380	1100
Cyclohexane	43	150	270	940
1,4-Dioxane	43	160	Not Detected	Not Detected
Bromodichloromethane	43	290	Not Detected	Not Detected
4-Methyl-2-pentanone	43	180	Not Detected	Not Detected
2-Hexanone	43	180	Not Detected	Not Detected
Dibromochloromethane	43	370	Not Detected	Not Detected
Bromoform	43	450	Not Detected	Not Detected
4-Ethyltoluene	43	210	1200	6100
Ethanol	43	82	Not Detected	Not Detected
Methyl tert-Butyl Ether	43	160	Not Detected	Not Detected
Heptane	43	180	460	1900

J = Estimated value.

Q = Exceeds Quality Control limits of 70% to 130%, due to matrix effects.

Container Type: 6 Liter Silco Canister

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	110	70-130
Toluene-d8	104	70-130
4-Bromofluorobenzene	185 Q	70-130

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-Inlet-Can

ID#: 9902273A-05A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022620	Date of Collection:	2/17/99
Dil. Factor:	26.8	Date of Analysis:	2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Freon 12	13	67	390	2000
Freon 114	13	95	190	1300
Chloromethane	13	28	Not Detected	Not Detected
Vinyl Chloride	13	35	Not Detected	Not Detected
Bromomethane	13	53	Not Detected	Not Detected
Chloroethane	13	36	130	350
Freon 11	13	77	15 J	88 J
1,1-Dichloroethene	13	54	Not Detected	Not Detected
Freon 113	13	100	Not Detected	Not Detected
Methylene Chloride	13	47	Not Detected	Not Detected
1,1-Dichloroethane	13	55	27 J	110 J
cis-1,2-Dichloroethene	13	54	510	2000
Chloroform	13	67	Not Detected	Not Detected
1,1,1-Trichloroethane	13	74	Not Detected	Not Detected
Carbon Tetrachloride	13	86	Not Detected	Not Detected
Benzene	13	44	330	1100
1,2-Dichloroethane	13	55	Not Detected	Not Detected
Trichloroethene	13	73	58	320
1,2-Dichloropropane	13	63	Not Detected	Not Detected
cis-1,3-Dichloropropene	13	62	Not Detected	Not Detected
Toluene	13	51	1900	7200
trans-1,3-Dichloropropene	13	62	Not Detected	Not Detected
1,1,2-Trichloroethane	13	74	Not Detected	Not Detected
Tetrachloroethene	13	92	24 J	170 J
Ethylene Dibromide	13	100	Not Detected	Not Detected
Chlorobenzene	13	63	530	2500
Ethyl Benzene	13	59	2000	8800
m,p-Xylene	13	59	2400	11000
o-Xylene	13	59	1200	5400
Styrene	13	58	100	440
1,1,2,2-Tetrachloroethane	13	94	Not Detected	Not Detected
1,3,5-Trimethylbenzene	13	67	640	3200
1,2,4-Trimethylbenzene	13	67	2200	11000
1,3-Dichlorobenzene	13	82	14 J	87 J
1,4-Dichlorobenzene	13	82	1000	6200
Chlorotoluene	13	71	Not Detected	Not Detected
1,2-Dichlorobenzene	13	82	70	430
1,2,4-Trichlorobenzene	13	100	Not Detected	Not Detected
Hexachlorobutadiene	13	150	Not Detected	Not Detected
Propylene	54	94	Not Detected	Not Detected
1,3-Butadiene	54	120	Not Detected	Not Detected
Acetone	54	130	140	350

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-Inlet-Can

ID#: 9902273A-05A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022620	Date of Collection: 2/17/99
Dil. Factor:	26.8	Date of Analysis: 2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Carbon Disulfide	54	170	Not Detected	Not Detected
2-Propanol	54	130	57 J	140 J
trans-1,2-Dichloroethene	54	220	Not Detected	Not Detected
Vinyl Acetate	54	190	Not Detected	Not Detected
2-Butanone (Methyl Ethyl Ketone)	54	160	130 J	400 J
Hexane	54	190	820	3000
Tetrahydrofuran	54	160	460	1400
Cyclohexane	54	190	310	1100
1,4-Dioxane	54	200	Not Detected	Not Detected
Bromodichloromethane	54	370	Not Detected	Not Detected
4-Methyl-2-pentanone	54	220	Not Detected	Not Detected
2-Hexanone	54	220	Not Detected	Not Detected
Dibromochloromethane	54	460	Not Detected	Not Detected
Bromoform	54	560	Not Detected	Not Detected
4-Ethyltoluene	54	270	1300	6700
Ethanol	54	100	Not Detected	Not Detected
Methyl tert-Butyl Ether	54	200	Not Detected	Not Detected
Heptane	54	220	520	2200

J = Estimated value.

Q = Exceeds Quality Control limits of 70% to 130%, due to matrix effects.

Container Type: 6 Liter Silco Canister

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	113	70-130
Toluene-d8	104	70-130
4-Bromofluorobenzene	173 Q	70-130

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902273A-09A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022608	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Freon 12	0.50	2.5	Not Detected	Not Detected
Freon 114	0.50	3.6	Not Detected	Not Detected
Chloromethane	0.50	1.0	Not Detected	Not Detected
Vinyl Chloride	0.50	1.3	Not Detected	Not Detected
Bromomethane	0.50	2.0	Not Detected	Not Detected
Chloroethane	0.50	1.3	Not Detected	Not Detected
Freon 11	0.50	2.9	Not Detected	Not Detected
1,1-Dichloroethene	0.50	2.0	Not Detected	Not Detected
Freon 113	0.50	3.9	Not Detected	Not Detected
Methylene Chloride	0.50	1.8	Not Detected	Not Detected
1,1-Dichloroethane	0.50	2.1	Not Detected	Not Detected
cis-1,2-Dichloroethene	0.50	2.0	Not Detected	Not Detected
Chloroform	0.50	2.5	Not Detected	Not Detected
1,1,1-Trichloroethane	0.50	2.8	Not Detected	Not Detected
Carbon Tetrachloride	0.50	3.2	Not Detected	Not Detected
Benzene	0.50	1.6	Not Detected	Not Detected
1,2-Dichloroethane	0.50	2.1	Not Detected	Not Detected
Trichloroethene	0.50	2.7	Not Detected	Not Detected
1,2-Dichloropropane	0.50	2.3	Not Detected	Not Detected
cis-1,3-Dichloropropene	0.50	2.3	Not Detected	Not Detected
Toluene	0.50	1.9	Not Detected	Not Detected
trans-1,3-Dichloropropene	0.50	2.3	Not Detected	Not Detected
1,1,2-Trichloroethane	0.50	2.8	Not Detected	Not Detected
Tetrachloroethene	0.50	3.4	Not Detected	Not Detected
Ethylene Dibromide	0.50	3.9	Not Detected	Not Detected
Chlorobenzene	0.50	2.3	Not Detected	Not Detected
Ethyl Benzene	0.50	2.2	Not Detected	Not Detected
m,p-Xylene	0.50	2.2	Not Detected	Not Detected
o-Xylene	0.50	2.2	Not Detected	Not Detected
Styrene	0.50	2.2	Not Detected	Not Detected
1,1,2,2-Tetrachloroethane	0.50	3.5	Not Detected	Not Detected
1,3,5-Trimethylbenzene	0.50	2.5	Not Detected	Not Detected
1,2,4-Trimethylbenzene	0.50	2.5	Not Detected	Not Detected
1,3-Dichlorobenzene	0.50	3.1	Not Detected	Not Detected
1,4-Dichlorobenzene	0.50	3.1	Not Detected	Not Detected
Chlorotoluene	0.50	2.6	Not Detected	Not Detected
1,2-Dichlorobenzene	0.50	3.1	Not Detected	Not Detected
1,2,4-Trichlorobenzene	0.50	3.8	Not Detected	Not Detected
Hexachlorobutadiene	0.50	5.4	Not Detected	Not Detected
Propylene	2.0	3.5	Not Detected	Not Detected
1,3-Butadiene	2.0	4.5	Not Detected	Not Detected
Acetone	2.0	4.8	Not Detected	Not Detected

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902273A-09A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	g022608	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 2/26/99

Compound	Det. Limit (ppbv)	Det. Limit (uG/m3)	Amount (ppbv)	Amount (uG/m3)
Carbon Disulfide	2.0	6.3	Not Detected	Not Detected
2-Propanol	2.0	5.0	Not Detected	Not Detected
trans-1,2-Dichloroethene	2.0	8.1	Not Detected	Not Detected
Vinyl Acetate	2.0	7.2	Not Detected	Not Detected
2-Butanone (Methyl Ethyl Ketone)	2.0	6.0	Not Detected	Not Detected
Hexane	2.0	7.2	Not Detected	Not Detected
Tetrahydrofuran	2.0	6.0	Not Detected	Not Detected
Cyclohexane	2.0	7.0	Not Detected	Not Detected
1,4-Dioxane	2.0	7.3	Not Detected	Not Detected
Bromodichloromethane	2.0	14	Not Detected	Not Detected
4-Methyl-2-pentanone	2.0	8.3	Not Detected	Not Detected
2-Hexanone	2.0	8.3	Not Detected	Not Detected
Dibromochloromethane	2.0	17	Not Detected	Not Detected
Bromoform	2.0	21	Not Detected	Not Detected
4-Ethyltoluene	2.0	10	Not Detected	Not Detected
Ethanol	2.0	3.8	Not Detected	Not Detected
Methyl tert-Butyl Ether	2.0	7.3	Not Detected	Not Detected
Heptane	2.0	8.3	Not Detected	Not Detected

Container Type: NA

Surrogates	% Recovery	Method Limits
1,2-Dichloroethane-d4	102	70-130
Toluene-d8	93	70-130
4-Bromofluorobenzene	78	70-130

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
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CHAIN-OF-CUSTODY RECORD

No 019815

Page ___ of ___

Contact Person <u>Jack Mills</u> Company <u>Roy F Weston Inc</u> Address <u>One Weston Way</u> City <u>West Chester</u> State <u>PA</u> Zip <u>19380</u> Phone <u>(610) 701-7245</u> / FAX <u>(610) 701-7401</u> Collected By: Signature <u>Jack Mills</u>		Project info: P.O. # _____ Project # _____ Project Name <u>Landfill</u>		Turn Around Time: ☐ Normal ☐ Rush _____ Specify _____	
Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum	Receipt
D1A	Q1-R1-Inlet-CAN	2/17/99 11:5-12:15	VOC, CH ₄ , NMOC, H ₂ S	28	2.5" Hg
D2A	Q1-R1-Outlet-CAN	2/17/99 11:5-12:15	CH ₄ , NMOC, H ₂ S	28	1.5" Hg
D3A	Q1-R2-Inlet-CAN	2/17/99 13:00-14:30	VOC, CH ₄ , NMOC, H ₂ S	28	5.0" Hg
D4A	Q1-R2-Outlet-CAN	2/17/99 13:00-14:30	CH ₄ , NMOC, H ₂ S	28	2.5" Hg
D5A	Q1-R3-Inlet-CAN	2/17/99 15:45-16:45	VOC, CH ₄ , NMOC, H ₂ S	27.5	5.0" Hg
D6A	Q1-R3-Outlet-CAN	2/17/99 15:45-16:45	CH ₄ , NMOC, H ₂ S	28	2.5" Hg
D7A	Q1-R4-Inlet-CAN	2/18/99 09:49-10:49	H ₂ S		5.0" Hg
D8A	Q1-R4-Outlet-CAN	2/18/99 09:49-10:49	H ₂ S		4.5" Hg
Relinquished By: (Signature) _____ Date/Time _____ Relinquished By: (Signature) <u>Jack Mills</u> Date/Time _____ Relinquished By: (Signature) _____ Date/Time _____ Relinquished By: (Signature) _____ Date/Time _____					
Notes: VOC - EPA Method 7014 - (8260 B List) NMOC, O ₂ , N ₂ , CH ₄ , CO ₂ - EPA 25C, 3C H ₂ S - 5504 (ASTM) H ₂ S - 5504 (ASTM)					
Shipper Name <u>Fed-Ex</u> Air Bill # <u>811230438620</u>		Opened By: <u>Jack Mills</u> Date/Time <u>2/19/99 10:05</u>		Condition <u>Good</u> Custody Seals Intact? <u>Yes</u> No <u>N/A</u>	
Lab Use Only		Work Order # <u>9902273A</u>			

@AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9902273C

Work Order Summary

CLIENT: Mr. Peter Virag
Roy F. Weston, Inc.
One Weston Way
West Chester, PA 19380-1499

BILL TO: Same

PHONE: 610-701-3000

FAX: 610-701-7401

DATE RECEIVED: 2/19/99

DATE COMPLETED: 3/3/99

P.O. # NR

PROJECT # Clarkstown Landfill

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>RECEIPT VAC./PRES.</u>
01A	CI-R1-Inlet-Can	ASTM D-5504	2.5 "Hg
02A	CI-R1-Outlet-Can	ASTM D-5504	1.5 "Hg
03A	CI-R2-Inlet-Can	ASTM D-5504	5.0 "Hg
04A	CI-R2-Outlet-Can	ASTM D-5504	2.5 "Hg
05A	CI-R3-Inlet-Can	ASTM D-5504	5.0 "Hg
06A	CI-R3-Outlet-Can	ASTM D-5504	2.5 "Hg
07A*	CI-R4-Inlet-Can	ASTM D-5504	5.0 "Hg
08A*	CI-R4-Outlet-Can	ASTM D-5504	4.5 "Hg
09A	Lab Blank	ASTM D-5504	NA

LAB NARRATIVE:

*Sample on hold per client's request.

CERTIFIED BY:

John Swanson for:
Laboratory Director

DATE: 3-3-99

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-Inlet-Can

ID#: 9902273C-01A

Sulfur Gases by ASTM D-5504 GC/SCD

File Name:	b022007	Date of Collection: 2/17/99
Dil. Factor:	58.4	Date of Analysis: 2/20/99

Compound	Det. Limit (ppbv)	Amount (ppbv)
Hydrogen Sulfide	230	22000
Carbonyl Sulfide	230	470
Methyl Mercaptan	230	Not Detected
Ethyl Mercaptan	230	Not Detected
Dimethyl Sulfide	230	Not Detected
Carbon Disulfide	230	Not Detected
Isopropyl Mercaptan	230	Not Detected
tert-Butyl Mercaptan	230	Not Detected
n-Propyl Mercaptan	230	Not Detected
Ethyl Methyl Sulfide	230	Not Detected
Thiophene	230	Not Detected
Isobutyl Mercaptan	230	Not Detected
Diethyl Sulfide	230	Not Detected
Butyl Mercaptan	230	Not Detected
Dimethyl Disulfide	230	Not Detected
3-Methylthiophene	230	Not Detected
Tetrahydrothiophene	230	Not Detected
2-Ethylthiophene	230	Not Detected
2,5-Dimethylthiophene	230	Not Detected
Diethyl Disulfide	230	Not Detected

Container Type: 6 Liter Silco Canister

AIR TOXICS LTD.

SAMPLE NAME : C1-R1-Outlet-Can

ID#: 9902273C-02A

Sulfur Gases by ASTM D-5504 GC/SCD

File Name:	b022005	Date of Collection: 2/17/99
Dil. Factor:	1.41	Date of Analysis: 2/20/99

Compound	Det. Limit (ppbv)	Amount (ppbv)
Hydrogen Sulfide	5.6	Not Detected
Carbonyl Sulfide	5.6	10
Methyl Mercaptan	5.6	Not Detected
Ethyl Mercaptan	5.6	Not Detected
Dimethyl Sulfide	5.6	Not Detected
Carbon Disulfide	5.6	Not Detected
Isopropyl Mercaptan	5.6	Not Detected
tert-Butyl Mercaptan	5.6	Not Detected
n-Propyl Mercaptan	5.6	Not Detected
Ethyl Methyl Sulfide	5.6	Not Detected
Thiophene	5.6	Not Detected
Isobutyl Mercaptan	5.6	Not Detected
Diethyl Sulfide	5.6	Not Detected
Butyl Mercaptan	5.6	Not Detected
Dimethyl Disulfide	5.6	Not Detected
3-Methylthiophene	5.6	Not Detected
Tetrahydrothiophene	5.6	Not Detected
2-Ethylthiophene	5.6	Not Detected
2,5-Dimethylthiophene	5.6	Not Detected
Diethyl Disulfide	5.6	Not Detected

Container Type: 6 Liter Silco Canister

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-Inlet-Can

ID#: 9902273C-03A

Sulfur Gases by ASTM D-5504 GC/SCD

File Name:	b022011	Date of Collection: 2/17/99
Dil. Factor:	64.4	Date of Analysis: 2/20/99

Compound	Det. Limit (ppbv)	Amount (ppbv)
Hydrogen Sulfide	260	33000
Carbonyl Sulfide	260	800
Methyl Mercaptan	260	Not Detected
Ethyl Mercaptan	260	Not Detected
Dimethyl Sulfide	260	Not Detected
Carbon Disulfide	260	Not Detected
Isopropyl Mercaptan	260	Not Detected
tert-Butyl Mercaptan	260	Not Detected
n-Propyl Mercaptan	260	Not Detected
Ethyl Methyl Sulfide	260	Not Detected
Thiophene	260	Not Detected
Isobutyl Mercaptan	260	Not Detected
Diethyl Sulfide	260	Not Detected
Butyl Mercaptan	260	Not Detected
Dimethyl Disulfide	260	Not Detected
3-Methylthiophene	260	Not Detected
Tetrahydrothiophene	260	Not Detected
2-Ethylthiophene	260	Not Detected
2,5-Dimethylthiophene	260	Not Detected
Diethyl Disulfide	260	Not Detected

Container Type: 6 Liter Silco Canister

AIR TOXICS LTD.

SAMPLE NAME : C1-R2-Outlet-Can

ID#: 9902273C-04A

Sulfur Gases by ASTM D-5504 GC/SCD

File Name:	b022006	Date of Collection: 2/17/99
Dil. Factor:	1.46	Date of Analysis: 2/20/99

Compound	Det. Limit (ppbv)	Amount (ppbv)
Hydrogen Sulfide	5.8	Not Detected
Carbonyl Sulfide	5.8	11
Methyl Mercaptan	5.8	Not Detected
Ethyl Mercaptan	5.8	Not Detected
Dimethyl Sulfide	5.8	Not Detected
Carbon Disulfide	5.8	Not Detected
Isopropyl Mercaptan	5.8	Not Detected
tert-Butyl Mercaptan	5.8	Not Detected
n-Propyl Mercaptan	5.8	Not Detected
Ethyl Methyl Sulfide	5.8	Not Detected
Thiophene	5.8	Not Detected
Isobutyl Mercaptan	5.8	Not Detected
Diethyl Sulfide	5.8	Not Detected
Butyl Mercaptan	5.8	Not Detected
Dimethyl Disulfide	5.8	Not Detected
3-Methylthiophene	5.8	Not Detected
Tetrahydrothiophene	5.8	Not Detected
2-Ethylthiophene	5.8	Not Detected
2,5-Dimethylthiophene	5.8	Not Detected
Diethyl Disulfide	5.8	Not Detected

Container Type: 6 Liter Silco Canister

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-Inlet-Can

ID#: 9902273C-05A

Sulfur Gases by ASTM D-5504 GC/SCD

File Name:	b022008	Date of Collection: 2/17/99
Dil. Factor:	64.4	Date of Analysis: 2/20/99

Compound	Det. Limit (ppbv)	Amount (ppbv)
Hydrogen Sulfide	260	32000
Carbonyl Sulfide	260	800
Methyl Mercaptan	260	Not Detected
Ethyl Mercaptan	260	Not Detected
Dimethyl Sulfide	260	Not Detected
Carbon Disulfide	260	Not Detected
Isopropyl Mercaptan	260	Not Detected
tert-Butyl Mercaptan	260	Not Detected
n-Propyl Mercaptan	260	Not Detected
Ethyl Methyl Sulfide	260	Not Detected
Thiophene	260	Not Detected
Isobutyl Mercaptan	260	Not Detected
Diethyl Sulfide	260	Not Detected
Butyl Mercaptan	260	Not Detected
Dimethyl Disulfide	260	Not Detected
3-Methylthiophene	260	Not Detected
Tetrahydrothiophene	260	Not Detected
2-Ethylthiophene	260	Not Detected
2,5-Dimethylthiophene	260	Not Detected
Diethyl Disulfide	260	Not Detected

Container Type: 6 Liter Silco Canister

AIR TOXICS LTD.

SAMPLE NAME : C1-R3-Outlet-Can

ID#: 9902273C-06A

Sulfur Gases by ASTM D-5504 GC/SCD

File Name:	b022004	Date of Collection: 2/17/99
Dil. Factor:	1.46	Date of Analysis: 2/20/99

Compound	Det. Limit (ppbv)	Amount (ppbv)
Hydrogen Sulfide	5.8	Not Detected
Carbonyl Sulfide	5.8	9.4
Methyl Mercaptan	5.8	Not Detected
Ethyl Mercaptan	5.8	Not Detected
Dimethyl Sulfide	5.8	Not Detected
Carbon Disulfide	5.8	Not Detected
Isopropyl Mercaptan	5.8	Not Detected
tert-Butyl Mercaptan	5.8	Not Detected
n-Propyl Mercaptan	5.8	Not Detected
Ethyl Methyl Sulfide	5.8	Not Detected
Thiophene	5.8	Not Detected
Isobutyl Mercaptan	5.8	Not Detected
Diethyl Sulfide	5.8	Not Detected
Butyl Mercaptan	5.8	Not Detected
Dimethyl Disulfide	5.8	Not Detected
3-Methylthiophene	5.8	Not Detected
Tetrahydrothiophene	5.8	Not Detected
2-Ethylthiophene	5.8	Not Detected
2,5-Dimethylthiophene	5.8	Not Detected
Diethyl Disulfide	5.8	Not Detected

Container Type: 6 Liter Silco Canister

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902273C-09A

Sulfur Gases by ASTM D-5504 GC/SCD

File Name:	b022003	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 2/20/99

Compound	Det. Limit (ppbv)	Amount (ppbv)
Hydrogen Sulfide	4.0	Not Detected
Carbonyl Sulfide	4.0	Not Detected
Methyl Mercaptan	4.0	Not Detected
Ethyl Mercaptan	4.0	Not Detected
Dimethyl Sulfide	4.0	Not Detected
Carbon Disulfide	4.0	Not Detected
Isopropyl Mercaptan	4.0	Not Detected
tert-Butyl Mercaptan	4.0	Not Detected
n-Propyl Mercaptan	4.0	Not Detected
Ethyl Methyl Sulfide	4.0	Not Detected
Thiophene	4.0	Not Detected
Isobutyl Mercaptan	4.0	Not Detected
Diethyl Sulfide	4.0	Not Detected
Butyl Mercaptan	4.0	Not Detected
Dimethyl Disulfide	4.0	Not Detected
3-Methylthiophene	4.0	Not Detected
Tetrahydrothiophene	4.0	Not Detected
2-Ethylthiophene	4.0	Not Detected
2,5-Dimethylthiophene	4.0	Not Detected
Diethyl Disulfide	4.0	Not Detected

Container Type: NA



AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

Nº 019815

Page ___ of ___

Contact Person <u>Jack Mills</u>		Project info:		Turn Around Time:		
Company <u>Roy F. Weston Inc</u>		P.O. # _____		☐ Normal		
Address <u>ONE WEST HASTIN WAY</u> City <u>WEST HASTIN</u> State <u>CA</u> Zip <u>95700</u>		Project # _____		☐ Rush _____ Specify _____		
Phone <u>(609) 701-7245 /</u> FAX <u>(609) 701-7401</u>		Project Name <u>Landfill</u>				
Collected By: Signature <u>Jack Mills</u>		Analyses Requested		Canister Pressure / Vacuum		
Lab I.D.	Field Sample I.D.	Date & Time		Initial	Final	Receipt
01A	CE-R1-INLET-CAN	2/17/99 11:55-12:15	VOC, CH ₄ , NMOC, H ₂ S	28	4.5	2.5" Vg
02A	CE-R1-OUTLET-CAN	I	CH ₄ , NMOC, H ₂ S	28	3.5	1.5" Vg
03A	CE-R2-INLET-CAN	2/17/99 13:30-14:30	VOC, CH ₄ , NMOC, H ₂ S	28	4.0	5.0" Vg
04A	CE-R2-OUTLET-CAN	I	CH ₄ , NMOC, H ₂ S	28	4.0	2.5" Vg
05A	CE-R3-INLET-CAN	2/17/99 15:45-16:45	VOC, CH ₄ , NMOC, H ₂ S	27.5	4.0	5.0" Vg
06A	CE-R3-OUTLET-CAN	I	CH ₄ , NMOC, H ₂ S	28	5.0	2.5" Vg
07A	CE-R4-INLET-CAN	2/18/99 07:19-10:49	H ₂ O			5.0" Vg
08A	CE-R4-OUTLET-CAN	I	H ₂ O			4.5" Vg
Relinquished By: (Signature) <u>Jack Mills</u> Date/Time <u>2/18/99 11:00 AM</u>		Notes: VOC - EPA Method 7014 - (8260B LIST) NMOC, O ₂ , N ₂ , CH ₄ , CO ₂ - EPA 85C, 3C H ₂ S - 5504 (ASTM)				
Received By: (Signature) _____ Date/Time _____		Temp. (°C) _____				
Relinquished By: (Signature) _____ Date/Time _____		Condition _____				
Shipper Name		Air Bill #	Opened By:	Date/Time	Custody Seals Intact?	Work Order #
Lab Use Only	Fed-ex	811230438620	TS	2/19/99 10:45 AM	Yes No None	9902273C

@AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9902131

Work Order Summary

CLIENT: Mr. Peter Virag
Roy F. Weston, Inc.
One Weston Way
West Chester, PA 19380-1499

BILL TO: Same

PHONE: 610-701-3000
FAX: 610-701-7401
DATE RECEIVED: 2/10/99
DATE COMPLETED: 3/4/99

P.O. # NR
PROJECT # Clarkstown Landfill

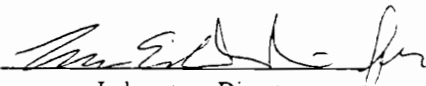
FRACTION #
01A/B
02A

NAME
Tube Cert. #8618A/B
Lab Blank

TEST
Tube Certification
Tube Certification

LAB NARRATIVE:

All tubes prepared by Air Toxics Ltd. are background certified as a batch. This Work Order contains the certification results for the tubes prepared for your project.

CERTIFIED BY: 

Laboratory Director

DATE: 3/10/99

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME : Tube Cert. #8618A/B

ID#: 9902131-01A

Modified VOST 5041A/8260B

File Name:	9022605	Date of Collection: 2/10/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	29 B
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: VOST Tube

Surrogates	% Recovery	Method Limits

AIR TOXICS LTD.

SAMPLE NAME : Tube Cert. #8618A/B

ID#: 9902131-01A

Modified VOST 5041A/8260B

File Name:	9022605	Date of Collection: 2/10/99
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	94	70-130
1,2-Dichloroethane-d4	87	69-112
Toluene-d8	101	72-134
4-Bromofluorobenzene	102	78-119

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902131-02A

Modified VOST 5041A/8260B

File Name:	9022604	Date of Collection: NA
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Compound	Det. Limit (nG)	Amount (nG)
Chloromethane	10	Not Detected
Vinyl Chloride	10	Not Detected
Bromomethane	10	24
Chloroethane	10	Not Detected
Freon 11	10	Not Detected
1,1-Dichloroethene	10	Not Detected
Carbon Disulfide	10	Not Detected
Acetone	50	Not Detected
Methylene Chloride	10	Not Detected
trans-1,2-Dichloroethene	10	Not Detected
1,1-Dichloroethane	10	Not Detected
Vinyl Acetate	50	Not Detected
2-Butanone (Methyl Ethyl Ketone)	50	Not Detected
Chloroform	10	Not Detected
1,1,1-Trichloroethane	10	Not Detected
Carbon Tetrachloride	10	Not Detected
Benzene	10	Not Detected
1,2-Dichloroethane	10	Not Detected
Trichloroethene	10	Not Detected
1,2-Dichloropropane	10	Not Detected
Bromodichloromethane	10	Not Detected
trans-1,3-Dichloropropene	10	Not Detected
4-Methyl-2-pentanone	50	Not Detected
Toluene	10	Not Detected
cis-1,3-Dichloropropene	10	Not Detected
1,1,2-Trichloroethane	10	Not Detected
Tetrachloroethene	10	Not Detected
2-Hexanone	50	Not Detected
Dibromochloromethane	10	Not Detected
Chlorobenzene	10	Not Detected
Ethyl Benzene	10	Not Detected
m,p-Xylene	10	Not Detected
o-Xylene	10	Not Detected
Styrene	10	Not Detected
Bromoform	10	Not Detected
1,1,2,2-Tetrachloroethane	10	Not Detected
1,3-Dichlorobenzene	10	Not Detected
1,4-Dichlorobenzene	10	Not Detected
1,2-Dichlorobenzene	10	Not Detected

Container Type: NA

Surrogates	% Recovery	Method Limits
Dibromofluoromethane	98	70-130
1,2-Dichloroethane-d4	93	69-112

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9902131-02A

Modified VOST 5041A/8260B

File Name:	9022604	Date of Collection: NA
Dil. Factor:	1.0	Date of Analysis: 2/26/99

Surrogates	% Recovery	Method Limits
Toluene-d8	98	72-134
4-Bromofluorobenzene	106	78-119

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APPENDIX D

EXAMPLE CALCULATIONS

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SAMPLE CALCULATIONS FOR FLOW, MOISTURE AND ISO

Client: Clarkstown Landfill

Plant: Clarkstown, NY

Test Number: Run 2

Test Date: 02/17/99

Test Location: Flare Stack

Test Period: 1331-1511

1. Volume of dry gas sampled at standard conditions (68 deg F, 29.92 in. Hg), dscf.

$$Vm(std) = \frac{17.64 \times Y \times Vm \times (Pb + \frac{\Delta H}{13.6})}{(Tm + 460)}$$

$$Vm(std) = \frac{17.64 \times 1.0116 \times 36.231 \times (30.04 + \frac{0.924}{13.6})}{62.83 + 460} = 37.231$$

Where:

$Vm(std)$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscf.
 Vm = Volume of gas sample measured by the dry gas meter at meter conditions, dcf.
 Pb = Barometric Pressure, in Hg.
 ΔH = Average pressure drop across the orifice meter, in H_2O
 Tm = Average dry gas meter temperature, deg F.
 Y = Dry gas meter calibration factor.
 17.64 = Factor that includes ratio of standard temperature (528 deg R) to standard pressure (29.92 in. Hg), deg R/in. Hg.
 13.6 = Specific gravity of mercury.

2. Volume of water vapor in the gas sample corrected to standard conditions, scf.

$$V_w(\text{std}) = (0.04707 \times V_{wc}) + (0.04715 \times W_{wsg})$$

$$V_w(\text{std}) = (0.04707 \times 52.0) + (0.04715 \times 7.9) = 2.820$$

Where:

$V_w(\text{std})$ = Volume of water vapor in the gas sample corrected to standard conditions, scf.

V_{wc} = Volume of liquid condensed in impingers, ml.

W_{wsg} = Weight of water vapor collected in silica gel, g.

0.04707 = Factor which includes the density of water (0.002201 lb/ml), the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft³/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), ft³/ml.

0.04715 = Factor which includes the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft³/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), and 453.6 g/lb, ft³/g.

3. Moisture content

$$bws = \frac{V_w(\text{std})}{V_w(\text{std}) + V_m(\text{std})}$$

$$bws = \frac{2.820}{2.820 + 37.231} = 0.070$$

Where:

bws = Proportion of water vapor, by volume, in the gas stream, dimensionless.

4. Mole fraction of dry gas.

$$M_d = 1 - bws$$

$$M_d = 1 - 0.070 = 0.930$$

Where:

M_d = Mole fraction of dry gas, dimensionless.

5. Dry molecular weight of gas stream, lb/lb-mole.

$$MWd = (0.440 \times \% CO_2) + (0.320 \times \% O_2) + (0.280 \times (\% N_2 + \% CO))$$

$$MWd = (0.440 \times 4.5) + (0.320 \times 16.0) + (0.280 \times (79.5 + 0.00))$$

$$= 29.36$$

Where:

MWd =	Dry molecular weight, lb/lb-mole.
% CO ₂ =	Percent carbon dioxide by volume, dry basis.
% O ₂ =	Percent oxygen by volume, dry basis.
% N ₂ =	Percent nitrogen by volume, dry basis.
% CO =	Percent carbon monoxide by volume, dry basis.
0.440 =	Molecular weight of carbon dioxide, divided by 100.
0.320 =	Molecular weight of oxygen, divided by 100.
0.280 =	Molecular weight of nitrogen or carbon monoxide, divided by 100.

6. Actual molecular weight of gas stream (wet basis), lb/lb-mole.

$$MWs = (MWd \times Md) + (18 \times (1 - Md))$$

$$MWs = (29.36 \times 0.930) + (18 \times (1 - 0.930)) = 28.56$$

Where:

MWs =	Molecular weight of wet gas, lb/lb-mole.
18 =	Molecular weight of water, lb/lb-mole.

7. Average velocity of gas stream at actual conditions, ft/sec.

$$Vs = 85.49 \times Cp \times ((\Delta p)^{1/2})_{avg} \times \left(\frac{T_s (avg)}{P_s \times MWs} \right)^{1/2}$$

$$Vs = 85.49 \times 0.84 \times 0.078030 \times \left(\frac{1559}{30.04 \times 28.56} \right)^{1/2} = 7.6$$

Where:

Vs =	Average gas stream velocity, ft/sec.
85.49 =	Pitot tube constant, ft/sec x $\frac{(lb/lb-mole)(in. Hg)^{1/2}}{(deg R)(in H_2O)}$
Cp =	Pitot tube coefficient, dimensionless.
Ts =	Absolute gas stream temperature, deg R = Ts, deg F + 460.
P _s =	Absolute gas stack pressure, in. Hg. = P _b + $\frac{P(static)}{13.6}$
Δp =	Velocity head of stack, in. H ₂ O

8. Average gas stream volumetric flowrate at actual conditions, wacf/min.

$$Qs(act) = 60 \times Vs \times As$$

$$Qs(act) = 60 \times 7.55 \times 69.64 = 31562$$

Where:

$Qs(act)$ = Volumetric flowrate of wet stack gas at actual conditions, wacf/min.

As = Cross-sectional area of stack, ft^2 .

60 = Conversion factor from seconds to minutes.

9. Average gas stream dry volumetric flowrate at standard conditions, dscf/min.

$$Qs(std) = 17.64 \times Md \times \frac{Ps}{Ts} \times Qs(act)$$

$$Qs(std) = 17.64 \times 0.930 \times \frac{30.04}{1559} \times 31562$$

$$= 9972$$

Where:

$Qs(std)$ = Volumetric flowrate of dry stack gas at standard conditions, dscf/min.

10. Isokinetic variation calculated from intermediate values, percent.

$$I = \frac{17.327 \times Ts \times Vm(std)}{Vs \times O \times Ps \times Md \times (Dn)^2}$$

$$I = \frac{17.327 \times 1559 \times 37.231}{7.55 \times 72 \times 30.04 \times 0.930 \times (0.800)^2} = 103.47$$

Where:

I = Percent of isokinetic sampling.

O = Total sampling time, minutes.

Dn = Diameter of nozzle, inches.

17.327 = Factor which includes standard temperature (528 deg R), standard pressure (29.92 in. Hg), the formula for calculating area of circle $D^{2/4}$, conversion of square feet to square inches (144), conversion of seconds to minutes (60), and conversion to percent (100),

$$\frac{(in. Hg)(in^2)(min)}{(deg R)(ft^2)(sec)}$$

SAMPLE CALCULATIONS FOR PARTICULATE

Client: Clarkstown Landfill

Plant: Clarkstown, NY

Test Number: Run 2

Test Date: 02/17/99

Test Location: Flare Stack

Test Period: 1331-1511

1. Particulate Concentration, gr/dscf.

$$\begin{aligned} C1 &= 15.432 \times \frac{Mt}{Vm(std)} \\ C1 &= 15.432 \times \frac{0.00280}{37.231} \\ &= 0.0012 \end{aligned}$$

Where:

$C1$ = Particulate concentration, gr/dscf.
 Mt = Total weight of particulate caught by train
adjusted for the site blank samples
 15.432 = Conversion factor from gms to gr.

2. Particulate mass emission rate, lbs/hr.

$$\begin{aligned} PMR1 &= 0.008571 \times C1 \times Qs(std) \\ PMR1 &= 0.008571 \times 0.0012 \times 9972 \\ &= 0.10 \end{aligned}$$

Where:

$PMR1$ = Particulate mass emission rate, lbs/hr.
 0.008571 = Conversion factor relating grains to pounds (7,000)
and minutes to hours.

**SAMPLE CALCULATIONS FOR
BIAS CORRECTION AND MASS EMISSION RATE OF
Nitrogen Oxide(s)**

Client: <u>Clarkstown Landfill</u> Test Run No.: <u>RUN 2</u> Test Location: <u>Flare Stack</u>	Plant: <u>Clarkstown, NY</u> Test Date: <u>18-Feb-99</u> Test Period: <u>1048-1148</u>

Bias corrected value of Nitrogen Oxide(s), ppm.

$$C(\text{corr}) = \frac{(AVG - Z_{\text{bias}})}{(S_{\text{bias}} - Z_{\text{bias}})} \times \text{SPAN GAS}$$

$$C(\text{corr}) = \frac{12.80 - 0.25}{25.50 - 0.25} \times 25.76$$

$$C(\text{corr}) = 12.8$$

Where:

AVG = Average NOx concentration for the test run.

Z_{bias} = The average of pre and post test zero bias checks.

S_{bias} = The average of pre and post test span bias check.

SPAN GAS = The calibration gas closest to the gas stream concentration, which was used for the BIAS check.

C(corr) = Bias corrected value, ppm.

Nitrogen Oxide(s) mass emission rate, lbs/hr.

$$MR(\text{NO}_x) = \frac{C(\text{corr}) \times Q_s(\text{std}) \times 46 \times 60 \text{ min/hr}}{385.35 \times 10^6}$$

$$MR(\text{NO}_x) = \frac{12.8 \times 10,910 \times 46 \times 60 \text{ min/hr}}{385.35 \times 10^6}$$

$$MR(\text{NO}_x) = 1.00$$

Where:

MR(NO_x) = Nitrogen Oxide(s) mass emission rate, lbs/hr.

Q_s(std) = Average volumetric gas stream flow rate at standard conditions, dscf/min.

46 = Molecular weight of NO_x

385.35x10⁶ = Conversion factor from ppm to lbs.

**SAMPLE CALCULATIONS FOR
BIAS CORRECTION AND MASS EMISSION RATE OF
Sulfur Dioxide**

Client:	<u>Clarkstown Landfill</u>	Plant:	<u>Clarkstown, NY</u>
Test Run No.:	<u>RUN 2</u>	Test Date:	<u>17-Feb-99</u>
Test Location:	<u>Flare Stack</u>	Test Period:	<u>1405-1511</u>

Bias corrected value of Sulfur Dioxide, ppm.

$$C(\text{corr}) = \frac{(AVG - Z_{\text{bias}})}{(S_{\text{bias}} - Z_{\text{bias}})} \times \text{SPAN GAS}$$

$$C(\text{corr}) = \frac{1.20 - 0.20}{39.60 - 0.20} \times 40.80$$

$$C(\text{corr}) = 1.0$$

Where:

AVG = Average SO₂ concentration for the test run

Z_{bias} = The average of pre and post test zero bias checks.

S_{bias} = The average of pre and post test span bias check.

SPAN GAS = The calibration gas closest to the gas stream concentration, which was used for the BIAS check.

C(corr) = Bias corrected value, ppm.

Sulfur Dioxide mass emission rate, lbs/hr.

$$MR(\text{SO}_2) = \frac{C(\text{corr}) \times Q_s(\text{std}) \times 64 \times 60 \text{ min/hr}}{385.35 \times 10^6}$$

$$MR(\text{SO}_2) = \frac{1.0 \times 9,973 \times 64 \times 60 \text{ min/hr}}{385.35 \times 10^6}$$

$$MR(\text{SO}_2) = 0.10$$

Where:

MR(SO₂) = Sulfur Dioxide mass emission rate, lbs/hr.

Q_s(std) = Average volumetric gas stream flow rate at standard conditions, dscf/min.

64 = Molecular weight of SO₂

385.35x10⁶ = Conversion factor from ppm to lbs.

**SAMPLE CALCULATIONS FOR
BIAS CORRECTION AND MASS EMISSION RATE OF
Carbon Monoxide**

Client: <u>Clarkstown Landfill</u> Test Run No.: <u>RUN 2</u> Test Location: <u>Flare Stack</u>	Plant: <u>Clarkstown, NY</u> Test Date: <u>17-Feb-99</u> Test Period: <u>1405-1511</u>

Bias corrected value of Carbon Monoxide, ppm.

$$C(\text{corr}) = \frac{(AVG - Z_{\text{bias}})}{(S_{\text{bias}} - Z_{\text{bias}})} \times \text{SPAN GAS}$$

$$C(\text{corr}) = \frac{17.20 - 0.20}{24.85 - 0.20} \times 25.17$$

$$C(\text{corr}) = 17.4$$

Where:

AVG = Average CO concentration for the test run.

Z_{bias} = The average of pre and post test zero bias checks.

S_{bias} = The average of pre and post test span bias check.

SPAN GAS = The calibration gas closest to the gas stream concentration, which was used for the BIAS check.

C(corr) = Bias corrected value, ppm

Carbon Monoxide mass emission rate, lbs/hr.

$$MR(\text{CO}) = \frac{C(\text{corr}) \times Q_{\text{s}}(\text{std}) \times 28 \times 60 \text{ min/hr}}{385.35 \times 10^6}$$

$$MR(\text{CO}) = \frac{17.4 \times 9,973 \times 28 \times 60 \text{ min/hr}}{385.35 \times 10^6}$$

$$MR(\text{CO}) = 0.75$$

Where:

MR(CO) = Carbon Monoxide mass emission rate, lbs/hr.

Q_s(std) = Average volumetric gas stream flow rate at standard conditions, dscf/min.

28 = Molecular weight of CO

385.35x10⁶ = Conversion factor from ppm to lbs.

SAMPLE CALCULATIONS FOR VOLATILE ORGANIC COMPOUNDS (TOLUENE)

Client: Clarkstown Landfill

Test Number: Run 1

Test Location: Flare Stack

Plant: Clarkstown, NY

Test Date: 02-17-99

Test Period: 1143-1203

FLARE STACK OUTLET-RUN 1, TUBE PAIR 2

1. Volume of dry gas sampled at standard conditions (68 °F, 29.92 in. Hg), dscf.

$$Vm(std) = \frac{17.64 \times Y \times Vm \times (Pb + \frac{\Delta H}{13.6}) \times 0.035316}{(Tm + 460)}$$

$$Vm(std) = \frac{17.64 \times 1.0181 \times 18.55 \times (30.07 + \frac{1.60}{13.6}) \times 0.035316}{61.25 + 460} = 0.6814$$

Where:

$Vm(std)$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscf.

Vm = Volume of gas sample measured by the dry gas meter at meter conditions, liters.

Pb = Barometric Pressure, in Hg.

ΔH = Average pressure drop across the orifice meter, in H₂O.

Tm = Average dry gas meter temperature, °F.

Y = Dry gas meter calibration factor

17.64 = Factor that includes ratio of standard temperature (528 °R) to standard pressure (29.92 in. Hg), °R/in. Hg.

13.6 = Specific gravity of mercury.

0.035316 = Conversion factor from liters to dcf.

2. Toluene concentration, lbs/dscf.(Tube Pair 2)

$$C1 = \frac{W \times 2.2046 \times 10^{-9}}{Vm(std)}$$

$$C1 = \frac{0.035 \times 2.2046 \times 10^{-9}}{0.6814}$$
$$= 1.13E-10$$

Where:

C1 = Toluene concentration, lbs/dscf.

W = Weight of toluene collected in tube pair, ug.

2.2046×10^{-9} = Conversion factor from ug to lbs.

3. Toluene mass emission rate, lb/hr.(Tube Pair 2)

$$MR1 = C1 \times Qs(std) \times 60 \text{ min/hr}$$

$$MR1 = 1.13E-10 \times 11335 \times 60$$
$$= 7.70E-05$$

Where:

MR1 = Toluene mass emission rate, lb/hr.(Tube Pair 2)

Qs(std) = Volumetric flowrate of stack gas at standard conditions, dscf/min.(flow measured by M5 sample train)

60 = Conversion factor from minutes to hours.

4. Toluene mass emission rate, lb/hr.(Flare Stack Outlet Run-1)

$$\text{SOMR} = \frac{\text{MR1} + \text{MR2} + \text{MR3}}{3}$$

$$\text{SOMR} = \frac{0.00121 + 0.000077 + 0.000038}{3}$$

$$\text{SOMR} = 4.43\text{E-}04$$

Where:

SOMR = Toluene mass emission rate, lb/hr.(stack outlet)

MR1 = Toluene mass emission rate, lb/hr.(Tube Pair 1)

MR2 = Toluene mass emission rate, lb/hr.(Tube Pair 2)

MR3 = Toluene mass emission rate, lb/hr.(Tube Pair 3)

FLARE STACK INLET RUN 1

5. Toluene concentration, lb/dscf.

$$\text{C2} = \frac{\text{C1}}{1.602 \times 10^{10}}$$

$$\text{C2} = \frac{3600}{1.602 \times 10^{10}}$$

$$\text{C2} = 2.25\text{E-}07$$

Where:

C1 = Toluene concentration, ug/dscm. (Lab reported value)

1.602×10^{10} = Conversion factor from ug/dscm to lbs/dscf.

C2 = Toluene concentration, lb/dscf

6. Toluene mass emission rate, lb/hr.(Flare Stack Inlet)

$$\text{IMR} = C2 \times Qs(\text{std}) \times 60 \text{ min/hr}$$

$$\text{IMR} = 2.25\text{E-}07 \times 428 \times 60$$

$$\text{IMR} = 5.77\text{E-}03$$

Where:

$$\text{IMR} = \text{Toluene mass emission rate, lb/hr. (Flare Stack Inlet-Run 1)}$$

$$Qs(\text{std}) = \text{Volumetric flowrate of stack gas at standard conditions, dscf/min. (flow measured by orifice plate instrumentation)}$$

$$60 = \text{Conversion factor from minutes to hours.}$$

DESTRUCTION/REMOVAL EFFICIENCY RUN 1

7. Toluene destruction/removal efficiency

$$\text{DRE} = \frac{(\text{Flare Stack Inlet} - \text{Flare Stack Outlet})}{(\text{Flare Stack Inlet})} \times 100$$

$$\text{DRE} = \frac{(5.77 \times 10^{-3}) - (7.70 \times 10^{-5})}{5.77 \times 10^{-3}} \times 100$$

$$\text{DRE} = 92.33\%$$

Where:

$$\text{Flare Stack Inlet} = \text{Flare Stack Inlet Mass Rate, lb/hr.}$$

$$\text{Flare Stack Outlet} = \text{Flare Stack Outlet Mass Rate, lb/hr.}$$

APPENDIX E

EQUIPEMENT CALIBRATIONS

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PITOT TUBE IDENTIFICATION NUMBER: P7!

TYPE S PITOT TUBE INSPECTION DATA FORM

PITOT TUBE ASSEMBLY LEVEL? ☒ (YES) ☐ (NO)

PITOT TUBE OPENINGS DAMAGED? ☐ (YES-EXPLAIN BELOW) ☒ (NO)

$\alpha_1 = 1^\circ (<10)$

$\alpha_2 = 0^\circ (<10)$

$\beta_1 = 0^\circ (<5)$

$\beta_2 = 1^\circ (<5)$

$\gamma = 2^\circ$

$\theta = 2^\circ$

$A = .94$ in.

$z = A \sin \gamma = .02$ in.; ($<1/8$ in.),

$w = A \sin \theta = .02$ in.; ($<1/32$ in.),

$P_a = .47$ in.

$P_b = .47$ in.

$D_t = .38$ in.

$P_a = P_b$? ☒ (YES) ☐ (NO)

COMMENTS _____

CALIBRATION REQUIRED? ☐ (YES) ☒ (NO)

INSPECTOR Tom Buzio DATE 12-22-88



DRY GAS METER CALIBRATION USING CRITICAL ORIFICES

CLIENT: ClarksTown Landfill

FACILITY: ClarksTown, PA.

DATE: <u>2/23/99</u>	DRY GAS METER SERIAL #: <u>6848168</u>	INITIAL <u>29.94</u>	FINAL <u>29.94</u>	AVG (P _{avg}) <u>29.94</u>	# Y VARIATION ORIFICE SHOULD
METER BOX #: <u>14</u>	CRITICAL ORIFICE SET SERIAL #: <u>13225</u>	BAROMETRIC PRESSURE (in Hg):			

ORIFICE #	RUN #	K' FACTOR (AVG)	TESTED VACUUM (in Hg)	DGM READINGS (FT ³)				TEMPERATURES °F				ELAPSED TIME (MIN)	DGM ΔH (in H ₂ O)	(1) V _m (STD)	(2) V _m (STD)	(3) Y
				INITIAL	FINAL	NET (V _m)		AMBIENT	DGM INLET	DGM INLET	DGM OUTLET					
24	1	0.6703	19	899.298	877.916	8.618		72	76	81	74	10.00	2.6	8.6408	8.7038	1.0190
	2	0.6703	19	877.916	886.674	8.768		72	80	80	76	10.00	2.6	8.6653	8.7038	1.0066
	3	0.6703	19	886.674	896.226	8.652		72	76	78	76	10.00	2.6	8.4714	8.7038	1.0274
AVG =																
18	1	0.6114	21	896.226	901.851	6.626		72	78	79	76	10.00	1.6	8.6374	6.6402	1.0167
	2	0.6114	21	901.851	908.636	6.886		72	79	79	76	10.00	1.6	6.8966	6.6402	1.0066
	3	0.6114	21	908.636	916.163	6.627		72	78	79	76	10.00	1.6	6.6394	6.6402	1.0164
AVG =																
11	1	0.3237	24	916.163	919.332	4.170		72	78	77	76	10.00	0.66	4.1149	4.2031	1.0214
	2	0.3237	24	919.332	923.501	4.168		72	77	77	76	10.00	0.66	4.1148	4.2031	1.0214
	3	0.3237	24	923.501	927.644	4.143		72	76	77	76	10.00	0.66	4.0820	4.2031	1.0271
AVG =																
AVERAGE DRY GAS METER CALIBRATION FACTOR, Y = 1.0178																

USING THE CRITICAL ORIFICES AS CALIBRATION STANDARDS

- 1) Select three critical orifices to calibrate the dry gas meter which bracket the expected operating range
- 2) Record barometric pressure before and after calibration procedure
- 3) Run at maximum attainable vacuum (open coarse valve, close fine valve) for period of 5 minutes minimum for large orifice up to 10 minutes for smallest orifice
- 4) Record readings in outlined boxes, other columns are automatically calculated

$$\begin{aligned}
 (1) \quad V_m (\text{std}) &= K' \cdot V_m \cdot \frac{P_{\text{bar}} + (\Delta H/13.6)}{T_m} & K' &= \text{Net volume of gas sample passed through DGM, corrected to standard conditions} \\
 & & K' &= 17.64 \text{ "Rin Hg (English), } 0.3858 \text{ "Rin Hg (Metric)} \\
 & & T_m &= \text{Absolute DGM avg. temperature ("R - English, "K - Metric)} \\
 (2) \quad V_m (\text{std}) &= K' \cdot \sqrt{\frac{P_{\text{bar}} \cdot \theta}{T_{\text{amb}}}} & K' &= \text{Volume of gas sample passed through the critical orifice, corrected to standard conditions} \\
 & & T_{\text{amb}} &= \text{Absolute ambient temperature ("R - English, "K - Metric)} \\
 (3) \quad Y &= \frac{V_m (\text{std})}{V_m (\text{std})} & K' &= \text{Average K' factor from Critical Orifice Calibration} \\
 & & & = \text{DGM calibration factor}
 \end{aligned}$$

Calibrator: G. Palmeri



STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

DATE 23 FEB 99POTENTIOMETER NUMBER NOTED 219AMBIENT TEMPERATURE 67.2 FBAROMETRIC PRESSURE 29.94CALIBRATION GP

REFERENCE: THERMOCOUPLE SIMULATOR

(ACCURACY: 1°F)

REFERENCE TEMPERATURE °C °F		TEMPERATURE READING FROM THERMOCOUPLE CHANNEL INPUT NUMBER					AVERAGE TEMPERATURE READING °	TEMPERATURE DIFFERENCE ° (%)
		1	2	3	4	5		
0	32	34	34	34	34	34	34	2° - .41
100	212	214	214	214	214	214	214	2° - .30%
500	932	934	934	934	934	934	934	2° - .14%
1000	1832	1831	1831	1831	1831	1831	1831	1° - .04%

COMMENTS

° AVERAGE TEMPERATURE READING = MEAN OF THE TEMPERATURE READINGS FOR THE THERMOCOUPLE CHANNELS

° THE CHANNEL READINGS MUST AGREE WITHIN ± 5°F OR 3°C

ACCEPTABLE TEMPERATURE DIFFERENCE ± 1.5 °

$$\left(\frac{(\text{REF TEMP}^{\circ}\text{F} + 460) \cdot (\text{TEST TEMP}^{\circ}\text{F} + 460)}{(\text{REF TEMP}^{\circ}\text{F} + 460)} \right) \times 100$$



LONG/PRE DRY GAS METER CALIBRATION DATA FORM

Calibrator L. J. WebbDate 2/28/98Meter Box Number 141Plant 249169Barometric pressure, $P_b =$ 29.96 in. HgDry Gas Meter Number 249169

Comments

Setting	Gas volume		Temperatures						
Orifice manometer	Wet test meter	Dry gas meter	Wet test meter	Dry gas meter					
(ΔH) in. H_2O	(V_1) ft^3	(V_2) ft^3	(t_w) $^{\circ}F$	Inlet (td) $^{\circ}F$	Outlet (td) $^{\circ}F$	Avg (td) $^{\circ}F$	Time (s), min	Y_1	ΔH @, in. H_2O
0.5	5	624.012 620.040 631.031	66	72.7980	75.7676	72.5	12.8	1.0085	18/50
1.0	5	626.031 641.132	66	80.8182	76.7277	79	9.2	1.0120	18700
1.5	10	631.308 646.464	66.5	83.8684	77.7278	81	15.3	1.013	14323
2.0	10	651.328 646.464	66.5	85.8890	78.7280	83.5	13.4	1.0135	19709
3.0	10	646.464 651.328	66.5	88.9192	80.8281	85.5	10.7	1.0126	1.94/90
							Avg	Y	ΔH @
If there is only one thermometer on the dry gas meter, record the temperature under td.									
								1.0116	1.9074

If there is only one thermometer on the dry gas meter, record the temperature under td_w .

(ΔH) in. H_2O	$\frac{\Delta H}{13.6}$	$Y_1 = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H @ i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \Theta}{V_w} \right]^2$
0.5	0.0368	$(5)(29.96)(73.5+460)$ $(5)(29.96+0.0368)(66+460)$	$(10317)(.5)$ $(29.96)(73.5+460)$ S
1.0	0.0735	$(5)(29.96)(77.5+460)$ $(5)(29.96+0.0735)(66+460)$	$(10317)(1.0)$ $(29.96)(77.5+460)$ S
1.5	0.110	$(10)(29.96)(81+460)$ $(10)(29.96+0.110)(66+460)$	$(10317)(1.5)$ $(29.96)(81+460)$ 10
2.0	0.147	$(10)(29.96)(83.5+460)$ $(10)(29.96+0.147)(66+460)$	$(10317)(2.0)$ $(29.96)(83.5+460)$ 10
3.0	0.221	$(10)(29.96)(85.5+460)$ $(10)(29.96+0.221)(66+460)$	$(10317)(3.0)$ $(29.96)(85.5+460)$ 10



Calibrator

F. M. Beck

POSTTEST DRY GAS METER CALIBRATION DATA FORM (VOST)

Date 3/22/99

Meter box number

2

Plant

Clark's town brick fillBarometric pressure, $P_b =$ 29.33

in. Hg

Dry gas meter number

500422Pretest $Y =$ 1.138

Setting	Gas Volume		Temperature			Vacuum Setting, in. Hg.	$Y_1 =$ $\frac{V_1 P_1 (t_2 + 460)}{V_2 (P_2 + \frac{\Delta H}{13.6}) (t_1 + 460)}$
	Orifice Manometer (ΔH) in. H_2O	Wet test meter (V_w) liters	Dry gas meter (V_d) liters	Wet test meter (t_w) $^{\circ}F$	Dry gas meter Inlet (t_d) $^{\circ}C$	Outlet (t_o) $^{\circ}C$	Average (t_a) $^{\circ}C/^{\circ}F$
Rotometer							
71	1.6	10	6793.29 6783.29	63	—	34.23 23.57	23.57
71	1.6	10	6805.33 6795.25	63	—	24.25 24.57	24.57
71	1.6	10	6817.57 6807.44	63	—	25.26 25.57	25.57
							$Y = 1.014$

If there is only one thermometer on the dry gas meter, record the temperature under t_{d_o} . $V_w =$ Gas volume passing through the wet test meter, liters. $V_d =$ Gas volume passing through the dry gas meter, liters. $t_w =$ Temperature of the gas in the wet test meter, $^{\circ}F$. $t_{d_i} =$ Temperature of the inlet gas of the dry gas meter, $^{\circ}C$. $t_{d_o} =$ Temperature of the outlet gas of the dry gas meter, $^{\circ}C$. $t_a =$ Average temperature of the gas in the dry gas meter, $\frac{t_{d_i} + t_{d_o}}{2}$. $\Delta H =$ Pressure differential across orifice, in. H_2O . $Y_1 =$ Ratio of accuracy of wet test meter to dry gas meter for each run. $Y =$ Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest $Y \pm 0.05Y$. $P_b =$ Barometric pressure, in. Hg. $\theta =$ Time of calibration run, min. $^{\circ}C/^{\circ}F =$ $(^{\circ}C \times 9/5) + 32 = ^{\circ}F$

1 and 1000

No

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

DATE _____

AMBIENT TEMPERATURE

CALIBRATION

POTENTIOMETER NUMBER

BAROMETRIC PRESSURE

REFERENCE: THERMOCOUPLE SIMULATOR

(ACCURACY: 1°F)

REFERENCE TEMPERATURE		TEMPERATURE READING FROM THERMOCOUPLE CHANNEL INPUT NUMBER					AVERAGE TEMPERATURE READING	TEMPERATURE DIFFERENCE
°C	°F	1	2	3	4	5		(%)
0	32	0	0	0	0		0	0.0%
100	212	101	101	101	101		101	1.0 - .27%
500	932	500	500	500	500		500	0.0 - 0%
1000	1832	999	999	999	999		999	1.0 - .16%

COMMENTS

● **AVERAGE TEMPERATURE READING = MEAN OF THE TEMPERATURE READINGS FOR THE THERMO-
COUPLE CHANNELS**

① THE CHANNEL READINGS MUST AGREE WITHIN: 5° F OR 3° C

ACCEPTABLE TEMPERATURE DIFFERENCE ≤ 1.5 °C

$$\left(\frac{(\text{REF TEMP}^{\circ}\text{F} + 450) \cdot (\text{TEST TEMP}^{\circ}\text{F} + 450)}{(\text{REF TEMP}^{\circ}\text{F} + 450)} \right) \times 100$$

Calibrator P. M. Smith

LONG/PRE DRY GAS METER CALIBRATION DATA FORM (VOST)

Date 4/2/92 Meter box number 2 Plant 2
Barometric pressure, $P_b =$ 29.41 in. Hg Dry gas meter number 500422 Comments Serial - approved cal.

Setting			Gas Volume		Temperature			Vacuum Setting in. Hg.	Y _i	Y ₁ = $\frac{V_i P_s (t_s + 460)}{V_s \left(P_s + \frac{\Delta H}{13.6} \right) (t_s + 460)}$
Liters per minute	Rotometer	Orifice Manometer (Δ H) in. H ₂ O	Wet test meter	Dry gas meter	Wet test meter	Dry gas meter				
			(V _s) liters	(V _d) liters	(t _s) °F	Inlet (t _d) °C	Outlet (t _d) °C	Average (t _d) °C/°F		
.5	44	1.4	5	2054.4 2054.4	70	22.1 22.33	—	22.33/72	2	1.0168
.5	44	1.4	5	2054.4 2060.77	70	23.24 24.24	—	23.07/74.5	2	1.0155
1.0	84	1.7	10	2065.4 2066.7	70	24.35 24.35	—	24.33/76	2	1.0172
1.0	84	1.7	10	2065.4 2071.46	70	25.25 25.25	—	25.177	2	1.0130
										Y = 1.0181

If there is only one thermometer on the dry gas meter, record the temperature under t_d . V_s = Gas volume passing through the wet test meter, liters. V_d = Gas volume passing through the dry gas meter, liters. t_s = Temperature of the gas in the wet test meter, °F. t_{d_i} = Temperature of the inlet gas of the dry gas meter, °C. t_{d_o} = Temperature of the outlet gas of the dry gas meter, °C. t_d = Average temperature of the gas in the dry gas meter, $\frac{t_{d_i} + t_{d_o}}{2}$. ΔH = Pressure differential across orifice, in. H_2O . Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run. Y = Average ratio of accuracy of wet test meter to dry gas meter for all four runs; tolerance = pretest $Y \pm 0.05Y$. P_b = Barometric pressure, in. Hg. e = Time of calibration run, min. $^{\circ}C/^{\circ}F$ ($^{\circ}C \ 9/5$) + 32 = $^{\circ}F$



STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

DATE 7/7/80
AMBIENT TEMPERATURE 71.0
CALIBRATION Ch. Potentiometer

POTENTIOMETER NUMBER 1050000
BAROMETRIC PRESSURE 30.91
REFERENCE: THERMOCOUPLE SIMULATOR
(ACCURACY: $\pm 1^{\circ}\text{F}$)

REFERENCE TEMPERATURE		TEMPERATURE READING FROM THERMOCOUPLE CHANNEL INPUT NUMBER					AVERAGE TEMPERATURE READING ^①	TEMPERATURE DIFFERENCE ^②
$^{\circ}\text{C}$	$^{\circ}\text{F}$	1	2	3	4	5		(%)
0	32	0	0	0	0		0	0% - 0%
100	212	100	100	100	100		100	0% - 0%
500	932	500	500	500	500		500	0% - 0%
1000	1832	1000	1000	1000	1000		1000	0% - 0%

COMMENTS

① AVERAGE TEMPERATURE READING = MEAN OF THE TEMPERATURE READINGS FOR THE THERMOCOUPLE CHANNELS

② THE CHANNEL READINGS MUST AGREE WITHIN $\pm 5^{\circ}\text{F}$ OR 3°C

ACCEPTABLE TEMPERATURE DIFFERENCE $\pm 1.5 = \left(\frac{(\text{REF TEMP } ^{\circ}\text{F} + 460) \cdot (\text{TEST TEMP } ^{\circ}\text{F} + 460)}{(\text{REF TEMP } ^{\circ}\text{F} + 460)} \right) \times 100$



Scott Specialty Gases

RATA CLASS

Dual-Analyzed Calibration Standard

6141 EASTON ROAD, BLDG 1, PLUMSTEADVILLE, PA 18949-0310

Phone: 215-766-1861

Fax: 215-766-2070

CERTIFICATE OF ACCURACY: EPA Protocol Gas

Assay Laboratory

SCOTT SPECIALTY GASES
6141 EASTON ROAD, BLDG 1
PLUMSTEADVILLE, PA 18949-0310

P.O. No.: VISA-P.MACK
Project No.: 01-16234-003

Customer

ROY F WESTON, INC (P.MACK)
C/O KEYSTONE BLDG
1420 PHOENIXVILLE PIKE
WEST CHESTER PA 19380

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; Procedure #G1; September, 1997.

Cylinder Number: BAL3454 Certification Date: 3/17/99 Exp. Date: 3/16/2001
Cylinder Pressure***: 0400 PSIG

COMPONENT	CERTIFIED CONCENTRATION	ANALYTICAL ACCURACY**	TRACEABILITY
SULFUR DIOXIDE *	40.6 PPM	+/- 1%	NIST
NITROGEN	BALANCE		

*** Do not use when cylinder pressure is below 150 psig.

** Analytical accuracy is inclusive of usual known error sources which at least include precision of the measurement processes.

Product certified as +/- 1% analytical accuracy is directly traceable to NIST standards.

* This Protocol has been certified using corrected NIST SO2 standard values, per EPA guidance dated 7/24/98 and will not correlate with uncorrected Protocols.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM R 1693	5/03/01	ALM039723	49.50 PPM	SULFUR DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
HQIRRA/CFA321A/56437102	03/04/99	NDIR

ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

First Triad Analysis

Second Triad Analysis

Calibration Curve

SULFUR DIOXIDE *

Date: 03/23/99	Response Units: VOLTS		
Z1 = 0.0000	R1 = 0.0000	T1 = 0.0000	
R2 = 0.0000	Z2 = 0.0000	T2 = 0.0000	
Z3 = 0.0000	T3 = 0.0000	R3 = 0.0000	
Avg. Concentration:	40.80	PPM	

Date: 03/17/99	Response Units: VOLTS		
Z1 = 0.0001	R1 = 0.8160	T1 = 0.6635	
R2 = 0.8166	Z2 = 0.0001	T2 = 0.6633	
Z3 = 0.0001	T3 = 0.6653	R3 = 0.8161	
Avg. Concentration:	40.40	PPM	

Concentration = A + Bx + Cx2 + Dx3 + Ex4	
r = 0.999916	NTRM R 1693
Constants:	A = 3.14E+01
B = 3.750E-01	C = 9.0000E-02
D = 0.0000E+00	E = 0.0000E+00

APPROVED BY:

AL Rojas
AL ROJAS



325 McCausland Court
Cheshire, CT 06410
Phone: (203) 250-6827
FAX: (203) 250-6842

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	2759	Purchase Order #	4866-1
Cylinder No :	CC63443	Expiration Date:	8/26/99
Cylinder Pressure:	2000	Laboratory:	Cheshire, CT
Certification Date	8/26/97		

Reference Standard Information:

<u>Type</u>	<u>Component</u>	<u>Cyl. Number</u>	<u>Concentration</u>
GMIS	Sulfur Dioxide	ALM15446	500.59 ppm

Instrumentation:

<u>Instrument/Model/Serial No.</u>	<u>Analytical Principle</u>
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

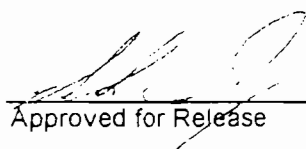
<u>Component</u>	<u>Concentration</u>	<u>Accuracy</u>	<u>Procedure</u>
Sulfur Dioxide	88.06 ppm	+/- 1%	G1
Nitrogen	Balance		

Analytical Results:

<u>1st Component:</u>		<u>Sulfur Dioxide</u>					
1st Analysis Date: 8/11/97							
R	502.255	S	88.275	Z	-0.370	Conc	88.286 ppm
S	53.487	Z	500.000	R	500.000	Conc	89.287 ppm
Z	0.920	R	500.254	S	88.534	Conc	87.834 ppm
						AVG.	88.469 ppm
2nd Analysis Date: 8/26/97							
R	501.985	S	88.394	Z	0.463	Conc	87.767 ppm
S	89.227	Z	0.846	R	500.020	Conc	88.632 ppm
Z	1.807	R	499.256	S	87.638	Conc	86.575 ppm
						AVG.	87.658 ppm

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.


Approved for Release

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	4832	Purchase Order #	5995-1
Cylinder No :	CC57077	Expiration Date:	6/25/00
Cylinder Pressure:	2000	Laboratory:	Cheshire, CT
Certification Date	6/25/98		

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Sulfur Dioxide	CC41442	477.43 ppm

Instrumentation:

Instrument/Model/Serial No.	Analytical Principle
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Sulfur Dioxide	250.64 ppm	+/- 2%	G1
Nitrogen	Balance		

Analytical Results:

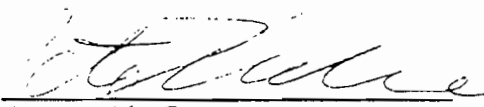
1st Component: Sulfur Dioxide

1st Analysis Date: 6/11/98			
R	475.607	S	250.177
S	250.052	Z	-0.517
Z	0.580	R	478.161
		S	249.919
		Conc	251.326 ppm
		Conc	250.725 ppm
		Conc	249.260 ppm
		AVG:	250.437 ppm

2nd Analysis Date: 6/25/98			
R	469.461	S	246.602
S	247.144	Z	1.591
Z	0.260	R	470.285
		S	246.691
		Conc	250.264 ppm
		Conc	251.945 ppm
		Conc	250.313 ppm
		AVG:	250.841 ppm

Certification performed in accordance with "EPA Traceability Protocol (Jan. 1998)" using the assay procedures listed.

Do not use cylinder below 150 psig.


Approved for Release

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec# 6074
Cylinder No : CC75208
Cylinder Pressure: 2000
Certification Date 11/13/98
Purchase Order # 7487
Expiration Date: 11/13/00
Laboratory: Cheshire, CT

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Nitric Oxide	CC41447	241.236 ppm

Instrumentation:

Instrument/Model/Serial No.	Analytical Principle
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Nitric Oxide	25.76 ppm	+/- 2%	G1
Nitrogen	Balance		

Analytical Results:

1st Component: Nitric Oxide

1st Analysis Date: 10/21/98

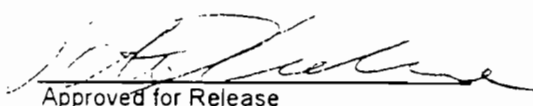
R	242.347	S	25.644	Z	0.137	Conc	25.404 ppm
S	25.527	Z	0.157	R	241.636	Conc	25.344 ppm
Z	-0.279	R	242.100	S	25.686	Conc	25.843 ppm
						AVG:	25.530 ppm

2nd Analysis Date: 11/13/98

R	243.782	S	25.869	Z	-0.190	Conc	25.768 ppm
S	26.597	Z	-0.184	R	243.420	Conc	26.521 ppm
Z	-0.031	R	242.773	S	25.796	Conc	25.659 ppm
						AVG:	25.983 ppm

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1997)" using the assay procedures listed

Do not use cylinder below 150 psig.


Approved for Release



Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	2726	Purchase Order #	4799-1
Cylinder No :	CC50986	Expiration Date:	8/13/99
Cylinder Pressure:	2000	Laboratory:	Cheshire, CT
Certification Date	8/13/97		

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Nitric Oxide	CC37432	96.03 ppm

Instrumentation:

Instrument/Model/Serial No.	Analytical Principle
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Nitric Oxide	54.08 ppm	+/- 1%	G1
Nitrogen	Balance		

Analytical Results:

1st Component:

Nitric Oxide

1st Analysis Date: 8/1/97

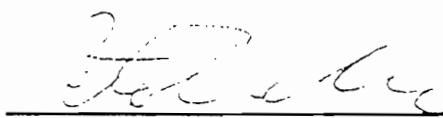
R	96.563	S	54.719	Z	-0.111	Conc	54.465 ppm
S	54.189	Z	-0.193	R	96.623	Conc	53.941 ppm
Z	-0.375	R	96.624	S	53.926	Conc	53.759 ppm
						AVG	54.055 ppm

2nd Analysis Date: 8/13/97

R	97.556	S	55.056	Z	0.008	Conc	54.192 ppm
S	54.825	Z	-0.270	R	97.409	Conc	54.164 ppm
Z	-0.218	R	96.976	S	54.395	Conc	53.959 ppm
						AVG:	54.105 ppm

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed

Do not use cylinder below 150 psig.


Approved for Release



325 McCausland Court
Cheshire, CT 06410
Phone: (203) 250-6827
FAX: (203) 250-6842

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	3067	Purchase Order #	147-1
Cylinder No :	CC79099	Expiration Date:	10/9/99
Cylinder Pressure:	2000	Laboratory:	Cheshire, CT
Certification Date	10/9/97		

Reference Standard Information:

<u>Type</u>	<u>Component</u>	<u>Cyl. Number</u>	<u>Concentration</u>
GMIS	Nitric Oxide	CC49464	47.18 ppm

Instrumentation:

<u>Instrument/Model/Serial No.</u>	<u>Analytical Principle</u>
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

<u>Component</u>	<u>Concentration</u>	<u>Accuracy</u>	<u>Procedure</u>
Nitric Oxide	88.22 ppm	+/- 1%	G1
Nitrogen	Balance		

Analytical Results:

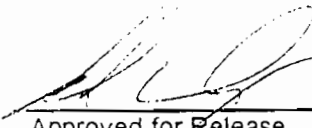
1st Component: Nitric Oxide

1st Analysis Date:	10/2/97				
R	46.930	S	88.037	Z	0.106
S	88.614	Z	-0.063	R	47.219
Z	0.141	R	47.311	S	88.286
				Conc	88.601 ppm
				Conc	88.486 ppm
				Conc	88.163 ppm
				AVG:	88.417 ppm

2nd Analysis Date:	10/9/97				
R	47.678	S	88.593	Z	0.163
S	89.054	Z	-0.149	R	47.482
Z	0.078	R	47.793	S	89.008
				Conc	87.807 ppm
				Conc	88.358 ppm
				Conc	87.933 ppm
				AVG:	88.033 ppm

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.


Approved for Release



325 McCausland Court
Cheshire, CT 06410
Phone: (203) 250-6827
FAX (203) 250-6842

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	3687	Purchase Order #	3084-1
Cylinder No :	CC78906	Expiration Date:	1/15/00
Cylinder Pressure:	2000	Laboratory:	Cheshire, CT
Certification Date	1/15/98		

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Nitric Oxide	CC41461	242.15 ppm

Instrumentation:

Instrument/Model/Serial No.	Analytical Principle
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Nitric Oxide	470.62 ppm	+/- 2%	G1
Nitrogen	Balance		

Analytical Results:

1st Component:

Nitric Oxide

1st Analysis Date: 1/8/98

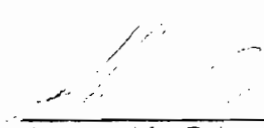
R	242.409	S	470.038	Z	-0.050	Conc	469.489 ppm
S	471.561	Z	0.262	R	243.244	Conc	469.685 ppm
Z	0.165	R	242.771	S	472.139	Conc	471.087 ppm
						AVG:	470.087 ppm

2nd Analysis Date: 1/15/98

R	244.049	S	474.984	Z	0.162	Conc	471.440 ppm
S	472.115	Z	-0.226	R	242.248	Conc	471.710 ppm
Z	0.059	R	242.342	S	470.618	Conc	470.300 ppm
						AVG:	471.150 ppm

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.


Approved for Release



325 McCausland Court
Cheshire, CT 06410
Phone (203) 250-6827
FAX (203) 250-6842

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec# 3689
Cylinder No: CC37302
Cylinder Pressure: 2000
Certification Date 1/20/98

Purchase Order # 3084-1
Expiration Date: 1/20/01
Laboratory: Cheshire, CT

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
NTRM	Carbon Dioxide	CC34977	14.08 %
GMIS	Oxygen	CC19914	10.07 %

Instrumentation:

Instrument/Model/Serial No.
Rosemount/NGA2000/Rack#1
Servomex/244/701/488

Analytical Principle
NDIR
Paramagnetic

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Carbon Dioxide	16.97 %	+/- 2%	G1
Oxygen	6.95 %	+/- 2%	G1
Nitrogen	Balance		

Analytical Results:

1st Component:

Carbon Dioxide

1st Analysis Date:	1/20/98				
R	3.471	S	3.779	Z	0.290
S	3.741	Z	0.288	R	3.433
Z	0.278	R	3.384	S	3.685
				Conc	16.959 %
				Conc	16.996 %
				Conc	16.962 %
				AVG:	16.972 %

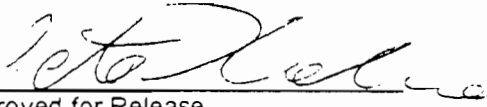
2nd Component:

Oxygen

1st Analysis Date:	1/5/98				
R	84.200	S	58.490	Z	0.200
S	58.510	Z	0.350	R	84.250
Z	0.250	R	84.200	S	58.480
				Conc	6.954 %
				Conc	6.947 %
				Conc	6.955 %
				AVG:	6.952 %

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.


Approved for Release



Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec# 3070
Cylinder No : CC3634
Cylinder Pressure: 2000
Certification Date 10/8/97Purchase Order # 1471-1
Expiration Date: 10/8/00
Laboratory: Cheshire, CT

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Carbon Dioxide	CC19645	6.951 %
GMIS	Oxygen	CC19914	10.07 %

Instrumentation:

Instrument/Model/Serial No.
Rosemount/NGA2000/Rack#1
Servomex/244/701/488Analytical Principle
NDIR
Paramagnetic

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Carbon Dioxide	7.95 %	+/- 1%	G1
Oxygen	14.07 %	+/- 1%	G1
Nitrogen	Balance		

Analytical Results:

1st Component:

Carbon Dioxide

1st Analysis Date 9/30/97

R	670310.000	S	683380.000	Z	515380.000	Conc	7.934 %
S	683510.000	Z	515310.000	R	670250.000	Conc	7.949 %
Z	515450.000	R	670300.000	S	683710.000	Conc	7.961 %
						AVG:	7.948 %

2nd Component:

Oxygen

1st Analysis Date 10/8/97

R	84.490	S	118.250	Z	0.350	Conc	14.078 %
S	118.320	Z	0.220	R	84.580	Conc	14.065 %
Z	0.250	R	84.490	S	118.180	Conc	14.062 %
						AVG:	14.069 %

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.

Approved for Release

9-18-99 02:59P

Airgas

Specialty Gases

1215 Mainland Blvd.

Cincinnati, OH 45240

(513) 260-0800

Fax: (513) 260-6842

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	3069	Purchase Order #	1471-1
Cylinder No :	CC43541	Expiration Date:	10/8/00
Cylinder Pressure:	2000	Laboratory:	Cheshire CT
Certification Date	10/8/97		

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Carbon Dioxide	CC37426	3.026 %
GMIS	Oxygen	CC23665	20.98 %

Instrumentation:

Instrument/Model/Serial No.	Analytical Principle
Rosemount/NGA2000/1000133	NDIR
Servomax/244/701/488	Paramagnetic

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Carbon Dioxide	3.95 %	+/- 1%	G1
Oxygen	21.08 %	+/- 1%	G1
Nitrogen	Balance		

Analytical Results:**1st Component: Carbon Dioxide**

1st Analysis Date: 9/30/97							
R	593750.000	S	519020.000	Z	513440.000	Conc	3.937 %
S	519320.000	Z	513410.000	R	596550.000	Conc	3.954 %
Z	513300.000	R	596630.000	S	519430.000	Conc	3.964 %
						AVG:	3.955 %

2nd Component: Oxygen

1st Analysis Date: 10/8/97							
R	84.450	S	177.000	Z	0.350	Conc	21.086 %
S	177.250	Z	0.220	R	84.580	Conc	21.076 %
Z	0.250	R	84.490	S	177.060	Conc	21.077 %
						AVG:	21.080 %

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1997)" using the assay procedures listed.

Do not use cylinder below 150 psig.

Approved for Release



Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	2755	Purchase Order #	4866-1
Cylinder No :	CC25656	Expiration Date:	8/26/00
Cylinder Pressure:	2000	Laboratory:	Cheshire, CT
Certification Date	8/26/97		

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Carbon Monoxide	CC23961	25.4 ppm

Instrumentation:

Instrument/Model/Serial No.	Analytical Principle
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Carbon Monoxide	25.17 ppm	+/- 1%	G1
Nitrogen	Balance		

Analytical Results:

1st Component: Carbon Monoxide

1st Analysis Date: 8/15/97

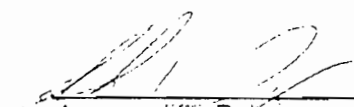
R	25.205	S	24.938	Z	0.063	Conc	25.130 ppm
S	24.945	Z	0.055	R	25.102	Conc	25.242 ppm
Z	0.047	R	25.095	S	24.858	Conc	25.159 ppm
						AVG:	25.177 ppm

2nd Analysis Date: 8/26/97

R	25.307	S	25.074	Z	0.059	Conc	25.165 ppm
S	25.020	Z	0.081	R	25.307	Conc	25.111 ppm
Z	0.095	R	25.263	S	25.073	Conc	25.209 ppm
						AVG	25.162 ppm

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.


Approved for Release



325 McCausland Court
Cheshire, CT 06410
Phone: (203) 250-6827
FAX: (203) 250-6842

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec# 3064
Cylinder No : CC37563
Cylinder Pressure: 2000
Certification Date 10/8/97

Purchase Order # 1471-1
Expiration Date: 10/8/00
Laboratory: Cheshire, CT

Reference Standard Information:

<u>Type</u>	<u>Component</u>	<u>Cyl. Number</u>	<u>Concentration</u>
GMIS	Carbon Monoxide	CC23961	25.4 ppm

Instrumentation:

<u>Instrument/Model/Serial No.</u>	<u>Analytical Principle</u>
Nicolet/550/ACN9402102	FTIR

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

<u>Component</u>	<u>Concentration</u>	<u>Accuracy</u>	<u>Procedure</u>
Carbon Monoxide	54.76 ppm	+/- 1%	G1
Nitrogen	Balance		

Analytical Results:

1st Component:

Carbon Monoxide

1st Analysis Date: 9/30/97

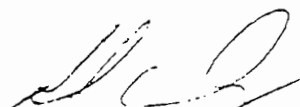
R	25.402	S	54.737	Z	0.020	Conc	54.756 ppm
S	54.927	Z	0.019	R	25.444	Conc	54.855 ppm
Z	0.005	R	25.317	S	54.593	Conc	54.778 ppm
						AVG:	54.796 ppm

2nd Analysis Date: 10/8/97

R	25.327	S	54.657	Z	-0.008	Conc	54.804 ppm
S	54.584	Z	-0.005	R	25.349	Conc	54.687 ppm
Z	0.015	R	25.326	S	54.489	Conc	54.666 ppm
						AVG:	54.719 ppm

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.


Approved for Release



Scott Specialty Gases, Inc.

1290 COMBERMERE STREET, TROY, MI 48083

Phone : (248) 589-2950 Fax : (248) 589-2134

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer

C A E INSTRUMENT RENTAL
500 WEST WOOD STREET
ATTN: JERRY MILLER
PALATINE, IL 60067

Assay Laboratory

Scott Specialty Gases, Inc
1290 Combermere
Troy, MI 48083

Purchase Order : 2104-71500

Scott Project # : 519095

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay and Certification of Gaseous Calibration Standards; Procedure G1; September, 1993.

Cylinder Number : ALM059700

Certificate Date : 10/25/97

Expiration Date : 10/25/2000

Cylinder Pressure + : 1900 psig

Previous Certificate Date : None

ANALYZED CYLINDER

Components

Carbon Monoxide

Certified Concentration

86.09 ppm

Analytical Uncertainty*

±1% NIST Directly Traceable

Balance Gas: Nitrogen

+Do not use when cylinder pressure is below 150 psig.

*Analytical accuracy is inclusive of usual known error sources which at least include precision of the measurement processes.

REFERENCE STANDARD

Type

NTRM1679

Expiration Date

5/9/98

Cylinder Number

ALM059830

Concentration

98.5 ppm Carbon Monoxide in Nitrogen

INSTRUMENTATION

Instrument/Model/Serial

CO: Horiba/OPE-135/565607092

Last Date Calibrated

10/25/97

Analytical Principle

Non-dispersive Infrared

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components

Carbon Monoxide

First Triad Analysis

Date: 10/18/97 Response Units: mv
Z1=0.00 R1=71.00 T1=62.30
R2=71.00 Z2=0.00 T2=62.30
Z3=0.00 T3=62.30 R3=71.00
Avg. Conc. of Cust. Cyl. 86.09 ppm

Second Triad Analysis

Date: 10/25/97 Response Units: mv
Z1=0.00 R1=71.00 T1=62.30
R2=71.00 Z2=0.00 T2=62.30
Z3=0.00 T3=62.30 R3=71.00
Avg. Conc. of Cust. Cyl. 86.09 ppm

Calibration Curve

Concentration=A+Bx+Cx²+Dx³+Ex⁴
r=1.00000 NTRM1679
Constants: A=0.645566300
B=1.300100000 C=0.001465446
D=-0.000005141 E=0.000000000

Special Notes

Cylinder

Analyst

Great Lakes Airgas, Inc.

1250 W. Washington St.
West Chicago, IL 60185
Phone: 708-231-7760
FAX: 708-293-0172



INDUSTRIAL GASES • WELDING SUPPLIES • SPECIALTY GASES

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Cylinder No :	<u>CC57048</u>	Order No.	<u>GM 42396</u>
Cylinder Pressure:	<u>2000 psig</u>	Expiration Date:	<u>6/28/99</u>
Certification Date	<u>6/28/96</u>	Laboratory:	<u>W. Chicago</u>

Reference Standard Information:

<u>Type</u>	<u>Component</u>	<u>Cyl. Number</u>	<u>Concentration</u>
SRM 1680b	Carbon Monoxide	CLM-09986	490.4 ppm

Instrumentation:

<u>Instrument/Model/Serial No.</u>	<u>Analytical Principle</u>
Nicolet/8220/AAB9400246	FTIR

Analytical Methodology does not require correction for analytical interferences.

Analytical Results:

1st Component: Carbon Monoxide

1st Analysis Date:	<u>6/18/96</u>				
R	<u>469.118</u>	S	<u>454.536</u>	Z	<u>0.138</u>
S	<u>457.538</u>	Z	<u>0.195</u>	R	<u>468.917</u>
Z	<u>0.107</u>	R	<u>472.163</u>	S	<u>456.847</u>
				Conc	<u>475.152 ppm</u>
				Conc	<u>478.495 ppm</u>
				Conc	<u>474.489 ppm</u>
				AVG:	<u>476.045 ppm</u>

2nd Analysis Date:	<u>6/28/96</u>				
R	<u>505.094</u>	S	<u>489.587</u>	Z	<u>0.253</u>
S	<u>490.192</u>	Z	<u>0.275</u>	R	<u>505.653</u>
Z	<u>0.225</u>	R	<u>503.802</u>	S	<u>491.270</u>
				Conc	<u>475.337 ppm</u>
				Conc	<u>475.397 ppm</u>
				Conc	<u>478.196 ppm</u>
				AVG:	<u>476.310 ppm</u>

Certified Concentrations:

<u>Component</u>	<u>Concentration</u>	<u>Accuracy</u>	<u>Procedure</u>
Carbon Monoxide	476.18 ppm	+/- 1%	G1
Nitrogen	Balance		

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1993)" using the assay procedures listed.

Do not use cylinder below 150 psig.

Edward Johnson
Approved for Release

**INTERFERENCE RESPONSE CHECK
SULFUR DIOXIDE
WESTERN RESEARCH MODEL 721 AT
ANALYZER DATA SUMMARY**

18 February 1999

TEST GAS	INSTRUMENT RESPONSE (ppm)
Zero Nitrogen (N ₂)	0.0
Oxides of Nitrogen (NO _x) - 470.62 ppm	0.1
Sulfur Dioxide (SO ₂) 40.8 ppm	40.8
Carbon Dioxide (CO ₂) - 7.95%	0.1
Carbon Monoxide (CO) - 476.18 ppm	0.4
Oxygen (O ₂) - 21.08%	0.1

INTERFERENCE RESPONSE CHECK
OXIDES OF NITROGEN
TECO MODEL 42 H
ANALYZER DATA SUMMARY

18 February 1999

TEST GAS	INSTRUMENT RESPONSE (ppm)
Zero Nitrogen (N ₂)	0.0
Oxides of Nitrogen (NO _x) -25.76 ppm	25.8
Sulfur Dioxide (SO ₂) - 250.64 ppm	0.2
Carbon Dioxide (CO ₂) - 7.95%	0.0
Carbon Monoxide (CO) - 476.18 ppm	0.1
Oxygen (O ₂) - 21.08%	0.0

22/NO

226 NOX

80

70

60

45/NO

462 NOX

Teco 42A

ASSET # 3319

0-100 out

0-1000 range

Temp 650°

Chamber 29

sample 5

bypass 2.5

1-26-99

J. Mara

848 NO ppm

855 NOX

100

90

80

70

60

45/NO

462 NOX

10

20

30

40

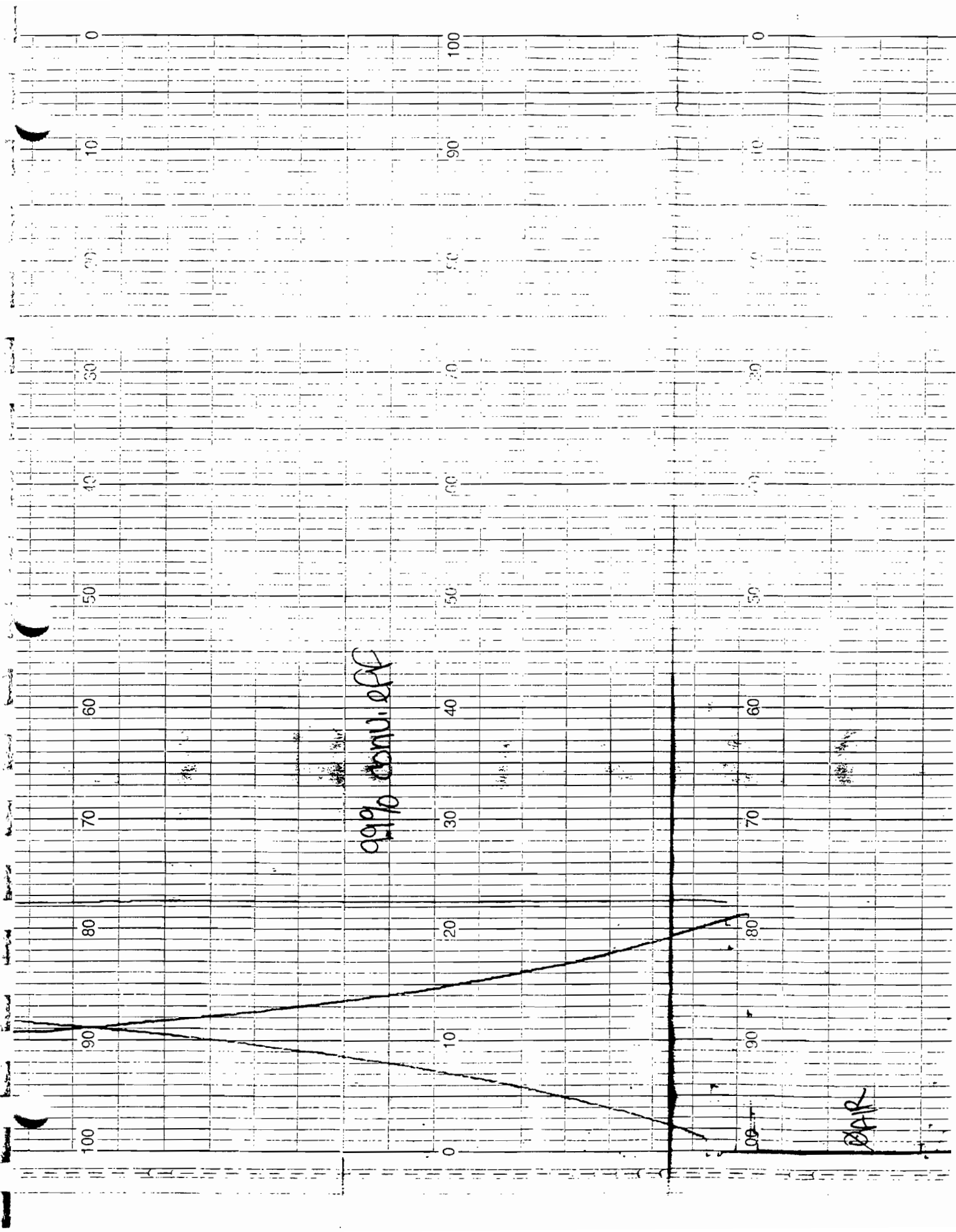
50

60

70

80

90



APPENDIX F
WESTON PROJECT PARTICIPANTS

LIST OF WESTON PROJECT PARTICIPANTS

The following WESTON employees participated in this project:

Neil Nowack
Project Manager

WESTON – Manhattan

Dave White

WESTON – Edison

John Woodley

WESTON – Edison

Jack Mills
Project Scientist

Emission Testing Practice

Ken Hill
Project Scientist

Emission Testing Practice

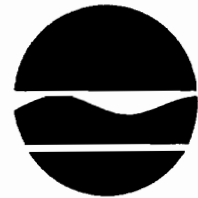
Tom Briggs
Senior Technician

Emission Testing Practice

Rolf Erga
Project Scientist

Emission Testing Practice

what's this?



John P. Cahill
Commissioner

FEB 02 1998

Mr. K. Luke Kalarickal, P.E.
Director, Department of Environmental Control
Town of Clarkstown
10 Maple Avenue
New City, New York 10956

Dear Mr. Kalarickal:

Re: Site No. 3-44-001
Clarkstown Landfill Closure
Rockland County
Change Orders

This office has reviewed Change Order Nos. 1 through 6 for the landfill closure contract with Ogden Remediation Services Corporation. As a result of this review, we have made the following EQBA eligibility determinations:

Change Order No. 1, for removal of fallen trees caused by a storm, is approved at an increase in eligible contract cost of \$2,100.00.

→ Change Order No. 2, for the substitution of poly vinyl chloride in place of the specified material as the geosynthetic capping material, is approved at a decrease in eligible contract cost of \$65,400.00.

Change Order No. 3, for installation of bentonite well seals in the dewatering wells along the south leachate collection line, is approved at an increase in eligible contract cost of \$4,898.30.

Change Order No. 4, for a change in trench grate material at a credit to the contract, is approved at a decrease in eligible contract cost of \$31,200.00.

Change Order No. 5, for additional efforts required to screen backfill supplied by the Town for use as slurry wall backfill, is approved at an increase in eligible contract cost of \$70,468.00. The approved amount is less than the amount requested of \$74,272 since costs for the contractor's administration and management should be included in the contractor's markup.

Change Order No. 6, for additional reinforcement required to be installed as part of the slurry wall work platform, is approved at an increase in eligible contract cost of \$5,812.00. The approved amount is less than the amount requested of \$6,443.00 due to costs for the contractor's administration and management as described in Change Order No. 5.

Cost Summary

	<u>Requested Amount</u>	<u>Approved Amount</u>
Original Contract	\$19,873,727.00	\$19,846,112.11
Change Order No. 1	2,100.00	2,100.00
Change Order No. 2	(65,400.00)	(65,400.00)
Change Order No. 3	4,898.30	4,898.30
Change Order No. 4	(31,200.00)	(31,200.00)
Change Order No. 5	74,272.00	70,468.00
Change Order No. 6	<u>6,443.00</u>	<u>5,812.00</u>
New Contract Amount	\$19,864,840.30	\$19,832,790.41

These change orders may now be submitted for payment in your next payment request. Since the sum of these approved change orders represents a net decrease in contract price, you may want to wait for additional change orders to be approved before submitting for payment.

If you have any questions regarding the above, please contact me at (518) 457-9280.

Sincerely,



Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

cc: E. Duer - Clarkstown
C. Holbrook - Clarkstown
D. Seaman - Roy F. Weston, Inc.
R. Pergadia - NYSDEC Region 3



John P. Cahill
Commissioner

FEB 02 1998

Mr. K. Luke Kalarickal, P.E.
Director, Department of Environmental Control
Town of Clarkstown
10 Maple Avenue
New City, New York 10956

Dear Mr. Kalarickal:

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Clarkstown Landfill Closure
Rockland County
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Cost Summary

	<u>Requested Amount</u>	<u>Approved Amount</u>
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Change Order No. 1	2,100.00	2,100.00
Change Order No. 2	(65,400.00)	(65,400.00)
Change Order No. 3	4,898.30	4,898.30
Change Order No. 4	(31,200.00)	(31,200.00)
Change Order No. 5	74,272.00	70,468.00
Change Order No. 6	<u>6,443.00</u>	<u>5,812.00</u>
New Contract Amount	\$19,864,840.30	\$19,832,790.41

These change orders may now be submitted for payment in your next payment request. Since the sum of these approved change orders represents a net decrease in contract price, you may want to wait for additional change orders to be approved before submitting for payment.

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Sincerely,



Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

cc: E. Duer - Clarkstown
C. Holbrook - Clarkstown
D. Seaman - Roy F. Weston, Inc.
R. Pergadia - NYSDEC Region 3

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010



John P. Cahill
Commissioner

FEB 02 1998

Mr. C. Duane Seaman, P.E.
Project Manager
Roy F. Weston, Inc.
Sutton Park, Suite 205
465 Columbus Avenue
Valhalla, NY 10595-1336

Dear Mr. Seaman:

Re: Site No. 3-44-001
Clarkstown Landfill
Rockland County
Change Orders

This is to document and summarize a telephone conversation between you and Mr. Daniel Evans of this office regarding Change Orders No. 7 through No. 10 to the construction contract between the Town of Clarkstown and Ogden Remediation Services Corporation. During this conversation, Mr. Evans requested additional information regarding these change orders to aid in the Department's eligibility determination. Additional information has been requested as follows:

Change Order No. 7 - This change order reduces the amount of slurry wall to be constructed from 16,500 square yards to 9,300 square yards. Since this is such a large decrease in quantity, the unit price has been increased from \$50.00/sy to \$75.08/sy. This office agrees that the increase in unit price has merit, however, we need to see a breakdown of cost before we can make the eligibility determination. Specifically a breakdown of the contractor's fixed costs and his operational costs should be submitted so that the approximately \$25/square yard increase can be justified.

Change Order No. 8 - North Leachate Trench Change

This change order is for extra costs incurred due to excessive water entering the trench during construction of the north leachate collection line. According to the contractor, this amount of water represents a changed condition to the contract.

This office has a copy of the April 25, 1997 letter from Anthony Barbella of Barbella Environmental Technology which documents his claim of changed conditions. Since this excavation took place adjacent a wetland area, we would expect that dewatering would be anticipated. We are requesting justification from Weston as to why this dewatering effort and construction difficulties represent changed conditions.

Change Order No. 9 - South Leachate Trench Change

This change also is due to excessive dewatering required during the installation of a leachate collection line. As with Change Order No. 8, we are requesting additional information from Weston as to why a dewatering effort for a trench being constructed adjacent to a wetland constitutes a change in condition.

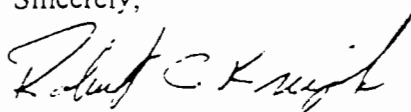
Change Order No. 10 - Dewatering Discharge Delay

The costs associated with this change order are due to the amount of time that was required to obtain permission for the direct discharge of the ± 450 gpm of groundwater generated during the dewatering in the area of the south leachate collection line. We do not doubt that Barbella's equipment was sitting idle during the wait for discharge approval. For this to be eligible, however, the contractor's loss must be documented. We are requesting documentation showing the contractor's actual loss. Certainly the equipment for this work was not specialized and could have been used for other pieces of work. If the equipment was rented, the rental invoices are required. If the equipment was contractor owned, it must be shown how the idle time caused him to lose money.

Any eligibility determination for these change orders will not be made until the requested information can be reviewed by this office.

If you have any questions, please contact me at (518) 457-9285.

Sincerely,



Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

cc: L. Kalarickal - Town of Clarkstown

DE/mj

bcc: R. Knizek

D. Evans

Dayfile

Evans #3 a: seaman.ltr

J. Helms

New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Construction Services, Room 267
50 Wolf Road, Albany, New York 12233-7010
Phone: (518) 457-9280 FAX: (518) 457-7743



APR 17 1998

C. Duane Seaman, P.E.
Project Manager
Roy F. Weston
Sutton Park, Suite 205
465 Columbus Avenue
Valhalla, New York 10595-1336

Dear Mr. Seaman:

Re: Site No. 3-44-001
Clarkstown Landfill Site

This office has reviewed the submitted Change Orders to state assistance contract C300058 for the closure of the Clarkstown Landfill Inactive Hazardous Waste Disposal Site, registry identification number 3-44-001. The reviewed Change Orders were numbers 7 (Slurry Wall Reduction Adjustment), 8 (North Leachate Collection Trench Change), 9 (South Leachate Collection Trench Change), 10 (Dewatering Discharge Delay), 11 (Lake Lucille Dredge Spoil Substitution), 12 (RAIA Properties Fill Substitution), and 13 (Repair of the Slurry Wall Failure). As a result of the review we have made the following EQBA eligibility determinations:

Change Order No. 7, for the change in unit price due to the reduction of the length of the slurry wall in the ballfield area. Additional information for this change order was requested in Mr. Robert Knizek's letter of February 2, 1998 to Mr. C. Duane Seaman of Roy F. Weston (Weston). Review of this change order has been suspended until the additional information is received.

In the interest of clear communication and efficiency in review, the Department would like to identify additional information that will be necessary for the review of this change order. Was the bentonite intended to be used for this slurry wall sold? If so, what was the value of this material, the purchase price originally paid, the price received and the final disposition of any money received from the sale of this material. If the value differs greatly from the price paid, please also provide an explanation for this difference. Please also identify what additional costs the project will now incur due to the need to

create wetlands somewhere else. Please also explain why the project management costs for Ogden and Ogden's markup on the subcontractor's work was submitted for reimbursement. The Municipal Assistance Program for Hazardous Waste Site Remediation Record Keeping and Payment Guide, dated November 1, 1993, indicates in Section 2.6 (f) that project management fees and markups will not be considered eligible.

Change Order No. 8, for the extra costs incurred due to water entering the trench excavation during construction of the north leachate collection line. Additional information for this change order explaining why this dewatering effort represented changed field conditions was requested in Mr. Robert Knizek's letter of February 2, 1998 to Mr. C. Duane Seaman of Weston. Review of this change order has been suspended until the additional information justifying this condition is received.

Change Order No. 9, for the extra costs incurred due to water entering the trench excavation during the construction of the south leachate collection line. Additional information for this change order explaining why this dewatering effort represented changed field conditions was requested in Mr. Robert Knizek's letter of February 2, 1998 to Mr. C. Duane Seaman of Weston. Review of this change order has been suspended until the additional information justifying this condition is received.

Change Order No. 10, for the extra costs incurred due to the dewatering discharge delay. Additional information for this change order documenting the contractor's actual loss was requested in Mr. Robert Knizek's letter of February 2, 1998 to Mr. C. Duane Seaman of Weston. Review of this change order has been suspended until the additional information documenting this loss is received.

Change Order No. 11, for the Lake Lucille Sediments structural fill substitution. This change order documents the costs associated with the substitution of this material for structural fill that was to be supplied at \$15 per cubic yard. The change order provides a breakdown of the cost of this material, that amounts to a total of \$12.87 a cubic yard. Previous correspondence on this topic, specifically Mr. Knizek's letter of August 27, 1997, indicates the state would approve a rate of \$10 a cubic yard, unless a higher rate could be justified.

A review of this change order, indicates that additional information must be provided to justify the requested rate. The requested rate was computed based on attachment 2, which calculates this rate based on a breakdown of the total volume of sediments and choking material, multiplied by various unit costs. One of these costs is evident: the cost of the materials placed on September 17, 19, 22, and 23 of 1997. However, justification of the costs for all of the various units must be provided. This justification must clearly indicate the separation of the handling costs by contractor and the material costs by contractor. For example, the documentation for the material testing program clearly indicates the project management costs, operation costs, equipment costs, and the material costs. Unfortunately, the material costs of \$1,394.94 for 42 cubic yards of drying additives do not appear to match the change orders costs of \$3,765.00 for 251 cubic yards. This discrepancy will need to be resolved. Similarly, the dredge spoils are given a cost of \$15.00 a cubic yard. Since this material was provided by the town at no cost, it is presumed that this rate is solely for handling and placement costs. Although additional handling costs are expected for such a material, this price seems high. A better breakdown of this cost is needed to justify this unit rate. A similar breakdown as given for the materials testing program should be provided for all of the materials. Without such a breakdown the eligibility will be limited to \$10.00 a cubic yard. Please refer back to Mr. Robert Knizek's letter of August 27, 1998.

Change Order No. 12, for the substitution of construction and demolition debris from the RAIA properties as structural fill. This change order documents the costs associated with the substitution of this material for structural fill that was to be supplied at \$15 per cubic yard. The change order substitutes this material at a cost of \$5.00 a cubic yard.

Although the change order does not provide a breakdown of this cost, it is assumed that this cost is entirely for the placement costs of the material. The hauling distance for this material should have been negligible as the source adjoins the site, and the road created for this haul was preexisting from the relocation of waste on the RAIA property. Additionally, the material was loaded at no cost by RAIA associates. Actually, RAIA associates paid an additional \$5.00 a cubic yard for the acceptance of this material. This cost is further modified by the lack of a compaction reduction factor for the charge

to the town for this material. As calculated in Mr. Seaman's cover letter of December 31, 1997, the unit cost of this material to the Town after application of a compaction reduction factor is \$7.21 a cubic yard. Considering these factors, the contractor received approximately \$12.21 a cubic yard, assuming that a reduction factor was applied for the charges to RAIA associates.

Considering these conditions, the Department requests a comparison of the price of compacting and handling this material to other materials stockpiled on the site and/or provided by the Town. The Department also requests an explanation as to how the fee charged to RAIA associates was arrived at. It is the Department's understanding that the cost for the disposal of such material at another facility would be in the order of \$55 a cubic yard.

Change Order No. 13, for the repair of the slurry wall. This change order documents the costs associated with the stabilization and elimination of the slurry wall around the ball field area. The change order provides a breakdown of the cost of the effort to stabilize the collapse so that landfill capping work could continue. However, the November 4, 1997 letter attached to the change order indicates that the responsibility of the slurry wall platform failure has not been determined. This determination directly affects the eligibility of these costs. If the cost of the collapse is borne by the subcontractor, the town should not incur the cost, and the cost will not be eligible for reimbursement. Therefore, the eligibility of this matter should be deferred until the responsibility for the collapse is determined. Additionally, this change order should await the elimination of the remainder of the slurry wall around the ball field and the project credit that will be generated by the elimination of this item.

Additionally, it is the Department's understanding that there is a pending change order, Change Order No. 14, for the justification of additional structural fill for the site. The Department agrees with Weston's approach of breaking out all of the various substitutions of alternative materials for structural fill as separate change orders. Furthermore, since these items are all interrelated and comparable, the Department will be withholding a final approval of the various change orders on this issue until the final volume and cost of this bid item has been determined. This final volume and cost will influence the reasonableness and necessity of the change orders associated with this item.

C. Duane Seaman, P.E.

Page 5

The Department would also like to receive a list itemizing all of the change orders submitted by the contractor to the Town, and the status of the change orders. The itemization should include the dollar amounts and materials proposed for each change. It was noted during the review of the supporting documentation provided for these change orders, that Ogden's original change order's are of a higher value. This would appear to indicate that other changes have been made in the remedial construction of the landfill. In order to properly evaluate the state's share of the cost of the remedial construction and the effectiveness of the constructed remedy, the Department must be informed of all design changes and any subsequent redistribution of project funds.

As always, if you should have any questions regarding the above matters, please contact me or the project manager at (518) 457-9285.

Sincerely,



Robert C. Knizek, P.E.
Chief, Eastern Field Services
Bureau of Construction Services
Division of Environmental Remediation

cc: L. Kalarickal - Clarkstown

JAH/ts

bcc: R. Knizek

J. Helmeset ✓

Daybook

a:seaman2.dft

189
J. Helms
New York State Department of Environmental Conservation

Division of Environmental Remediation

Bureau of Construction Services, Room 267

50 Wolf Road, Albany, New York 12233-7010

Phone: (518) 457-9280 FAX: (518) 457-7743



John P. Cahill
Commissioner

JUL 08 1998

Mr. K. Luke Kalarickal, P.E.
Director, Department of Environmental Control
Town of Clarkstown
10 Maple Avenue
New City, New York 10956

Dear Mr. Kalarickal:

Re: Site No. 3-44-001
Clarkstown Landfill Closure
Rockland County
Change Orders

This office has reviewed Change Order Nos. 16, 17, 19, 20, 21, 22 and 23 for the landfill closure contract with Ogden Remediation Services Corporation at the Clarkstown Inactive Hazardous Waste Disposal Site, state registry number 3-44-001. As a result of this review, we have made the following EQBA eligibility determinations:

Change Order No. 16, for woven geotextile around the perimeter berm of the landfill at the request of the engineer. This change order is approved at an increase in eligible contract cost of \$29,261.00. The approved amount is based on discussions with Weston on June 16, 1998 and documentation in the change order which estimates 14,500 square feet of material used at the requested rate of \$2.02 per square yard.

Change Order No. 17, for the installation of 800 linear feet of 4 inch diameter HDPE piping for a hard pipe overflow of the drip legs for the landfill gas collection system. This change order is approved at an increased in eligible contract cost of \$6,838.00. This is \$9,994.00 less than the requested amount. The approved amount is based on discussions with Weston on June 16, 1998 and the documentation in the change order, which shows that only 325 feet were actually installed at a price of \$21.04 per linear foot.

Change Order No. 19, for the overrun of light riprap as aprons for the sediment basins. This additional material was needed as part of an overall design change of the sediment basins and perimeter berm for the landfill closure. This change order is approved at an increase in eligible cost of \$11,250.00. This is \$37,647.45 less than the requested amount. The approved amount is based upon an analysis of the cost for the placement of the light rip rap.

Although, the negotiated price is 9.7% less than the bid price of \$190.00 per square yard, this price still appears to be artificially high. Comparatively, the engineers estimate for this item was \$55.00 a cubic yard and RSMeans 1998 Construction Cost Data indicates a cost in the order of \$59.47. Using the conversion factor included in the change order of 1.3 tons per cubic yard, the engineers estimate correlates to a rate of \$71.5 and RSMeans correlates to a rate of \$77.31. Therefore, the requested volume of 150 tons was approved at a rate of \$75.00 per ton, for a reimbursement of \$11,250.00.

Change Order No. 20, for additional materials for the extension and relocation of power feed and control wiring cables between collection chambers #2 and #3. This work was required due to lack of access to the Riverso Property. As such, this work and related expenditures are not eligible for reimbursement.

Change Order No. 21, \$35,000 credit for reduction in work and materials required to be installed for the construction and demolition of sediment control basin number 7, and the revised design of the remaining basins that eliminated the rock bedding below the riser and other piping. This change order is being held pending the submission of further documentation clarifying the worth of the unused materials that were turned over to the Town of Clarkstown. The change order indicates that these materials were purchased for the construction of the sediment control basin number 7, and were then delivered to and turned over to the Town of Clarkstown recycling facility when the construction of this basin was dropped from the closure plan.

Change Order No. 22, for 115,000 cubic yards of additional structural fill required to achieve landfill preparatory grades. This change order is being held pending the determination and further discussion on the final amount of structural fill needed for the completion of this project. Please refer back to my letter of July 1, 1998.

Change Order No. 23, for the placement of approximately 35,000 cubic yards of additional fill from the RAJA Properties and the Practice Tee. Based on our discussions on June 16, 1998, this change order is being withdrawn by the Town of Clarkstown. As agreed to at the May 6, 1998 meeting, the Town will not be seeking reimbursement for any of the costs associated with the placement of these materials.

<u>Cost Summary</u>	<u>Requested Amount</u>	<u>Approved Amount</u>
	19,873,272	
Original Contract	CO-16 19,832,796.71	
Change Order No. 16	29,261.00	29,261.00
Change Order No. 17	16,832.00	6,838.00
Change Order No. 19	48,897.45	11,250.00
Change Order No. 20	5,985.00	0.00
Change Order No. 21	35,000.00	*****
Change Order No. 22	1,725,000.00	*****
Change Order No. 23	185,436.00	withdrawn
Total	1,976,411.50	47,349.00
New Contract Amount	21,809,202.91	19,880,139.41

***** change order is held pending additional information.

These change orders may now be submitted for payment in your next payment request.

Mr. K. Luke Kalarickal, P.E.

Page 4

If you have any questions regarding the above, please contact me at
(518) 457-9285.

Sincerely,



Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

JAH/ts

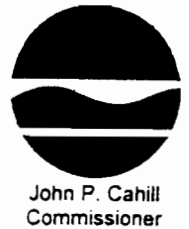
bcc: J. Helmeset

R. Knizek

Dayfile

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New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Construction Services, Room 267
50 Wolf Road, Albany, New York 12233-7010
Phone: (518) 457-9280 • FAX: (518) 457-7743
Website: www.dec.state.ny.us



APR 21 2003

Mr. Neil Nowak
Roy F. Weston
130 W. 30th Street
12th Floor
New York, New York 10001

Dear Mr. Nowak:

Re: Site No. 3-44-001
Clarkstown Landfill

Our staff has received and reviewed the recently transmitted copies of the explanations for Change Order 27, Perimeter Berm Redesign, and Change Order 28, slurry wall failure. As we are now in receipt of a full draft of each proposed change order, we have completed our preliminary review of each change order. Based on this review we would like to advise you as to the following status for each, based on the information currently provided to us. This status is summarized on the attached table.

Change Order 27

The change order for the perimeter redesign, number 27, is considered incomplete. Upon review of the justification why the change is necessary, B.11, we cannot agree with the need for this change, especially considering the magnitude and cost for this proposed change. This change resulted in a modification to approximately 75% of the design drawings and resulted in a sizable delay and cost to the project. The provided explanation merely notes that unforeseen weak subsurface conditions resulted in settlement beyond that which was expected or indicated during the design phase.

It is the Department's position that a redesign would need to be the result of either a design error/omission or a dramatic change in the field conditions. Please clarify what the specific change in field conditions was, and when the engineer was informed and approved a notice of changed field conditions. Please also clarify specifically why the

weak subsurface conditions were unforeseen. The Department paid for a substantial investigation and design for this remedial project, and is concerned why and what unforeseen conditions arose.

The Department will also need further explanation as to the need for the size of the redesign. A review of the redesign documents has identified several changes that were made that do not appear to be directly attributable to the need to conform to a lower perimeter berm elevation. Notable, all of the basin outfall structures were redesigned to a spillway system in contrast to the original culvert design, the revision of the temporary final cover system termination, general revisions to the landfill parcels other than the parcels that experienced the substantial settlement (3 and 4), the elimination of storm water basin number 2, the widening of the roadway and inclusion of vehicle passing zones, changes in the slurry wall alignment, relocation of the asphalt roadway termination, rerouting of the force main piping, revisions in the scheduling of the capping of the sedimentation basins, changes in the day lighting for the aggregate drainage layer, changes to accommodate the RAIA II materials, and changes to accommodate the Rivero Property. It appears unreasonable that the revisions in the perimeter berm elevation should have such dramatic and far reaching of an impact on the entire landfill as this redesign did.

Change Order 28

The change order for the slurry wall failure, number 28, is considered incomplete. Upon review of the recently provided justification of why the change is necessary, B.11, we cannot agree with the merits for this change order, especially considering the magnitude and cost for this proposed change. This change resulted in the deletion of a portion of the remedial system and a requested increase in cost of over a million dollars. The provided explanation theorizes that the conditions in a critical layer at the toe of the slurry wall and wetland could not have been the same as at the trench. This explanation does not appear to be in agreement with the provided supporting documentation and in itself is insufficient to justify such a substantial change order and related cost increase. It is the Department's position that such a large change order would need to be the result of either a design error/omission or a drastic change in the field conditions.

It was our understanding, based on the technical information provided, that the failure mechanism which caused the slurry wall failure was the lateral compression of the peat layer upon the placement of backfill in the slurry trench. The existence of this peat layer was known, however, the lack of lateral strength was unanticipated in the design. This is supported by the inability of the subsequent failure investigations to identify a condition at the slurry wall that was not consistent with the contract drawing profiles. We are also unaware of the approval by the engineer of a changed field condition. Additional discussion is needed as to why this weakness in the lateral strength of this layer was not anticipated in the design. It is our belief that peat is highly compressible, both vertically and laterally, and this instability should have been evaluated during the design of the slurry wall. This is especially troubling to the Department as we paid for a substantial investigation and design for this project.

We also request further explanation as to the obligations of the contractor, as presented in the change order justification. It is our understanding that the contract allowed the contractor to select the material for the slurry wall, but did not allow him the latitude to deal with the conditions present. As noted in the change order, the use of extraordinary slope and trench reinforcement measures were beyond the scope of this contract. Further, the weight of the backfill material to be used, which caused the compression of the peat layer, was approved by Weston. As for the use of an expert by the contractor, the specifications regarding the use of an expert appear to limit their responsibilities to the use, testing, quality control, and placement aspects of the slurry and backfill. In summary, it is our understanding that the contractor was not under an obligation to assess the overall stability of the wall, but to simply construct it as designed. However, it is the engineer's responsibility to design the project so it may be constructed by the methods identified in the contract.

Change Order 22R

The change order for the structural fill overrun above 115% of the bid quantity, 22R, is considered incomplete. We are currently awaiting the finalization of the Further Explanation of Structural Fill Quantities document previously submitted. Although it is not essential to receive a final version of this document to resolve this change order, we

do require several pieces of information previously requested as part of the final version of that document in order to calculate a final quantity of structural fill that we will consider eligible for reimbursement. Other than this supporting documentation, we consider the discussion of this item complete.

The more significant information we still require includes the quantification of the amount of overfilling (including a breakout of the quantities relative to the RAIA II materials and the remainder of the landfill surface), a complete list of structural fill sources and their compaction values, the justification of the amount of fill that could have been saved by the changing of the side slope elevations at which parcel 6 and 7 began from (46,450), and confirmation that there were no other stockpiles on site that would have induced settlement and created a need for additional structural fill.

Change Order 29

We consider this change order for storm damage, change order 29, to be complete. The final eligible amount is anticipated to be for the full settlement amount of \$ 100,000. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

Change Order 30

We consider this change order for damaged utilities, change order 30, to be complete. The final eligible amount is anticipated to be \$0. This is in conformance with our position that this cost is ineligible for reimbursement for a variety of reasons, most notable that the Town should have been aware of the location of these utilities and the contract is quite clear that the contractor will be responsible for damages to utilities. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

Change Order 31

We consider this change order for the substitution of stream fill versus granular drainage, change order 31, to be complete. The final eligible amount is anticipated to be for the full settlement amount of \$ 191,974. Although we believe a renegotiation in unit price for the aggregate drainage material and the stream fill should have been pursued, we find the identified eligible amount to be a reasonable and equitable adjustment to the contract for this change in work and materials. Therefore we propose to approve this amount in the interest of closing this project. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

Change Order 32

We find this change order for additional permanent seed and straw mulch, change order 32, to be complete. The final eligible amount is anticipated to be for the full settlement amount of \$ 6,185. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders. Specifically, the need for the Perimeter Berm and Redesign change order which relocated the perimeter berm and resulted in the additional area to be seeded and mulched.

Change Order 33

We find this change order for knockout tank repairs, change order 33, to be complete. The final eligible amount is anticipated to be for the full settlement amount of \$ 20,121. Although we believe that there are issues with respect to the overall design and failure of the contractor to protect his work, we find these issues unworthy of further discussion. This amount is a fair and reasonable payment for the necessary repairs to this essential component of the landfill gas flare. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

Change Order 34

We find this change order for out of season work, change order 34, to be complete. The final eligible amount is anticipated to be \$0. This change order is essentially for work to replace materials associated with work performed out of the normal construction season. This change order was substantially reduced by Roy F. Weston, and the remaining items essentially consisted of the replacement of liner upon the resumption of construction in the spring. The determination of these costs being ineligible for reimbursement is in conjunction with the Department's position that this work is the result of the contractor's failure to adequately protect his work.

Change Order 35

We find this change order for additional excavation costs around the landfill scales, change order 35, to be complete. The final eligible amount is anticipated to be \$0. This is in conjunction with our position that this cost is ineligible for reimbursement for a variety of reasons, most notable that the Town should have been aware of the location of the geomembrane placed around the waste transfer station. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

Change Order 36

We find this change order for additional costs for the improvement of the concrete travelway, change order 36, to be complete. The final eligible amount is anticipated to be \$3,500. The additional costs are for the improvement of this component of the remedy, and do not reflect any of the costs associated with the contractor's failure to initially install the concrete travelway as designed. As this is an improvement with merit at a reasonable cost, we find it acceptable and eligible. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

Change Order 37

We find this change order for fence replacement, change order 36, to be withdrawn and therefore, complete.

Change Order 38

We find this change order for rip rap replacement, change order 38, to be incomplete. The final eligible amount is anticipated to be less than \$12,062. This is in conjunction with our position that the cost of the rip rap should be in the order of \$75 per square yard, as approved in change order 19. We find this issue incomplete due to the unprovided value of the light rip rap that was paid for and washed out. This value should be deducted from the cost of the placement of the heavier rip rap as the washed out material was previously paid for by the Department. It is the Department's position that this deduction from the eligibility for this work is reasonable because this work is directly attributable to the requirement to field fit the diversion dikes due to the omission of their layout in the redesign. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

Change Order 39

We have not fully evaluated this change order for schedule impacts and delays, change order 39, and therefore cannot conclude if it is complete. In order to fully ascertain the value and merit of this claim, we need to fully evaluate the causes of the claim. Notable the redesign and its overall size and scope in conjunction with the overall impact and delay to the schedule. At this point, we have identified several items within the claim that will need further clarification or discussion once we have fully evaluated the causes, but we have not identified any additional data that we will need for this claim at this time.

Mr. Neil Nowak

Page 8

Change Order 40

We have evaluated this change order titled RAIA deductions, change order 40, and find it to be complete. It is our understanding that this change order reflects those additional costs associated with the additional work and materials necessary to accommodate the RAIA II material. The final eligible amount is anticipated to be \$0. This is in conjunction with our position that the placement of this additional material should have been performed at no additional cost to the project or the state. The final eligible amount will be dependent on the final signed change order and may be affected by the final eligibility of related, incomplete change orders.

The status of these change orders is summarized in the attached table. As always, if there are any questions or concerns please feel free to contact myself or the assigned project manager. Both myself and Mr. Helmeset can be reached at (518) 457-9285.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert C. Knizek". The signature is fluid and cursive, with a large loop at the end of the last name.

Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

Summary of Status Change Orders/Settlement Items with respect to April 20, 1999 Letter

	claim item	change order	claim amount	settlement amount	eligible amount
27	Perimeter Berm and				
	Riverso Redesign Costs		1,821,400	306,030	incomplete
28	Slurry Wall Failure		1,363,851	1,000,900	incomplete
22R	Structural Fill Overrun		1,009,132	1,247,702	incomplete
29	Storm Damage		138,636	100,000	100,000
30	Subcontractor Markup		46,904	0	0
30	Damaged Utilities		18,031	6,981	0
31	Stream Fill vs. Granular				
	Drainage		191,974	191,974	191,974
32	Permanent Seed/Straw Mulch		6,185	6,185	dependent on A
33	Knockout Tank Repair		23,073	20,121	20,121
	Structural Fill Above the Liner in				
	LFP 1		498,818	included in C (22R)	included in 22R
	Structural Fill Along Roads		19,601	included in C (22R)	included in 22R
34	Out of Season Work		48,311	10,000	0
35	Structural Fill Above Liner in				
	LFP 8		92,654	included in C (22R)	included in 22R
36	Excavation of Geocomposite				
	Near Scales		31,259	11,250	0
36	RAIA Deductions		31,368	11,861	0
37	Leachate Dewatering Delay		50,000	0	0
36	Concrete Replacement		25,299	3,500	3,500
37	Liner Testing Repairs		16,611	0	0
37	Fence Change Order		9,539	9,539	withdrawn
38	Rip-Rap Replacement		26,546	20,000	12,062
	Acceleration		266,730	0	0
	Interest		496,719	0	0
	Claim Prep Costs		122,045	0	0
39	Schedule Impacts/Delays		included	780,000	dependent on 27, 28, 22R
	Totals		6,354,686	3,726,043	327,657

New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Construction Services, Room 267
50 Wolf Road, Albany, New York 12233-7010
Phone: (518) 457-9280 • FAX: (518) 457-7743
Website: www.dec.state.ny.us



JUN 01 1999

RECEIVED

JUN 04 1999

ENVIRONMENTAL CONTROL
TOWN OF CLARKSTOWN

Mr. K. Luke Kalarickal, P.E.
Director, Department of Environmental Control
Town of Clarkstown
10 Maple Avenue
New City, New York 10956

Dear Mr. Kalarickal:

Re: Site No. 3-44-001
Clarkstown Landfill Closure
Rockland County
Change Orders

This office has reviewed the Final Change Orders 29, 30, 31, 32, 33, 34, 35, 36, 38, and 40 of the landfill closure contract with Ogden Remediation Services Corporation for the Clarkstown Landfill Inactive Hazardous Waste Disposal Site, state registry number 3-44-001. As a result of this review, we accept these change orders as final and complete, and have made the following EQBA eligibility determinations:

Change Order No. 29 for storm damage at the site as a result of the June 13, 1997 storm. This change order is approved at an increase in eligible contract cost of \$78,310. The approved amount is based on documentation in this final change order which identifies the necessary repairs and work due to this unforeseen event.

Change Order No. 30 for the utilities damaged in the vicinity of the scale house. This change order is disapproved. This damage was the result of the contractors work and the specifications clearly makes any damage and repairs to subsurface utilities the responsibility of the contractor. The value of this change order was \$6,981.

Change Order No. 31 for the costs associated with the replacement of granular drainage stone with stream fill aggregate. This final change order is approved at an increase in eligible cost of \$191,974. Although we believe a renegotiation in unit price for the aggregate drainage material and the stream fill should have been pursued, we find the identified eligible amount to be a reasonable and equitable adjustment to the contract for this change in work and materials.

Mr. K. Luke Kalarickal

Page 2

Change Order No. 32 for additional permanent seed and straw mulch. This change order is approved for the full settlement amount of \$6,185. However, we would like to note that this change order is considered to be directly related to the perimeter berm and redesign change order which relocated the perimeter berm and resulted in the additional area to be seeded and mulched. Therefore, we will consider the value of this change order in any potential approval of the perimeter berm and redesign change order on a prorated or percentage basis.

Change Order No. 33 for knockout tank repairs. This change order is approved for the full settlement amount of \$20,121. Although we believe that there are issues with respect to the overall design and failure of the contractor to protect his work, we find these issues unworthy of further discussion. This amount is a fair and reasonable payment for the necessary repairs to this essential component of the landfill gas flare.

Change Order 34 for out of season work. This change order is disapproved. This change order is essentially for work to replace materials associated with work performed out of the normal construction season. This change order was substantially reduced by Roy F. Weston, and the remaining items essentially consist of the replacement of liner upon the resumption of construction in the spring. The determination of these costs being ineligible for reimbursement is in conjunction with the Department's position that this work is the result of the contractor's failure to adequately protect his work. The value of this change order was \$10,002.

Change Order 35 for additional excavation costs around the landfill scales. This change order is disapproved. This is in conjunction with our position that this cost is ineligible for reimbursement for a variety of reasons, most notable that the Town should have been aware of the location of the geomembrane placed around the waste transfer station. The value of this change order was \$11,252.64.

Change Order 36 for additional costs for the improvement of the concrete travel way. This change order is approved for the full settlement amount of \$3,500. This additional cost is for the improvement of this component of the remedy and does not reflect any of the costs associated with the contractor's failure to initially install the concrete travel way as designed. As this is an improvement with merit at a reasonable cost, we find it acceptable and eligible.

Mr. K. Luke Kalarickal

Page 3

Change Order 38 for rip rap replacement within the drainage channels. This change order is approved, but at a reduced amount which results in no additional payment from the state. This is in conjunction with our position that we will pay the difference between the placement of the light rip rap and the placement of the fine rip rap, but we will not pay for the placement of both. Further, this difference must be based on a reasonable cost for these materials.

The cost of the fine rip rap is determined by the bid price. The cost of the light rip rap should be in order with the value for this material as approved in change order 19, \$75 per ton. Based on discussions with Roy F. Weston, we have identified errors with the units in the submitted change order and our subsequent evaluation. Thus we have reevaluated change order 19 and are revising the unit cost to reflect a more reasonable placement rate.

Based on the Means construction cost book, we have calculated a cost of \$59.45 a cubic yard, or \$32.50 a square yard for the light rip rap. This contrasts significantly with the engineer's estimate of \$55 a cubic yard, and Ogden's estimate of \$171.57 a square yard. Ogden's estimate is based on actual material, equipment, and labor costs contained in the backup for change order 19. A review of these costs found certain labor classes and corresponding equipment hours in need of slight adjustments, but for the most part acceptable. However, the placement rate was not acceptable considering the labor and equipment utilized. A gradall, front end loader, dump truck, operators for each and three laborers should be able to install more than 39 square yards a day, especially since they were working ten hour days. This productivity was increased to 80 square yards a day, and with the other slight adjustments, a revised cost of \$67.13 square yard is approved.

Please note that this revised unit rate will also be applied to change order 19. It is our understanding that Roy F. Weston is evaluating whether or not to resubmit change order 19 with a revised quantity and discussion.

Change Order 40 this change order is titled RAIA deductions. It is our understanding that this change order reflects those additional costs associated with the additional work and materials necessary to accommodate the RAIA II material. This change order has been disapproved for any reimbursement by the state. This is in conjunction with our position that the placement of this additional

Mr. K. Luke Kalarickal

Page 4

material, second removal of soils from the RALA property and the practice tee, should have been performed at no additional cost to the project or the state.

<u>Cost Summary</u>	<u>Requested Amount</u>	<u>Approved Amount</u>
Revised Contract**	21,809,202.91	19,880,139.41
Change Order No. 29	78,310.00	78,310.00
Change Order No. 30	6,981.00	0.00
Change Order No. 31	191,974.00	191,974.00
Change Order No. 32	6,185.00	6,185.00
Change Order No. 33	20,128.77	20,128.77
Change Order No. 34	10,002.00	0.00
Change Order No. 35	11,252.00	0.00
Change Order No. 36	3,500.00	3,500.00
Change Order No. 38	19,876.88	0.00
Change Order No. 40	11,861.00	0.00
Total	360,070.65	300,097.77
New Contract Amount	22,169,273.56	20,180,237.18

**Revised Contract Amount is based upon our letter of July 8, 1998 (COs 16-23)
Original Contract Amount was \$19,873,727.00

These change orders may now be submitted for payment in your next payment request. We are also in receipt of change order 41, balancing change order. As this change order will balance out the remaining line item changes, we would like to process it after all the other contract change orders have been finalized.

If you have any questions regarding the above, please contact me or John Helmeset, P.E. at (518) 457-9285.

Sincerely,

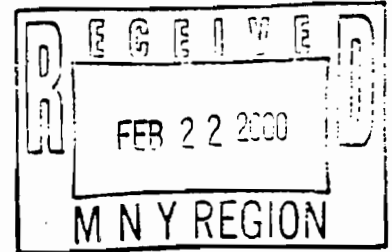


Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

New York State Department of Environmental Conservation
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FEB 16 2000



Mr. Tim Leonard, P.E.
Roy F. Weston
130 W. 30th Street
12th Floor
New York, New York 10001

Dear Mr. Leonard:

Re: Site No. 3-44-001
Clarkstown Landfill

Thank you for taking the time recently to discuss with my staff the Cover Geomembrane Evaluation Report for the Clarkstown Municipal Sanitary Landfill Remediation, dated October 28, 1999. This report was prepared by GeoSyntec Consultants to address concerns our Department had with respect to the cover liner seams that were constructed as part of the Title Three closure of the referenced landfill.

Based on this conversation, as well as numerous other conversations, emails and correspondence our Department is satisfied with the evaluations in this report and accepts this report as final and complete.

In conjunction with this report and our numerous other conversations, emails and correspondence on this issue, notably Roy F. Weston's correspondence of January 14, 2000, from Mr. Andrew Harpur to myself, we find the discussions on the integrity of the cover liner seams complete. Based on these discussions, we concur and accept Roy F. Weston's findings and belief that the cover system performance will not be negatively impacted as a result of the seam shear strength values less than the specified contract value of 74 pounds per inch.

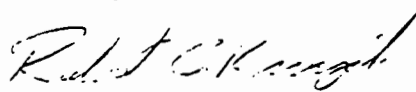
With the resolution of this issue and the previous resolution of the flare's performance, we believe all of our concerns with the significant exceptions to conformance with the landfill design have been addressed. Therefore, we look forward to the completion and submission of



the closure report in the near future. As always, should there be any concerns or questions, please feel free to contact myself or the assigned project manager directly. Both myself and John Helmeset can be reached at (518) 457-9285.

We also would like to take this opportunity to thank you and your coworkers for your patience and diligence in resolving this difficult issue.

Sincerely,



Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

cc: P. O'Connor, Roy F. Weston
N. Nowak, Roy F. Weston



Roy F. Weston of New York, Inc.
130 West 30th Street
New York, New York 10001-4004
212-502-7800 • Fax 212-502-7801

08 November 1999

Robert C. Knizek, P.E.
Bureau of Construction Services, Room 267
Division of Environmental Remediation
New York State Department of
Environmental Conservation (NYSDEC)
50 Wolf Road
Albany, NY 12233-7010

**Re: Clarkstown Landfill Remediation
NYSDEC Site No. 3-44-001
Response to NYSDEC letter of 04 May 1999, regarding the Field Constructed PVC
Geomembrane Seams**

Dear Mr. Knizek

This letter is written by Roy F. Weston of New York, Inc. (WESTON®), on behalf of the Town of Clarkstown (TOWN), in response to a NYSDEC letter dated 04 May 1999, regarding the field constructed seams between adjacent panels of the polyvinyl chloride (PVC) flexible geomembrane component of the final cover system (herein after referred to as "the seams").

The information presented in this letter is separated into the following sections:

- Background
- Summary of NYSDEC issues
- WESTON's responses to NYSDEC letter of 04 May 1999
- Summary of the GeoSyntec Report
- Conclusions
- Engineer's Certification of geomembrane seams
- Next Step

Background

The subject of this letter and of the letters mentioned above relates to several seam samples that were destructively tested (i.e. second round of testing) and found to have lower than the specified shear strength of 74 pounds per inch (ppi). The lowest measured shear strength value for any seam sample was 65 ppi. Please note that all peel test results were above the specified minimum of 10 ppi.



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The information in WESTON's 29 April 1999 letter included the test results for several seam samples that were re-tested (second round of testing) as a result of apparent deficiencies in testing methodology utilized by WESTON's subcontractor testing laboratory. The initial testing was performed at M&T/NAMOW/TCL, Inc. (M&T). The contract with M&T and the technical specifications for the project, which were part of the contract with M&T, required that the procedures used to test the seam samples meet ASTM standards for the testing of geomembrane seams.

During the course of the project, WESTON discovered that M&T was not properly performing the tests as per the contract and ASTM requirements. Immediately thereafter, any additional seam samples were sent to EMCON, Inc. The EMCON laboratory is a Geosynthetic Research Institute (GRI) accredited and NYSDEC accepted laboratory for the testing of field constructed seams. The seam sample test results performed by EMCON are acceptable and were never the subject of any re-testing. Only the seam samples initially tested by M&T were re-tested.

To assure that the test results of the samples tested by M&T were reliable, M&T was directed to hire a reputable testing laboratory (i.e. who was industry accredited and acceptable to WESTON) to re-test the seam samples that were initially tested by M&T. M&T hired NTH Consultants, Ltd. (NTH), which was found to be acceptable to WESTON and who has the necessary GRI accreditation.

Upon testing the archive seam samples (i.e. the seam numbers as identified in our 29 April 1999 letter to NYSDEC, totaling 136 samples), the NTH test results revealed that several of the seam samples did not meet the required shear strength value of 74 ppi, although all samples tested by NTH (and for the entire project) met and exceeded the required peel strength value of 10 ppi. Of the 136 samples tested by NTH, 30 seam sample results were less than 74 ppi, but not less than 65 ppi.

WESTON hired TRI/Environmental, Inc. (TRI) to evaluate the NTH test results. TRI sent a letter to WESTON dated 16 December 1998, that included their analysis. This TRI letter was then forwarded to NYSDEC under WESTON transmittal letter dated 29 April 1999.

NYSDEC raised several issues in its letter, which required additional discussion and analysis by WESTON.



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Summary of NYSDEC issues

The issues raised by NYSDEC include the following:

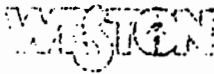
1. Further explanation of the TRI/Environmental, Inc. letter dated 16 December 1999.
2. Provide a certification, by the engineer – specifically WESTON, that the field constructed geomembrane seams are of sufficient quality to meet the design intent, and that the seams will perform as intended for the Clarkstown Landfill remediation.
3. NYSDEC requests that the certification of the seams be completed prior to the final certification report.
4. NYSDEC requests that the location of the seam samples with lower than specified shear strength be identified on a drawing of the as-built PVC geomembrane layout.
5. NYSDEC requests that a narrative of the deviation from standards and specifications for the seam samples be prepared.
6. The information in numbers 4. and 5. above can be included in the final certification report.

These issues will be addressed by WESTON in the order listed above.

WESTON's Responses to NYSDEC letter of 04 May 1999

In preparation of WESTON's responses to NYSDEC letter dated 04 May 1999, WESTON commissioned an independent evaluation of the field constructed seams and the measured shear strength of these seams. The independent evaluation was performed by Mr. J.P. Giroud of GeoSyntec Consultants. Mr. Giroud is considered a world renowned expert in the geomembrane industry who has published several books, papers, and technical research documents. Mr. Giroud's publications have been used extensively by the geomembrane industry, by regulatory agencies, and by design engineers to establish design and testing criteria for the use of geomembrane systems in landfill caps and baseliner, as well as other construction applications. Mr. Giroud's professional profile is attached.

GeoSyntec Consultants (GeoSyntec) has prepared a document entitled, "Cover Geomembrane Evaluation for the Clarkstown Municipal Sanitary Landfill Remediation," dated 28 October 1999 (herein referred to as the "GeoSyntec Report"), in which many of the issues raised by NYSDEC are discussed. This GeoSyntec Report is enclosed with this letter for your review. WESTON has relied on the results of the GeoSyntec Report, and the evaluations and conclusions presented



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within their report. WESTON will reference the GeoSyntec Report in the responses to NYSDEC issues.

WESTON's responses to the above listed NYSDEC issues are as follows:

1. Further explanation of the TRI letter dated 16 December 1999 is addressed by the GeoSyntec Report. WESTON concurs with the GeoSyntec discussion and analysis of the TRI letter.
2. Regarding the Engineer's Certification, please refer to the subsequently provided section in this letter entitled "Engineer's Certification of Geomembrane Seams".
3. As requested by NYSDEC, the certification of the geomembrane seams is included herein this letter, which is separate from the submission of the final certification report. WESTON will incorporate the seam strength and testing discussion and data in the final certification report.
4. A plan view drawing of the as-built conditions of the geomembrane liner will be included with the final certification report. This drawing(s) will include the locations and assigned numbers of the seams, locations and assigned numbers of the destructive seam samples, repairs made to the geomembrane or seam, panel numbers, and limits of geomembrane coverage over the landfill cap. This as-built drawing is attached to this letter for reference, which includes the 30 seam sample locations that did not meet the 74 ppi criteria.
5. The GeoSyntec Report explains the deviation from standards and specifications for the seam samples. GeoSyntec has concluded that the seam integrity, even at the lowest tested value of 65 ppi in shear, will perform under the worst case scenarios expected. Please refer to the subsequent section of this letter and to the GeoSyntec Report itself for further details.
6. See numbers 4. and 5. above.

Summary of the GeoSyntec Report

The GeoSyntec report presents the following:

- An evaluation of the liner system in terms of resistance to localized subsidence on the relatively flat areas of the landfill, and
- An evaluation of the tension potentially induced by displacement of cover system components on the landfill sideslopes.

These are considered as the "worst case" scenarios. The stresses upon the seams in these two (2) scenarios are the maximum that can be realistically expected to occur to the buried geomembrane seams.

Localized Subsidence

Localized subsidence is described as a depression or cavity of varying sizes that may occur directly below the geomembrane and the associated geotextiles due to a localized pocket of waste collapsing downward, thereby forming the cavity. Two localized subsidence scenarios are discussed, which include the following:

- A cavity formed at varying sizes (diameter and depth) with the geomembrane bridging the cavity (i.e. "bridging" is defined as the geomembrane being suspended over the open depression or space of the cavity without being in contact with the below cavity bottom). This case is described in the GeoSyntec report as a "cavity". This condition is the worst case of any stress induced on the seams.
- A cavity formed at varying sizes (diameter and depth) with the geomembrane not bridging the cavity or in other words the geomembrane being in direct contact with the below cavity walls, thereby, being supported by the cavity bottom. This case is described in the GeoSyntec Report as a "depression".

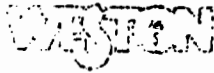
These above local subsidence scenarios were calculated with and without the added support of the geotextiles that exist directly on top of and below the geomembrane. The results of the lower boundary of the Factor of Safety (FS) for the seams at the specified strength of 74 ppi and at the lowest measured strength of 65 ppi are compared. No significant difference exists between the FS for 74 ppi and that for 65 ppi strength seams.

Please refer to the GeoSyntec Report for a detailed discussion and calculations of FS for the seams.

Slope Stability

The slope stability of geomembrane system is described by the GeoSyntec Report as the stresses and strains induced on the geomembrane seams that are caused by the following:

- Static load, which is the weight of the final cover soil on top of the geomembrane, and by a quasi-static load, which includes seepage forces in the static loading condition.



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- Load resulting from the construction equipment placing the cover soils overlying the geomembrane, which are considered to be both static and dynamic loads.

These above conditions are analyzed using the classical approach that consists of using limit equilibrium calculations and by using an analyses following an approach based on the displacements required to mobilize interface friction.

Please refer to the GeoSyntec Report for a detailed discussion and calculations of FS for the seams.

Conclusions

The GeoSyntec Report concludes that "...there is no significant difference between the performance of the geomembrane with seams that meet the shear strength specifications (74 ppi) and the performance of the geomembrane with seams that have a shear strength of 65 ppi." The conclusion was reached for both the relatively flat and sideslope sections of the geomembrane based on the scenarios taking into account local subsidence and side slope stability. These scenarios are considered the "worst" case impacts to seam integrity.

Engineer's Certification

Based on the conclusions presented in the GeoSyntec Report WESTON concurs with the information and discussion presented by GeoSyntec. Based on the GeoSyntec Report findings, WESTON hereby certifies that the geomembrane seams initially tested by M&T and re-tested by NTH, even those that are below 74 ppi (the lowest of which was measured to be 65 ppi) are of sufficient quality and strength to meet the design intent.

All other seam samples will be discussed and certified in the Certification Report for the entire remedial construction, with the exception of the Riverso Property.

Next Step

WESTON and GeoSyntec are available to meet with or discuss the findings of the report. WESTON will incorporate the conclusions of the GeoSyntec Report into the Certification Report for the entire remedial construction, with the exception of the Riverso Property.

WESTON

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If you have questions regarding the information presented in this letter or in the enclosures, please contact me at (303) 980-1299, ext. 226, or Paul O'Connor at (212) 502-7856.

Very truly yours,

ROY F. WESTON OF NEW YORK, INC.



Neil C. Nowak, P.E.
Project Manager

Enclosures:

- GeoSyntec Report dated 28 October 1999
- J. P. Giroud's professional profile
- As-built drawing of constructed PC geomembrane with seam sample locations

cc: J. Helemset- NYSDEC (1 copy w/ enclosures)
L. Kalarickal - Town of Clarkstown (1 copy w/ enclosures)
P. O'Connor, B. LaPenta, T. Leonard, D. Bauer, File - WESTON (1 copy w/ enclosures)

Prepared for

ROY F. WESTON OF NEW YORK, INC.

130 W. 30th Street
New York, New York 10001-4004

COVER GEOMEMBRANE EVALUATION

**FOR THE CLARKSTOWN
MUNICIPAL SANITARY LANDFILL REMEDIATION**

Prepared by

GEOSYNTEC CONSULTANTS

621 N.W. 53rd Street, Suite 650
Boca Raton, Florida 33487

Project Number JP1046

28 October 1999

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- Appendix 1. Review of Destructive Testing on Seams
- Appendix 2. Results of Uniaxial Tensile Tests on the Geomembrane
- Appendix 3. Geomembrane Fabrication Report
- Appendix 4. Results of Multi-Axial Tensile Tests on the Geomembrane
- Appendix 5. Results of Shear Strength Tests on Soil and Interfaces

1 INTRODUCTION

1.1 General Information on this Report

1.1.1 Terms of Reference

This report has been prepared at the request of J. Hackenbrach, Esq., on behalf of Roy F. Weston. This report has been prepared by J.P. Giroud of GeoSyntec Consultants (GeoSyntec). All the analyses contained in this report were developed by J.P. Giroud and reviewed by K.L. Soderman, of GeoSyntec, in accordance with the internal peer review policy of GeoSyntec. Some parts of this report (i.e. assumptions, approach, conclusions) have also been reviewed by J.F. Beech, also of GeoSyntec.

1.1.2 Purpose of this Report

The purpose of this report is to provide an independent evaluation of the geomembrane used as part of the cover system of the Clarkstown Municipal Sanitary Landfill. The need for this evaluation arose when it was realized that some of the seams of the installed geomembrane did not meet the specification for shear strength (although all of the seams met the specification for peel strength).

1.1.3 Scope of this Report

The potential situations in a landfill cover that are relevant to the purpose of this report are the situations where the geomembrane is subjected to tensile stresses. This is because tensile stresses in the geomembrane result in shear stresses in the seams. A review of the potential situations in a landfill cover where the geomembrane is likely to be subjected to tensile stresses was performed. It was determined that two such potential situations existed: the situation where the cover system is subjected to localized subsidence due to deformation of the waste, and the situation where the cover system is subjected to movements caused by gravity along a side slope. Accordingly, this report comprises two main sections: Section 2 dealing with localized subsidence and Section 3 dealing with slope stability. Technical information that will be used in the analyses presented in Sections 2 and 3 of the report is presented in Section 1.2.

Another situation that could potentially cause tensile stresses in the geomembrane is the situation that exists at the abrupt change in slope between the top of the landfill, where the slope is approximately 4%, and the side slopes, where the slope is up to 33%. However, this situation is only likely to generate peel stresses (in addition to the tensile and shear stresses that exist on a slope and that are addressed in Section 3), and, therefore, is not relevant to the subject of this report, since the geomembrane seams meet the peel strength specification. Furthermore, significant peel stresses at an abrupt change in slope are likely to exist only if the geomembrane is not covered with soil. When the geomembrane is covered with soil, as it is the case in the considered cover system, the stresses normal to the geomembrane prevent the seam flap from moving freely, thereby eliminating or, at least, minimizing the type of seam deformation that would generate peel stresses. Accordingly, this situation was not analyzed.

1.1.4 Originality of this Report

The subjects of the analyses presented in this report (i.e. localized subsidence and slope stability) are typical subjects addressed in design calculations. However, the analyses presented in this report are not typical of the analyses normally performed for the design of a landfill cover system. Parts of the analyses presented herein go beyond the state of practice and even, in some parts, advance the state of the art. When necessary, available design methods were extended and new equations were developed. However, it is important to note that no extraordinary assumptions were made for the development of the extension of the existing design methods or the establishment of the new equations. It should, therefore be concluded that, although the analyses presented in this report should not be expected to be found in typical landfill cover design calculations, the conclusions drawn from these analyses are based on usual assumptions and accepted engineering principles.

1.2 Relevant Technical Information

1.2.1 Description of the Cover System

The cover system includes top slopes where the slope is approximately 4% and side slopes where the slope is 3H:1V (i.e. 33%) maximum. The cover system on the top slopes consists from top to bottom of:

- a soil layer with a thickness of 2.5 ft;
- a geotextile with a mass per unit area of 6 oz/yd²;

- a drainage geonet;
- a 40 mil thick smooth polyvinyl chloride (PVC) geomembrane; and
- a geotextile with a mass per unit area of 6 oz/yd².

The cover system on the side slopes consists from top to bottom of:

- a soil layer with a thickness of 2.5 ft;
- a drainage geocomposite;
- a 40 mil thick embossed PVC geomembrane; and
- a geotextile with a mass per unit area of 6 oz/yd².

The geotextile, which is the lowermost component of the cover system rests on a layer of cushioning material at least 6 in. thick. This material is a silty sand with no particle greater than 1 in. Beneath the cushioning material is the waste or structural fill as needed for grading purposes.

1.2.2 Results of Seam Testing and Related Comments

As indicated in Section 1.1.2, the need for the study presented in this report arose when it was realized that some of the seams of the installed geomembrane did not meet the specification for shear strength (although all of the seams met the specification for peel strength). A detailed review of the seam test results (see Appendix 1) was prepared by R.W. Thomas of TRI/Environmental Inc (TRI), who is very knowledgeable on geosynthetic testing. The following important facts are reported by R.W. Thomas:

- The specified value was 74 lb/in. for shear strength and 10 lb/in. for peel strength. These values are from the National Sanitation Standard 54, which was developed in the 1980s based on available seaming technology and not on the basis of engineering requirements.
- In each seam sample, 5 specimens are subjected to a shear test and 5 specimens are subjected to a peel test. A sample is acceptable regarding shear (peel) strength if 4 of the 5 specimens subjected to a shear (peel) test have a measured shear (peel) strength at or above the required value of 74 lb/in. (10 lb/in.).
- Of the 136 seam samples tested for both peel strength and shear strength, 30 samples had test results below the specified value for shear strength. All of the test results were above the specified value for peel strength.

- For the 30 samples that did not meet the shear strength specification, the average shear strength values (i.e. average value of the five specimens) were as follows: 7 samples >74 lb/in. (these samples did not meet the shear strength specification in that they did not meet the requirement that 4 of the 5 specimens had a peel strength of at least 74 lb/in.); 15 samples 70-74 lb/in.; and 8 samples 65-70 lb/in. All average shear strength values were greater than 65 lb/in. The test results were very consistent, with small standard deviations.
- The measured peel strengths were very large, typically 30 to 50 lb/in., with an average peel strength of approximately 40 lb/in.

R.W. Thomas explains the low shear strengths as follows: (i) the high peel strengths were probably obtained by using modern welding equipment with high roller pressure; (ii) the high roller pressure may result in geomembrane thickness reduction at the edge of the seam; and (iii) the geomembrane thickness reduction results in a reduction in shear strength. This explanation is plausible, but no thickness measurements were conducted to evaluate the validity of this explanation.

The author of this report agrees with the review of the test results presented by R.W. Thomas. However, the author of this report does not agree with the following comments by R.W. Thomas on the impact of seam shear strength on the performance of a geomembrane in a cover system: *"the actual shear strength has little impact on the overall performance of the cap because shear values are typically much higher than peel values."* . . . *"if loads on the sheet approach 40 lb/in., the seams will fail through a peeling failure before they fail in shear. This means that the peel strengths are the weak link"*. In the field, a geomembrane is subjected to a variety of mechanical actions that result in loads applied to seams in the shear mode and in the peel mode. Virtually all of the mechanical actions exerted on a landfill cover result in a load level that is much higher in the shear mode than in the peel mode, and there is no identified type of mechanical action that subjects seams to the same load level in the shear mode and in the peel mode. In contrast, the *"weak link"* mentioned by R.W. Thomas implies that the load levels in shear and peel are the same. In those usual cases where the load level is higher in the shear mode than in the peel mode, a geomembrane seam can fail in the shear mode even though its peel strength is significantly less than its shear strength.

1.2.3 Relevant Information on the Landfill Cover

The following information is relevant to the subsidence analysis presented in Section 2. At the design stage, it was considered that the presence of large rocks in one part of the northwestern slope could foster the development of cavities likely to cause localized subsidence of the cover system. As was indicated to the author of this report, these rocks were removed prior to constructing the cover system. Also, it has been indicated to the author of this report that the composition of the waste could be observed in excavations required for regrading prior to the placement of the cover system; it was found that the waste included neither cavities nor bulky elements or large appliances such as refrigerators.

The following information is relevant to the slope stability analysis presented in Section 3. The geomembrane was anchored at the top of the 3H:1V side slopes on the northern, western and southern sides, but was not anchored on the eastern side, as it was installed continuously over the top of the landfill cover on that side. It should be noted that many of the seams that did not meet the shear strength specification were on the eastern slope. As shown on as-built drawings, there are geomembrane seams across the slope direction (i.e. horizontal seams). As was indicated to the author of this report, the soil was placed on the side slopes in 1-ft thick lifts, and no side slope slide or localized instability was observed during construction, even under the action of construction equipment placing the soil over the geosynthetics. As was indicated to the author of this report, the bulldozers used were of the "low-ground pressure" type, and the following instructions were given to the bulldozer operators: they were not authorized to push soil in the downslope direction; and they were only authorized to push soil in the upslope direction or horizontally, i.e. along contour lines. As was also indicated to the author of this report, quality assurance was provided during soil placement to ensure that the bulldozers were driven in a way that minimizes impact on slope stability; it was checked, in particular, that the operators would not brake when the bulldozers were moving downslope. Finally, as was indicated to the author of this report, when the bulldozers were pushing soil horizontally, the operators were reminded that they were not authorized to push soil in the downslope direction.

1.2.4 Effect of Temperature on Material Properties

Temperatures below 0°C increase the stiffness of PVC geomembranes. As a result, PVC geomembranes at temperatures below 0°C exhibit a yield point on their tension-

strain curves that is similar to the yield point observed at ordinary temperature (20°C) on the tension-strain curves of high density polyethylene (HDPE) geomembranes. This yield point at low temperature is detrimental to the behavior of PVC geomembranes. It has been shown in Volume 2, Appendix D, of the engineering calculations that the depth of frost penetration should be equal to or less than 2.3 ft. Since the thickness of the soil layer located above the geosynthetics in the cover system is 2.5 ft, it may be concluded that the PVC geomembrane should not be subjected to temperatures below 0°C and, accordingly, in all the analyses presented in this report, the tension-strain curves of the PVC geomembrane obtained in normal laboratory conditions will be used.

1.2.5 Terminology

In this report, the terms “stress” and “tension” are used extensively. The stresses related to the geomembrane that are mentioned in this report include: (i) the normal stresses that are applied perpendicular to the geomembrane; (ii) the tensile stresses that are applied in the direction of the geomembrane (i.e. the stresses that exist inside the geomembrane and tend to elongate the geomembrane); and (iii) the shear stresses that are applied parallel to the geomembrane, on the surface of the geomembrane or between the geomembrane and an adjacent material (e.g. at the interface between the geomembrane and the soil), or at the interface between two layers of geomembrane (such as in a seam). The tension of the geomembrane is the tensile stress multiplied by the geomembrane thickness. In calculations, it is generally easier to use the tension than the tensile stress; however, in generic discussions both tension and tensile stress may be used interchangeably.

The strain of a geomembrane is the amount of elongation of the geomembrane per unit length. The elongation is the change in length due to tension (tensile stress). The elongation is, therefore, the difference in displacement between two points of the geomembrane. Consequently, the strain is the spatial derivative of the displacement. For a given geomembrane, the tension (tensile stress) and the strain are related through the tension-strain curve (stress-strain curve).

In this report, the terms “cavity” and “depression” are used extensively. Cavities are voids located under the cover system that are so deep that the geomembrane and the associated geotextiles cannot deflect enough to reach the bottom. In contrast, the geomembrane and the associated geotextiles can deflect enough to reach the bottom of a depression.

2 LOCALIZED SUBSIDENCE

2.1 Introduction to Section 2

2.1.1 *Scope of Section 2*

In this section, the performance of the geomembrane subjected to localized subsidence is analyzed. It is assumed that the soil supporting the geomembrane subsides over a circular area after the geomembrane has been installed on a flat surface. The performance of the geomembrane without and with seams is analyzed.

The goal is to determine the factor of safety as a function of seam strength. Two scenarios are considered: (i) imposed stresses, and (ii) imposed strains. In the scenario where the stresses are imposed, the geomembrane and the associated geotextiles bridge a cavity, i.e. the geomembrane and the associated geotextiles are not in contact with the bottom of the cavity. In contrast, in the scenario where the strains are imposed, the geomembrane and the associated geotextiles are in contact with the bottom of a depression. (See Section 1.2.5, for the definition of cavity and depression.)

Prior to considering these two scenarios, four preliminary discussions are presented: (i) a discussion of tension distribution in a geomembrane; (ii) a discussion of the tension-strain curves of the geomembrane, as available from the results of uniaxial and multi-axial testing on geomembrane specimens; (iii) a discussion of the results of seam testing; and (iv) a discussion of the design criterion.

2.1.2 *Discussion of Tension Distribution in a Deformed Geomembrane*

A geomembrane subjected on one side to a normal stress over a circular area, while being unsupported on the other side, takes the shape of a dome. The actual shape of the deformed geomembrane is extremely complex, even if the normal stress is uniformly distributed, as indicated in the first paper devoted to this subject (Giroud, 1981). However, as recommended in that paper, it can be assumed that the shape of the deformed geomembrane is approximately spherical for strains less than 57%, i.e. for deflections less than the radius of the circular area. Also, the distribution of tension and tensile stresses in a geomembrane that deforms as a dome is extremely complex. However, as suggested by Giroud (1981), it can be assumed that the tension and tensile stress are uniformly distributed. Beyond a strain of 57%, an elliptical shape is assumed.

This approach has been adopted by the ASTM for the interpretation of the multi-axial tensile test (ASTM D 5617).

The above considerations are valid for geomembranes that are isotropic and uniform. If the geomembrane that deforms as a dome under a given load contains an area with a tensile strength lower than in the rest of the geomembrane, the shape of the deformed geomembrane is different from the shape of a deformed geomembrane having a uniform strength. However, if the area where the tensile strength is lower is small compared to the total area of the deformed geomembrane, the shape of the deformed geomembrane is close to the shape of a deformed geomembrane having a uniform strength (unless the geomembrane has a tension-strain curve with a yield point and the tension is close to the tension at yield, which is not the case with a PVC geomembrane at a temperature above 0°C, since there is no yield point in this case). This is because the different strain that is undergone by the portion of geomembrane with a lower strength exists only in a small area. A case where the low-strength area is small is the case where this area is a line, such as the line having a low strength along a seam. Therefore, a geomembrane with a seam deformed over a circular depressed area can be assumed to be spherical, and, as a result, it can be assumed that the tension is uniformly distributed, based on a comment made above. In contrast, no assumption can be made on the distribution of the tensile stress because the cause of the non-uniform strength is not known. For example, if the cause of the non-uniform strength is a non-uniform thickness, the stress is inversely proportional to the thickness. If the cause of the non-uniform strength is stress concentration, then the use of stress becomes impractical.

For the discussion to be complete, the effect of the added stiffness due to the double geomembrane thickness at the seam should be addressed. This effect has been discussed by Giroud (1984) in a paper that shows that it may result in a peel effort on the seam. Since the seams of the considered geomembrane have adequate peel strength, this effect is not studied herein. In conclusion, the analysis will focus on the effect of the weak line along a seam on the behavior of the geomembrane.

2.1.3 Geomembrane Tension-Strain Curves

Ideally, in subsidence calculations, the geomembrane tension-strain curve obtained in a tensile test with an isotropic biaxial state of stress should be used. The multi-axial tensile test has an isotropic biaxial state of stress only in the central portion of the specimen and, therefore, the tension-strain curve derived from the multi-axial tensile test

is only an approximation of the tension-strain curve that would correspond to the ideal isotropic biaxial state of stress. However, this is the only type of test currently available that gives an approximation of the tension-strain curve that would correspond to the ideal isotropic biaxial state of stress. Therefore, the tension-strain curve from the multi-axial tensile test will be used. However, prior to using that curve, the correctness of the curve will be checked, as discussed below.

The tension-strain curves derived from multi-axial tensile tests are approximate for two reasons: (i) as discussed above, the state of stress in the multi-axial tensile test is not exactly an isotropic biaxial state of stress; and (ii) the calculations required for the interpretation of the test are based on the assumption that the shape of the deformed geomembrane is spherical whereas the shape is not exactly spherical, as indicated by Giroud (1981). It is, therefore, appropriate to check the correctness of the tension-strain curves derived from the multi-axial tensile tests performed on the project geomembranes. This can be done by using published relationships between tension-strain curves from uniaxial and biaxial tensile tests. Soderman and Giroud (1995) have developed relationships between tension-strain curves from uniaxial tensile tests (i.e. the conventional tensile test) and multi-axial tensile tests. For a non-reinforced geomembrane, such as the PVC geomembrane used in the project, these relationships show that the modulus is twice greater in the case of the multi-axial tensile test than in the case of the conventional tensile test.

Complete uniaxial tension-strain curves for the geomembrane used in this project are not available. However, a number of uniaxial tensile tests were performed and the following data were recorded: the tensile modulus at 100% strain, and the tension and strain at break. The data regarding the uniaxial tensile tests are provided in Appendix 2. It is not clear in these data if the tested geomembranes were smooth or embossed. However, a review of an excerpt of the fabrication quality control report (Appendix 3) indicates that Lot W17B27 was a smooth geomembrane. Many of the tests reported in Appendix 2 are for Lot W17B27. Therefore, the results of these tests were used to generate an average tension-strain curve for the smooth geomembrane in a uniaxial state of stress (Figure 1).

Four data sheets reporting the results of multi-axial tensile tests on the project geomembranes were provided. Two of the tests were performed on 13 June 1997 (one on smooth geomembrane, the other on textured geomembrane) and two of the tests were performed on 22 January 1998 (one on smooth geomembrane, the other on textured

geomembrane). It appears that the results of the tests performed on 13 June 1997 contain significant errors and cannot be used. Therefore, only the results of tests performed on 22 January 1998 are reproduced in Appendix 4 and are used in subsequent analyses.

Figure 1 presents the average tension-strain curves for the smooth geomembrane derived by the author of this report from the uniaxial tensile tests (Appendix 2) and the multi-axial tensile tests (Appendix 4). In Figure 1, the multi-axial tension-strain curve of the smooth geomembrane is presented to be consistent with the fact that the uniaxial tension-strain curve is for the smooth geomembrane, and also because the geomembrane most likely to be subjected to localized subsidence is the geomembrane installed on the top of the landfill cover, i.e. the smooth geomembrane installed on a gentle slope. It appears in Figure 1 that the initial modulus of the tension-strain curve from the multi-axial tensile tests is approximately twice the initial modulus of the tension-strain curve from the uniaxial tensile tests. This is consistent with the relationship developed by Soderman and Giroud (1995) mentioned above. Therefore, the average tension-strain curve from the multi-axial tensile tests will be deemed to be an acceptable approximation for the tension-strain curve that would correspond to the ideal isotropic biaxial state of stress. Accordingly, the average tension-strain curve from the multi-axial tensile tests will be used in subsequent calculations. This tension-strain curve is shown in Figure 2 at a larger scale for the strain axis.

It is important to note that a typical geotextile with a mass per unit area of 6 oz/yd² has a tension-strain curve that is above the tension-strain curve for the PVC geomembrane considered herein. Therefore, if the geotextiles located above and below the geomembrane consisted of adjacent rolls that are sewn together instead of being simply overlapped, they would contribute more than the geomembrane to the resistance of the cover system to localized subsidence. However, even though the geotextiles located above and below the geomembrane are not sewn, they contribute to a significant degree to the resistance of the cover system to localized subsidence (see Section 2.3).

2.1.4 Discussion of the Results of Seam Testing

The minimum average shear strength that was measured on the field seams was 65 lb/in., which is less than the specified value of 74 lb/in. Compared to the specified tensile strength of 92 lb/in., the 74 lb/in. shear strength is 80% and the 65 lb/in. shear strength is 71%. It should be noted that these ratios are related to uniaxial tests, i.e. the type of tests used to generate the specified tensile strength of 92 lb/in. and to evaluate the shear

strength of the seams. Since the subsidence calculations presented hereafter are performed using the tension-strain curve from the multi-axial tensile tests, it is necessary to establish ratios similar to the above ratios, but related to the multi-axial tensile tests.

Giroud et al. (1995a) have analyzed the geometry of geomembrane seams subjected to tensile forces and have shown that significant strain concentration exists next to seams. They found that the strain next to a seam could be two or more times the average strain in the geomembrane, which explains why geomembranes rupture next to seams in a shear test when the seam is of good quality (i.e. when the seam itself does not fail). This finding is applied as follows to develop a ratio between seam shear strength and geomembrane tensile strength that is related to the multi-axial tensile test. Figure 3 (which reproduces the uniaxial tension-strain curve from Figure 1) shows that a seam shear strength of 74 lb/in. corresponds to a strain of approximately 250%, that is 2.0 times less than the strain at failure of the geomembrane in a uniaxial test (500%). This indicates that the strain in the vicinity of a seam that has a shear strength of 74 lb/in. (i.e. the specified value) is twice greater than the average strain in the geomembrane, which causes the rupture. Similarly, it appears in Figure 3 that a seam shear strength of 65 lb/in. corresponds to a strain of approximately 200%, that is 2.5 times less than the strain at failure of the geomembrane in a uniaxial test. Figure 4 (which reproduces the multi-axial tension-strain curve from Figure 2) shows that strain ratios of 2.0 and 2.5 correspond to geomembrane strains of 50 and 40%, respectively, hence shear strengths of 45 and 41.5 lb/in., respectively, in a biaxial situation. When divided by the maximum tension in the multi-axial tension-strain curve, which is 54 lb/in., these two shear strengths correspond to ratios of 0.83 and 0.77, respectively. These two ratios will be used in the subsequent analysis, as they characterize, in a biaxial situation, the two considered seams (i.e. the seams having shear strengths of 74 and 65 lb/in. in a conventional shear test).

It should be noted that the above ratios were established using the actual characteristics at break (i.e. a strain of 500%, which corresponds to a tension at break of 110 lb/in., see Figure 3) and not the specified tension at break (92 lb/in.). This is conservative because higher ratios would have been obtained if the specified tension at break had been used.

2.1.5 Discussion of the Design Criterion

In the section on "Geomembrane Differential Settlement" of Appendix D of the Engineering Calculations, the design engineer assumed, based on the presence of large

rocks, that 3 ft-deep cavities with a diameter of 6 ft may exist beneath the geomembrane. Assuming a conical shape of the deformed geomembrane, a strain of $\sqrt{2} - 1 = 41.4\%$ was correctly calculated by the design engineer. Using a factor of safety of 2 and rounding up, this calculation was used by the design engineer to establish the specified minimum 85% strain at failure. This design criterion does not correspond to the actual situation for three reasons: (i) the rocks that would have made possible the development of cavities were removed prior to constructing the cover system (see Section 1.2.3); (ii) the composition of the waste, as it is known from some excavations performed as part of regrading prior to geomembrane installation, does not appear to justify the potential development of a large cavity directly under the geomembrane (see Section 1.2.3); and (iii) even if a cavity with a diameter of 6 ft were to develop, the pressure applied by the soil overlying the geomembrane would not be sufficient to cause a 3 ft deflection of the geomembrane, as shown by calculations presented below, and, therefore, a 41.4% strain could not occur. Based on the foregoing discussion, a cavity with a diameter of 6 ft is unrealistic and will be the limit case considered in the scenario where stresses are imposed. No diameter limit will be considered in the scenario where strains are imposed (i.e. in the case of depressions, the difference between cavity and depression being explained in Section 1.2.5).

The approach used in Section 2 will consist of considering a spherical shape instead of the conical shape considered in the Engineering Calculations. The actual shape is neither conical nor spherical, but the spherical shape is generally similar to the deformed shape of the surface of a soil undergoing localized subsidence, and it gives a more conservative value of the strain than the conical shape. Furthermore, a spherical shape is consistent with the use of the results of the multi-axial tensile test for the calculations.

2.2 Analysis of the Two Scenarios

2.2.1 Scope of Section 2.2

As indicated in Section 2.1.1, two scenarios are considered: imposed stresses, and imposed strains. The scenario where strains are imposed will be discussed in Section 2.2.2, and Section 2.2.1 is devoted to the scenario where stresses are imposed.

It is important to note that, in Section 2.2, the strength of the geotextiles is neglected. Therefore, in Section 2.2, only a lower boundary of the factors of safety is calculated. The factors of safety, taking into account the geotextile strength as well as the

geomembrane strength, will be calculated in Section 2.3. The reason for this two-step approach is the following. Since the adjacent geotextile rolls were simply overlapped, they do not form a continuous sheet. To the best of the author's knowledge, no analytical method has been published for this case. As a result, calculations including the strength of the geotextiles can only be approximate (see Section 2.3). In contrast, the geomembrane forms a continuous sheet and, as a result, rigorous calculations can be performed when the geomembrane is considered alone (i.e. when the strength of the geotextiles is neglected). The two-step approach can then be summarized as follows: (i) a rigorous lower boundary of the factor of safety is obtained in Section 2.2; and (ii) in Section 2.3, the lower boundary of the factor of safety will be increased by an approximate (but conservative) amount to account for the strength of the geotextiles, which will give the factors of safety. This two-step approach is fruitful because: (i) the first step will show rigorously that there is no significant difference in performance between the case of a seam having a shear strength of 65 lb/in. and a seam having the specified shear strength of 74 lb/in.; and (ii) the second step will show that the factors of safety for the various relevant cases are satisfactory.

2.2.2 Scenario Where the Stress is Imposed

As indicated in Section 2.2.1, Section 2.2.2 is devoted to the scenario where stresses are imposed. In the scenario where the stresses are imposed, it is assumed that a cavity develops directly below the geomembrane and that the cavity is deep enough that the geomembrane is not in contact with the bottom of the cavity, i.e. the geomembrane bridges the cavity (see the definition of cavity in Section 1.2.5).

The applied stress results from the weight of the soil overlying the geomembrane. The soil layer above the geomembrane is 2.5 ft thick. Consistent with the engineering calculations for the project design, the unit weight of this soil is assumed to be 120 lb/ft³. Therefore, the normal stress applied by the soil layer on the geomembrane is:

$$p = \gamma t = (120)(2.5) = 300 \text{ lb / ft}^2 = 2.083 \text{ psi} \quad (1)$$

where: p = pressure applied by the soil layer; γ = unit weight of soil; and t = thickness of soil layer.

The tension required for equilibrium in the spherical geomembrane is given by the following equation (Giroud, 1981):

$$T = \frac{pd}{2} f(\varepsilon) \quad (2)$$

where: d = diameter of the depressed area; ε = geomembrane strain; and $f(\varepsilon)$ = implicit function of ε tabulated by Giroud (1981) and defined by:

$$f(\varepsilon) = \frac{1}{4} \left(\frac{2y}{d} + \frac{d}{2y} \right) \quad (3)$$

and:

$$1 + \varepsilon = \frac{f(\varepsilon)}{2} \arcsin \left[\frac{2}{f(\varepsilon)} \right] = \frac{1}{2} \left(\frac{2y}{d} + \frac{d}{2y} \right) \arcsin \left[\frac{1}{\frac{1}{2} \left(\frac{2y}{d} + \frac{d}{2y} \right)} \right] \quad (4)$$

where y is the deflection of the geomembrane.

In Equation 2, the value of the geomembrane strain, ε , is unknown. The value of the geomembrane strain, ε , used in Equation 2 and the resulting geomembrane tension, T , calculated using Equation 2 must be consistent with the geomembrane tension-strain curve corresponding to a biaxial state of stress (Figure 2). In other words, the calculated tension and strain of the geomembrane correspond to the intersection of the geomembrane tension-strain curve and the curve that represents Equation 2 for the considered values of the parameters. For example, the curve representing Equation 2 for $d = 6$ ft and p from Equation 1 is shown in Figure 5. It intersects the tension-strain curve at $\varepsilon = 35\%$ and $T = 39$ lb/in. This can be checked as follows. For $\varepsilon = 35\%$, $f(\varepsilon) = 0.52$, as tabulated by Giroud (1981), hence:

$$T = \frac{(2.083)(72)}{2} \times 0.52 = 39 \text{ lb/in.} \quad (5)$$

which is consistent with the value seen on the tension-strain curve in Figure 2 for $\varepsilon = 35\%$.

To calculate the lower boundary of the factor of safety of the seams, the calculated tension of 39 lb/in. cannot be compared to the specified shear strength of 74 lb/in. or the measured shear strength of 65 lb/in. because 39 lb/in. was obtained for a multi-axial state,

whereas 74 lb/in. and 65 lb/in. were obtained for a uniaxial state. Therefore, the following approach is used.

As shown in Figure 2, the maximum tension available in the geomembrane in a multi-axial state is 54 lb/in. Therefore, the following lower boundary of the factor of safety can be calculated for the hypothetical case where the geomembrane has no seams:

$$\min(FS) = \frac{54}{39} = 1.38 \quad (6)$$

As indicated in Section 1.4, this lower boundary of the factor of safety has to be multiplied by 0.83 and 0.77, respectively, to obtain the lower boundary of the factor of safety in the case of the seams that have a shear strength of 74 and 65 lb/in., respectively, hence:

$$\min(FS) = 1.38 \times 0.83 = 1.15 \quad (7)$$

for the geomembrane with seams having a shear strength of 74 lb/in.

$$\min(FS) = 1.38 \times 0.77 = 1.06 \quad (8)$$

for the geomembrane with seams having a shear strength of 65 lb/in.

Tables based on Equation 4 and published by Giroud (1995) give $y/d = 0.3806$ for $\varepsilon = 35\%$, hence:

$$y = (0.3806)(6 \times 12) = 27.4 \text{ in.} \quad (9)$$

Similar calculations were performed for cavities having diameters of 1 to 5 ft, and results are presented in Table 1. The lower boundary of the factors of safety thus determined are also presented in Figure 6. It is important to note that the values presented in Table 1 and Figure 6 are lower boundaries of the factors of safety because the strength of the geotextiles was not taken into account. The factors of safety will be calculated in Section 2.3.

It appears in Table 1 and Figure 6 that there is a significant difference in the lower boundary of the safety factor between a hypothetical geomembrane without seams and a geomembrane with seams. However, there is not a significant difference between the two considered seams: the lower boundary of the factor of safety of a geomembrane having

seams with a shear strength of 65 lb/in. (i.e. a shear strength that does not meet the projects specifications) is only 7% less than the lower boundary of the factor of safety of a geomembrane having seams with a shear strength that does meet the projects specifications (74 lb/in.). Clearly, the impact on the geomembrane performance of the seam with a shear strength of 65 lb/in. is not significant. It should be noted that the values presented in Table 1 and Figure 6 are lower boundaries that should only be used for comparing the seams having a shear strength of 65 lb/in. with the seams having a shear strength of 74 lb/in. and the hypothetical geomembrane without seams. The factors of safety will be obtained in Section 2.3 by taking into account the strength of the geotextiles overlying and underlying the geomembrane, in addition to the strength of the geomembrane.

2.2.3 Scenario Where the Strain is Imposed

As indicated in Section 2.1.1, two scenarios are considered: imposed stresses, and imposed strains. The scenario where stresses are imposed was discussed in Section 2.2.2, and Section 2.2.3 is devoted to the scenario where strains are imposed. In this case, there is no cavity under the geomembrane. The geomembrane is supported over its entire area. However, it is assumed that the material underlying the geomembrane has settled, which has resulted in a depressed area. In other words, there is no cavity under the geomembrane, but there is a depression. The difference between cavity and depression is explained in Section 1.2.5.

The depressed area is assumed to be circular. In this case, the deflection of the geomembrane is imposed, as it is equal to the depth of the depression of the supporting material. The strain in the geomembrane is imposed, as it is directly derived from the deflection using Equation 4. In contrast, the pressure applied on the geomembrane in this case is not known; it is only known that it is less than or equal to the pressure resulting from the weight of the overlying soil that is expressed by Equation 1. This case cannot lead to geomembrane failure if the diameter of the depression is less than the values giving a lower boundary of the factor of safety of one in the case of the geomembrane bridging a cavity addressed in Section 2.1. These limit values are obtained by the same calculation that gave Table 1. They are:

$d = 6.4$ ft for the geomembrane with seams having a 65 lb/in. shear strength

$d = 7.5$ ft for the geomembrane with seams having a 74 lb/in. shear strength

$d = 8.6$ ft in the case of a hypothetical geomembrane without seams

For diameters greater than the above values, failure of the geomembrane occurs if the depth of the depression is greater than the following values:

$y = 0.410 d$	for the geomembrane with seams having a 65 lb/in. shear strength
$y = 0.464 d$	for the geomembrane with seams having a 74 lb/in. shear strength
$y = 0.750 d$	in the case of a hypothetical geomembrane without seams

The above values of the deflection, y , were obtained as follows. As indicated in Section 1.4, the seam having a 65 lb/in. shear strength fails at a calculated strain of 40% in an isotropic biaxial situation, and the seam having a 74 lb/in. shear strength fails at a calculated strain of 50% in an isotropic biaxial situation. Using Equation 4, or values tabulated by Giroud (1995), shows that a geomembrane strain of 40% corresponds to a y/d ratio of 0.410 and a geomembrane strain of 50% correspond to a y/d ratio of 0.464. In the case of a hypothetical geomembrane without seams, the strain at failure in an isotropic biaxial situation is 100% (see Figure 4), which is greater than 57%; as a result, Equation 4 is not valid. In this case, as indicated in Section 1.2, the geomembrane is assumed to have an elliptical shape. The relationship between strain, deflection and diameter is then:

$$1 + \varepsilon = \pi \sqrt{\frac{1 + 4(y/d)^2}{8}} \quad (10)$$

For $\varepsilon = 100\%$, Equation 10 gives $y/d = 0.750$.

The above discussion is represented graphically in Figure 7. In this graph:

The straight line AA' represents the equation $y = 0.410 d$

The straight line BB' represents the equation $y = 0.464 d$

The straight line CC' represents the equation $y = 0.750 d$

However, these straight lines do not extend to the origin, O, of the axes. They are interrupted at points A, B and C, respectively, where they meet the curve OABC that represents the case where the geomembrane is not supported, i.e. the case where the geomembrane bridges a cavity addressed in Section 2.1. The graph in Figure 7 can then be used as follows. Consider the actual case of the geomembrane with seams having a shear strength of 65 lb/in. This case is represented by Curve OAA'. (It should be noted

that the straight line AA' is endless, i.e. the point A' could be infinitely far on the right of the graph.) The portion OA of the curve depends on the overburden stress, p , whereas the portion AA' does not depend on p . The factor of safety is one on AA' and is greater than one on OA (which represents the case where the geomembrane bridges a cavity). The lower boundary of the factor of safety is greater than one for all points below Curve OAA'. Points above the Curve OAA' do not exist: (i) points above OA do not exist because the geomembrane bridges the cavity; and (ii) points above AA' correspond to geomembrane failure. Similar descriptions would apply to Curve OBB' for the geomembrane with seams having a 74 lb/in. shear strength, and Curve OCC' for the hypothetical geomembrane without seams.

It is clear in Figure 7 that: (i) there is a marked difference between the behavior of the hypothetical geomembrane without seams (Curve OCC') and the behavior of the geomembrane with seams (Curves OAA' and OBB'); (ii) there is no significant difference between Curves AA' and BB', i.e. between the case of the geomembrane with seams having a 65 lb/in. shear strength and the case of the geomembrane with seams having a 74 lb/in. shear strength. Clearly, the conclusion is the same as for the case of the geomembrane bridging a cavity (addressed in Section 2.2.1): there is no significant difference between the performance of the geomembrane with seams that meet the shear strength specification (74 lb/in.) and the performance of the geomembrane with seams that have a shear strength of 65 lb/in. Furthermore, it appears that the geomembrane with seams having a 65 lb/in. shear strength would resist the strains imposed by very large depressions, e.g. a 4 ft deep depression with a 10 ft diameter. In other words, the lower boundary of the factor of safety of the geomembrane is greater than one for a wide range of extreme situations. Finally, it should be noted that the case of the behavior of a geomembrane on a depression of a given depth (addressed in Section 2.2.3) is an important complement to the more drastic case of the behavior of a geomembrane bridging a cavity (addressed in Section 2.2.2) because the case of a depression of a given depth is probably more realistic.

To further illustrate the use of Figure 7, the lower boundary of the factor of safety for a 2 ft deep depression is calculated. The horizontal dashed line in Figure 7 shows that, for a diameter of the depression less than 5.8 ft, a geomembrane deflection of 2 ft is not possible because the geomembrane then bridges the depression, i.e. the geomembrane is not in contact with the bottom of the depression. The deflection is then given by curve OD in Figure 7, and the lower boundary of the factor of safety is then obtained as

indicated in Section 2.2.2. Thus, the values of the lower boundary of the factor of safety given in Table 2 for a diameter less than 5.8 ft are copied from Table 1. For a cavity diameter greater than 5.8 ft, the geomembrane strain, ϵ , is calculated using Equation 4 with $y = 2$ ft (e.g. $\epsilon = 16\%$ for $d = 8$ ft). The geomembrane tension is then obtained from the tension-strain curve presented in Figure 2 (e.g. $T = 30$ lb/in. for $\epsilon = 16\%$). The lower boundary of the factor of safety is then calculated as with Equations 6, 7 and 8 for the hypothetical geomembrane without seams, the geomembrane with seams having a shear strength of 74 lb/in., and the geomembrane with seams having a shear strength of 65 lb/in., respectively. The following values are thus obtained:

$$\min(FS) = \frac{54}{30} = 1.80 \quad \text{for the hypothetical geomembrane without seams} \quad (11)$$

$$\min(FS) = 1.80 \times 0.83 = 1.49 \quad (12)$$

for the geomembrane with seams having a shear strength of 74 lb/in.

$$\min(FS) = 1.80 \times 0.77 = 1.39 \quad (13)$$

for the geomembrane with seams having a shear strength of 65 lb/in.

Lower boundaries of the factors of safety calculated for several diameters of the depression are presented in Table 2. Again it appears that there is no significant difference in performance between the seams having a shear strength of 65 lb/in. and the seams having the specified shear strength of 74 lb/in., while there is a significant difference between the hypothetical geomembrane without seams and a geomembrane with seams.

It should be remembered that the values presented in Table 2 are lower boundaries that should only be used for comparing the seams having a shear strength of 65 lb/in. with the seams having a shear strength of 74 lb/in. and the hypothetical geomembrane without seams. The factors of safety will be obtained in Section 2.3 by taking into account the strength of the geotextiles overlying and underlying the geomembrane, in addition to the strength of the geomembrane.

It is important to note that a 2 ft deep depression with a diameter of 5.8 ft or less is unlikely. It would take the collapse of a major cavity located in the waste near the

geomembrane to create such a depression at the level of the geomembrane. In the absence of large appliances (e.g. refrigerator) in the upper levels of the waste (see Sections 1.2.3 and 2.1.5), this is unlikely. Depressions deeper than 2 ft may develop over larger areas. However, based on Equation 4, these depressions create less strain (and, therefore, less tension) in the geomembrane than depressions over a smaller area. Indeed, Table 2 shows that the lower boundary of the factor of safety increases as the diameter of the depression increases beyond the limit diameter for which the geomembrane bridges a cavity (5.8 ft in the considered case).

2.3 Evaluation of the Factor of Safety

Adjacent geotextile strips are overlapped. Therefore, a certain fraction of the tensile stress existing in a geotextile strip is transmitted to the adjacent strip through interface friction. Therefore, it is conservative to assume that tensile stresses are not transmitted from one strip to the adjacent strip. Accordingly, it is conservatively assumed that a geotextile overlying a cavity or a depression provides tensile strength only in one direction. To the best of the author's knowledge, no study has been published of the case of a circular cavity or depression overlain by a geosynthetic providing strength in only one direction. However, it is conservative to replace the circular cavity or depression by an infinitely long trough overlain by a geosynthetic providing strength in the direction perpendicular to the direction of the trough. In this case, Giroud (1981) has shown that the following relationship exists between the applied pressure, p , the width of the trough, b , and the geosynthetic strain, ϵ :

$$T = pb f(\epsilon) \quad (14)$$

Comparing Equations 2 and 14 shows that, for a trough width, b , equal to the diameter of the cavity or the depression, d , and the same values of the pressure, p , and the geosynthetic strain, ϵ , the geosynthetic tension is twice greater in the case of the trough than in the case of the circular cavity or depression. This indicates that the contribution of the geosynthetic strength in the case of a trough (where the geosynthetic acts only in one direction) is half the contribution of the same geosynthetic in the case of a circular cavity or depression. As indicated above, the case of a trough can be conservatively used for the case of a circular cavity or depression overlain by a geosynthetic acting in only one direction. Therefore, the following situations exist:

- If the geotextile overlaps are away from the cavity or depression, the full strength of the geotextile is available.
- If a geotextile overlap is close to the cavity or depression, only half the strength of the geotextile is available.
- If a geotextile overlap overlies the cavity or depression it is likely that almost half the strength of the geotextile will be available. To be conservative, it will be assumed that, in this case, a quarter of the geotextile strength is available.

As indicated in Section 2.1.3, the geotextile tension-strain curve is higher than the geomembrane tension-strain curve. Accordingly, it is conservative to assume that the geotextile strength is identical to that of the geomembrane. Therefore, since there is a geotextile above and a geotextile below the geomembrane, in the best possible case (geotextile overlaps above and below the geomembrane are away from the cavity or depression) the geomembrane strength is to be multiplied by a factor of 3, whereas, in the worst case, the geomembrane strength is to be multiplied by a factor of 1.5. In most cases, the geomembrane strength is to be multiplied by a factor of 2.

The factor of safety is not proportional to the geosynthetic strength. Therefore, the impact of geotextile strength on the factor of safety can only be evaluated on a case by case basis. Calculations performed by the author of this report, but not presented in detail herein, show that:

- For the worst case (i.e. when the geomembrane strength is multiplied by a factor of 1.5), the factor of safety is increased by 22% for a 3 ft diameter cavity and by 30% for a 6 ft diameter cavity.
- For the most likely case (i.e. when the geomembrane strength is multiplied by a factor of 2), the factor of safety is increased by 36% for a 3 ft diameter cavity and by 51% for a 6 ft diameter cavity.

It should be noted that the best possible case (i.e. when the geomembrane strength is multiplied by a factor of 3) has not been considered for the sake of conservatism. It should also be noted that the worst case is more likely to occur with a 6 ft diameter cavity than with a 3 ft diameter cavity because it is more likely that two geotextile overlaps will overlie a 6 ft diameter cavity than a 3 ft diameter cavity. Therefore, it is conservative to assume, based on the above results, that the lower boundaries of the factors of safety calculated without taking into account the strength of the geotextiles can be increased by 30% of the factor of safety for the case of the geomembrane without seams to account for

the strength of the geotextiles overlying and underlying the geomembrane. The factors of safety presented in Tables 3 and 4 were thus derived from the lower boundaries presented in Tables 1 and 2.

2.4 Conclusions Regarding Localized Subsidence

The analyses presented in Section 2 show that the presence of a seam (any seam) does affect the performance of a geomembrane located on a soil that exhibits localized subsidence, compared to the hypothetical case of a geomembrane without seams. The analyses also show that there is no significant difference between the performance of the geomembrane with seams that meet the shear strength specification (74 lb/in.) and the performance of the geomembrane with seams that have a shear strength of 65 lb/in. It may, therefore, be concluded from the analyses presented in Section 2 that, from the viewpoint of resistance to localized subsidence, the fact that some of the geomembrane seams have a shear strength of 65 lb/in., instead of the specified value (74 lb/in.), does not significantly impact the behavior of the geomembrane and the cover system. Furthermore, Tables 3 and 4 show that, in all the cases analyzed in Section 2, the calculated factor of safety of the geomembrane with seams having a shear strength of 65 lb/in. is greater than 1.4, which is greater than 1.3, a value that is generally considered satisfactory for this type of situation. It should be noted that a wide range of cases were considered in Section 2, from the most realistic cases to a limit case that is considered unrealistic, a deep cavity with a diameter of 6 ft (see Sections 1.2.3 and 2.1.5).

3 SLOPE STABILITY

3.1 Introduction to Section 3

3.1.1 Scope of Section 3

In Section 3, the stresses and strains induced in the geomembrane on the side slopes of the landfill cover will be evaluated. The loads considered will include not only the weight of the cover material (static load), but also seepage forces (quasi-static loads), and the load resulting from construction equipment (static and dynamic loads). Two types of analyses will be performed: (i) analyses following the classical approach that consists of using limit equilibrium calculations; and (ii) analyses following an approach based on the displacements required to mobilize interface shear strength.

The goal of the analyses of the first type (limit equilibrium analyses) is to calculate the factor of safety of the slope. Therefore, these analyses will indicate if, and to which extent, the factor of safety of the slope depends on the shear strength of the seams. These analyses will also make it possible to calculate the tension in the geomembrane, but only when the geomembrane tension is required to ensure the stability of the slope.

The goal of the analyses of the second type (analyses based on the required displacements) is to calculate the tension in the geomembrane in the cases where the analyses of the first type indicate that the slope is stable (i.e. has a factor of safety greater than one) and, as a result, do not allow the calculation of the geomembrane tension. The analyses of the second type can be used to determine if the geomembrane could rupture in tension due to a weak seam, even though the slope is stable. Indeed, it is conceivable that a weak geomembrane (such as a geomembrane including weak seams) could rupture, even though the slope is stable, as a result of the displacements that are required to mobilize shear strength to ensure stability.

3.1.2 Relevant Material Properties

The shear strengths used in the subsequent slope stability analyses are presented in Table 5. The property values presented in Table 5 are from the tests conducted in 1998 for the selection of the materials used for construction. Detailed test results are provided in Appendix 5.

The soil unit weight used in the design calculations for slope stability was 125 lb/ft³. The same unit weight will be used herein. (It should be noted that this unit weight is slightly different from the unit weight used in the calculations presented in Section 2; however, the difference is insignificant and has no consequence on the conclusions drawn from the analyses.) In some slope stability calculations, the buoyant soil unit weight and the saturated soil unit weight are also used. The buoyant soil unit weight is obtained using the following classical equation:

$$\gamma_b = \gamma_d \left(1 - \frac{1}{G_s} \right) = \frac{\gamma}{1 + w} \left(1 - \frac{1}{G_s} \right) \quad (15)$$

where: γ_b = buoyant soil unit weight; γ_d = dry soil unit weight; γ = soil unit weight; w = soil water content; and G_s = specific gravity of the soil particles.

The saturated soil unit weight is obtained using the following classical equation:

$$\gamma_{sat} = \gamma_d \left(1 - \frac{1}{G_s} \right) + \gamma_w = \gamma_b + \gamma_w \quad (16)$$

where: γ_{sat} = saturated soil unit weight; and γ_w = unit weight of water.

Typically, $G_s = 2.7$. Assuming that the soil water content is zero (which gives slightly exaggerated values of γ_b and γ_{sat} , which is slightly conservative for slope stability calculations), Equations 15 and 16 give, respectively:

$$\gamma_b = 125 \left(1 - \frac{1}{2.7} \right) = 78.7 \text{ lb / ft}^3 \quad (17)$$

$$\gamma_{sat} = 125 \left(1 - \frac{1}{2.7} \right) + 62.4 = 141.1 \text{ lb / ft}^3 \quad (18)$$

3.2 Limit Equilibrium Calculations

3.2.1 Overview of Limit Equilibrium

The classical slope stability calculations are based on the limit equilibrium method. Such calculations are only intended to evaluate to which extent a slope is safe. This is achieved by calculating a factor of safety, FS , with $FS \geq 1$ indicating a stable slope and $FS < 1$ indicating an unstable slope. These calculations ignore small movements of the components of the cover system that are required to mobilize the shear strengths of the various materials and interfaces involved. In other words, these calculations ignore the steps that are required for the development of equilibrium and only quantify the conditions at equilibrium.

As mentioned in the foregoing discussion, the calculations based on limit equilibrium ignore the stresses and strains that may exist in the geosynthetics unless the geosynthetics contribute to the stability of the slope. This is the case if the following two conditions are met: (i) the considered geosynthetics are above the considered potential slip surface; and (ii) the factor of safety would be less than one without the contribution of the considered geosynthetics and is more than one with the contribution of the considered geosynthetics.

When these two conditions are met, the geomembrane tension, T , can be calculated. In contrast, if the factor of safety of the slope is greater than one without the contribution of the considered geosynthetics (i.e. if the second of the above conditions is not met), no tension can be calculated in the geosynthetics.

As indicated above, limit equilibrium analyses make it possible to calculate the factor of safety of the slope. Therefore, these analyses will indicate if, and to which extent, the factor of safety of the slope depends on the geomembrane tension and, therefore, on the shear strength of the geomembrane seams.

3.2.2 Cases Considered

The stability of a slope can be affected by a variety of loads. The loads considered herein include not only the weight of the cover material (static load due to gravity), but also seepage forces (quasi-static loads), and the loads resulting from construction equipment (static and dynamic loads). Seepage forces exist when, due to an intense rainfall, water flows downslope in the soil layer overlying the geosynthetics. In the case where equipment loading is considered, no water flow is considered since construction equipment is not supposed to be active during intense rainfalls.

3.2.3 Case Where no Equipment Loading is Considered

As it was suggested in the design calculations, seepage forces are considered. The magnitude of the seepage forces is proportional to the thickness of water flow in the soil. The flow thickness considered in design calculations is 3 in. (0.25 ft), which seems conservative since there is a geocomposite drainage layer that is designed to convey the flow and, therefore, should limit the flow thickness to a few millimeters (i.e. less than the thickness of the geocomposite). Since the 3 in. flow thickness is probably conservative, it will be used herein. However, slope stability calculations will also be done, later in Section 3.2.3, for the more typical case where the flow thickness is negligible.

The slope stability analysis method used herein is the method developed by Giroud et al. (1995c) because it results in a simple equation that: (i) gives the factor of safety of the slope as a function of seepage forces; and (ii) shows readily the influence of the various parameters, in particular the geosynthetic tension. As shown by Giroud et al. (1995c), when seepage forces are considered, the factor of safety is calculated using a different equation whether the potential slip surface is above or below the geomembrane. The

factor of safety for the case where the potential slip surface is above the geomembrane is given by the following equation (Giroud et al., 1995c):

$$\begin{aligned}
 FS_A = & \frac{\gamma (t-t_w) + \gamma_b t_w}{\gamma (t-t_w) + \gamma_{sat} t_w} \frac{\tan \delta_A}{\tan \beta} + \frac{a_A/\sin \beta}{\gamma (t-t_w) + \gamma_{sat} t_w} \\
 & + \frac{\gamma (t-t_w^*) + \gamma_b t_w^*}{\gamma (t-t_w) + \gamma_{sat} t_w} \frac{t}{h} \frac{\tan \phi / (2 \sin \beta \cos^2 \beta)}{1 - \tan \beta \tan \phi} \\
 & + \frac{c t/h}{\gamma (t-t_w) + \gamma_{sat} t_w} \frac{1/(\sin \beta \cos \beta)}{1 - \tan \beta \tan \phi} \\
 & + \frac{T/h}{\gamma (t-t_w) + \gamma_{sat} t_w}
 \end{aligned} \tag{19}$$

The factor of safety for the case where the potential slip surface is below the geomembrane is given by the following equation (Giroud et al., 1995c):

$$\begin{aligned}
 FS_B = & \frac{\tan \delta_B}{\tan \beta} + \frac{a_B/\sin \beta}{\gamma (t-t_w) + \gamma_{sat} t_w} \\
 & + \frac{\gamma (t-t_w^*) + \gamma_b t_w^*}{\gamma (t-t_w) + \gamma_{sat} t_w} \frac{t}{h} \frac{\tan \phi / (2 \sin \beta \cos^2 \beta)}{1 - \tan \beta \tan \phi} \\
 & + \frac{c t/h}{\gamma (t-t_w) + \gamma_{sat} t_w} \frac{1/(\sin \beta \cos \beta)}{1 - \tan \beta \tan \phi} \\
 & + \frac{T/h}{\gamma (t-t_w) + \gamma_{sat} t_w}
 \end{aligned} \tag{20}$$

where: δ_A = interface friction angle along a slip surface located above the geomembrane; a_A = interface adhesion along a slip surface located above the geomembrane; δ_B = interface friction angle along a slip surface located below the geomembrane; a_B = interface adhesion along a slip surface located below the geomembrane; ϕ = internal friction angle of the soil located above the geomembrane; c = cohesion of the soil located above the geomembrane; γ = unit weight of the soil located above the geomembrane; γ_b = buoyant soil unit weight; γ_{sat} = saturated soil unit weight; t = thickness of soil above the geomembrane; h = height of slope; β = slope angle; T = geosynthetic tension above the slip surface; t_w = thickness of flow along the slope; and t_w^* = thickness of flow at the toe of the slope.

Equations 19 and 20 comprise five terms. These terms can be characterized as follows:

- The first term quantifies the contribution of the interface friction angle to stability.
- The second term quantifies the contribution of the interface adhesion to stability.
- The third and fourth terms quantify the contribution of the toe buttressing effect, which results from the shear strength of the soil located at the toe of the slope above the slip surface. Both terms depend on the soil internal friction angle, whereas only the fourth term depends on the soil cohesion.
- The fifth term quantifies the contribution to the factor of safety of any tension in the geosynthetics located above the slip surface.

These five terms are related to three mechanisms: (i) the first and second terms quantify the contribution of the interface shear strength to stability; (ii) the third and fourth terms quantify the contribution of the toe buttressing effect to stability; and (iii) the fifth term quantifies the contribution to stability of any tension in the geosynthetics located above the slip surface.

In the slope stability calculations presented herein, the interface adhesion and the soil cohesion are neglected, which is conservative and is often done in design, considering the uncertainties in the measurement of these parameters. Accordingly, the second and fourth terms described above are equal to zero.

The most likely slip surface is at the interface between the geomembrane and the overlying material (i.e. the geocomposite) because this interface is the one with the lowest interface friction angle, 23.1°, according to Table 5 (see the footnote of Table 5). The factor of safety can then be calculated as follows, using Equation 20:

$$\begin{aligned}
 FS_A = & \frac{125(2.5 - 0.25) + (78.7)(0.25)}{125(2.5 - 0.25) + (141.1)(0.25)} \frac{\tan 23.1^\circ}{1/3} + 0 \\
 & + \frac{125(2.5 - 0.25) + (78.7)(0.25)}{125(2.5 - 0.25) + (141.1)(0.25)} \left(\frac{2.5}{60} \right) \frac{1.7568 \tan 29.8^\circ}{1 - (\tan 29.8^\circ)/3} + 0 \\
 & + \frac{T/60}{125(2.5 - 0.25) + (141.1)(0.25)}
 \end{aligned} \tag{21}$$

The numerical values used in Equation 21 were selected as follows: the soil densities are from Section 3.1.2; the soil thickness, 2.5 ft, is in accordance with Section 1.1.3; the thickness of liquid flow along the slope is 0.25 ft, as indicated at the beginning of Section

3.2.3; the thickness of liquid flow at the toe of the slope is also 0.25 ft because the configuration of the toe of the slope is such that flooding of the toe is not likely; the soil friction angle was measured to be 29.8° (see Appendix 5); the interface friction angles are from Table 5; the slope angle is 18.435° , i.e. a 3H:1V slope (33%), which is the maximum slope angle of the side slopes of the considered cover; and the height of the slope is 60 ft, which is the greatest height of the side slopes having a slope angle of 18.435° in the considered cover.

$$FS_A = 1.2165 + 0.0492 + \frac{T}{18,992} = 1.2657 + \frac{T}{18,992} \quad (\text{with } T \text{ in lb/ft}) \quad (22)$$

Since the factor of safety is greater than one without the tension of the geosynthetic located above the critical slip surface (i.e. the geocomposite), the term T can be omitted from the above equation, hence:

$$FS = 1.22 + 0.05 = 1.27 \quad (23)$$

The factor of safety is greater than one without any contribution from the geocomposite tension, T . Therefore, the limit equilibrium method does not allow the calculation of the tension in the geocomposite located above the potential slip surface. Furthermore, no tension can be calculated in the geomembrane because the geomembrane is located beneath the potential slip surface.

In the case of a potential slip surface at the interface between the geomembrane and the underlying material (i.e. the geotextile), the factor of safety can be calculated as follows, using Equation 21:

$$\begin{aligned} FS_B = & \frac{\tan 26.4^\circ}{1/3} + 0 \\ & + \frac{125(2.5 - 0.25) + (78.7)(0.25)}{125(2.5 - 0.25) + (141.1)(0.25)} \left(\frac{2.5}{60} \right) \frac{1.7568 \tan 29.8^\circ}{1 - (\tan 29.8^\circ) / 3} + 0 \\ & + \frac{T / 60}{125(2.5 - 0.25) + (141.1)(0.25)} \end{aligned} \quad (24)$$

hence:

$$FS_B = 1.4892 + 0.0492 + \frac{T}{18,992} = 1.5384 + \frac{T}{18,992} \quad (\text{with } T \text{ in lb/ft}) \quad (25)$$

Equation 25, compared to Equation 22, shows that the factor of safety is greater for a slip surface located below the geomembrane than for a slip surface located above the geomembrane. This confirms that, in the considered case, the critical slip surface is above the geomembrane and the factor of safety of the slope is as given by Equation 23.

If the flow takes place only in the geocomposite drainage layer, i.e. if seepage forces are negligible, the same equation gives the factor of safety for a slip surface located above or below the geomembrane. The equation is (Giroud et al., 1995b):

$$FS = \frac{\tan \delta}{\tan \beta} + \frac{a/\sin \beta}{\gamma t} + \frac{t}{h} \frac{\tan \phi / (2 \sin \beta \cos^2 \beta)}{1 - \tan \beta \tan \phi} + \frac{c t}{\gamma h} \frac{1/(\sin \beta \cos \beta)}{1 - \tan \beta \tan \phi} + \frac{T}{\gamma h t} \quad (26)$$

Equation 26 is used with δ_A and a_A to calculate the factor of safety for a slip surface located above the geomembrane and δ_B and a_B to calculate the factor of safety for a slip surface located below the geomembrane. The factor of safety for a potential slip surface above the geomembrane (i.e. the factor of safety for the critical slip surface) is then:

$$FS = \frac{\tan 23.1^\circ}{1/3} + 0 + \left(\frac{2.5}{60} \right) \frac{1.7568 \tan 29.8^\circ}{1 - (\tan 29.8^\circ)/3} + 0 + \frac{T}{125(60)(2.5)} \quad (27)$$

hence:

$$FS = 1.2796 + 0.0519 + \frac{T}{18,750} = 1.3315 + \frac{T}{18,750} \quad (28)$$

Since the factor of safety is greater than one without the tension of the geosynthetics located above the critical slip surface, the term T can be omitted from the above equation, hence:

$$FS = 1.28 + 0.05 = 1.33 \quad (29)$$

In Equation 29, the first term represents the contribution of the interface friction (1.28) and the second term (0.05) represents the contribution of the toe buttressing effect. If the slope had an infinite length (or height), the contribution of the toe buttressing effect would become negligible, and the factor of safety would be 1.28.

Comparing Equations 29 and 22 shows that the calculated factor of safety decreases from 1.33 to 1.27 when seepage forces are considered. Therefore, the calculated factor of safety is 1.33 under usual circumstances (i.e. no rainfall and no equipment on the slope) and 1.27 if there is an intense rainfall that temporarily exceeds the capacity of the geocomposite drainage layer.

3.2.4 Case Where Equipment Loading is Considered

In the case where equipment loading is considered, no water flow is considered since construction equipment is not expected to be active during intense rainfalls. The slope stability analysis method developed by Giroud et al. (1995b) can be extended to the case of equipment loading by adding two forces: the weight of the equipment, and a force parallel to the slope and oriented downward. This force represents either: (i) deceleration or braking of equipment moving downslope; or (ii) acceleration of equipment moving upslope and/or reaction of the soil pushed by the equipment moving upslope. The factor of safety can be expressed as follows:

$$FS = \frac{F_{R/slope}}{F_{D/slope}} \quad (30)$$

where: $F_{R/slope}$ = projection on the slope of the resisting forces; and $F_{D/slope}$ = projection on the slope of the driving forces. The following expressions for these two forces were obtained by adding the terms including V_{eq} and F_{eq} in the equations for $F_{R/slope}$ and $F_{D/slope}$ developed by Giroud et al. (1995b):

$$F_{R/slope} = \frac{\tan \delta}{\tan \beta} (\gamma h t + V_{eq} \sin \beta) + \frac{ah}{\sin \beta} + \frac{\gamma t^2 \tan \phi / (2 \sin \beta \cos^2 \beta)}{1 - \tan \beta \tan \phi} + \frac{ct / (\sin \beta \cos \beta)}{1 - \tan \beta \tan \phi} + T \quad (31)$$

$$F_{D/slope} = \gamma h t + V_{eq} \sin \beta + F_{eq} \quad (32)$$

where: V_{eq} = vertical force per unit width due to the weight of the equipment; and F_{eq} = force per unit width parallel to the slope and oriented downward that represents either: (i) deceleration or braking of equipment moving downslope; or (ii) acceleration of equipment moving upslope and/or reaction of the soil pushed by the equipment moving upslope.

The vertical force per unit width, V_{eq} , is equal to the weight of the equipment divided by the width over which the normal stress due to the weight of the equipment is applied at the level of the considered potential slip surface. Considering a classical load distribution pyramid with an angle of $\arctan 1/2$, V_{eq} , is given by the following equation:

$$V_{eq} = \max \left(\frac{W_{eq}}{B_{eq} + t}, \frac{W_{eq} / 2}{B_{tra} + t} \right) \quad (33)$$

where: W_{eq} = weight of equipment; B_{eq} = total width of equipment footprint (i.e. from the left of the left track to the right of the right track); B_{tra} = width of a track; and t = soil layer thickness. The reason the maximum of the two above expressions should be used is to ensure that the first expression is used in the case where the load distribution pyramid for one track intersects the load distribution pyramid for the other track, and the second expression is used in the opposite case.

As mentioned above, there is a force parallel to the slope and oriented downward that represents either: (i) deceleration or braking of equipment moving downslope; or (ii) acceleration of equipment moving upslope and/or reaction of the soil pushed by the equipment moving upslope. The acceleration or deceleration of the equipment generates a force that is expressed as follows:

$$F_{accel/decel} = (\Gamma / g) V_{eq} \quad (34)$$

where: Γ = acceleration or deceleration of the equipment; g = acceleration due to gravity (32.2 ft/s^2); and V_{eq} = vertical force per unit width due to the weight of the equipment.

The following classical relationship exists:

$$\Gamma = \frac{|V_2 - V_1|}{\bar{t}} = \frac{(V_2 - V_1)^2}{2x} \quad (35)$$

where: V_1 = velocity of equipment before acceleration or deceleration (or braking); V_2 = velocity of equipment after acceleration or deceleration (or braking); $\bar{t}$ = time required to accelerate or decelerate from velocity V_1 to velocity V_2 ; and x = distance over which the acceleration or deceleration takes place (i.e. distance traveled by the equipment during the time $\bar{t}$).

Combining Equations 34 and 35 gives:

$$F_{accel/decel} = \frac{|V_2 - V_1| V_{eq}}{g \bar{t}} = \frac{(V_2 - V_1)^2 V_{eq}}{2 g x} \quad (36)$$

At this stage, it should be noted that, in a number of landfill designs, the following value is used for the force generated by equipment acceleration or deceleration:

$$F_{accel/decel} = 0.3 V_{eq} \quad (37)$$

There is no published justification for this 0.3 factor. Design engineers often quote for this 0.3 factor a paper by McKelvey (1994) that refers for this factor to a paper by Drushel and Underwood (1993) that refers for this factor to a manual by Richardson and Koerner (1988), which does not discuss the topic. The apparent source of this practice is a numerical example, presented in the manual by Richardson and Koerner (1988), where the 0.3 factor is used with no explanation or justification neither in the example nor in the related text. The author of this report agrees with Parukavat and Richardson (1999) who consider the expression presented by Equation 37 as an “arbitrarily assigned braking force”. Considering the lack of basis for the usual 0.3 factor, the rationale described above and quantified by Equations 34, 35 and 36 is used in this report.

The force generated by the reaction of the soil pushed by the equipment blade can be expressed as follows, based on the classical passive earth pressure theory (adapted from Parukavat and Richardson, 1999):

$$F_{bla} = (1/2) \gamma D^2 B_{bla} K_p \cos \alpha \sin \omega \left[\max \left(\frac{1}{B_{eq} + t}, \frac{1}{2(B_{tra} + t)} \right) \right] \quad (38)$$

where: γ = soil unit weight; D = thickness of soil pushed by the blade; B_{bla} = width of the blade; K_p = coefficient of passive pressure of the soil pushed by the blade; α = interface friction angle between the soil and the blade; and ω = angle of the blade with the slope.

The above equations are used hereafter for the case of the bulldozer used during construction. The relevant characteristics of this bulldozer are: $W_{eq} = 43,590$ lbs; $B_{eq} = 10.3$ ft; $B_{tra} = 3$ ft; $B_{bla} = 11$ ft. Regarding the soil layer thickness, the worst case is the placement of the first lift, when the bulldozer tracks are closest to the potential slip surface and, as a result, the stresses induced by the equipment on the potential slip surface are highest, while the weight of the cover soil is lowest. In this case, the effect of construction equipment is relatively large. Accordingly, a thickness of 1 ft is considered,

as it is the thickness of the first lift of soil during placement (see Section 1.2.2). Based on these values, Equation 33 gives:

$$V_{eq} = \max\left(\frac{43,590}{10.3+1}, \frac{43,590/2}{3+1}\right) = \max(3,857.52, 5,448.75) = 5,448.75 \text{ lb/ft} \quad (39)$$

The effect of construction equipment on the stability of a slope is more significant in the case of a short slope than in the case of a long slope with the same slope angle, because the weight of the equipment relative to the weight of the soil cover is greater on a short slope than on a long slope. On the other hand, in the absence of construction equipment, the factor of safety of a slope increases as the length (or height) of the slope decreases (for a given slope angle). Therefore, it is not possible to predict, without a calculation, if the factor of safety of a slope, with a given slope angle and subjected to a given construction equipment, will increase or decrease as the length (or height) of the slope increases. To evaluate this effect, the height of the slope is kept as an unknown in the following equations.

First, the resisting force is calculated. Equation 31 gives:

$$F_{R/slope} = \frac{\tan 23.1^\circ}{1/3} [(125)(h)(1) + 5,448.75 \sin 18.435^\circ] + 0 \\ + \frac{(125)(1)^2 (\tan 29.8^\circ) / (2 \sin 18.435^\circ \cos^2 18.435^\circ)}{1 - (\tan 29.8^\circ) / 3} + 0 + T \quad (40)$$

hence:

$$F_{R/slope} = 159.95 h + 2,204.82 + 155.44 + T = 159.95 h + 2,360.26 + T \quad (41)$$

Then, the driving force is calculated.

First, the case of the bulldozer moving downslope is considered. As the bulldozer operators were not authorized to brake while moving downslope, only deceleration between a high and a low velocity is considered. It is assumed that the bulldozer decelerates from 10 to 5 miles/hour (i.e. from 14.67 to 7.33 ft/s), and it is assumed that this deceleration takes place over a distance of 10 ft. Equation 36 gives:

$$F_{eq-down} = F_{decel} = \frac{(14.67 - 7.33)^2 (5,448.75)}{(2)(32.2)(10)} = 455.00 \text{ lb/ft} \quad (42)$$

It is realized that this value of $F_{eq-down}$ is somewhat arbitrary, due to the assumption made on the bulldozer velocity. However, it is known that no slope failure was caused during construction by the equipment used on the slopes. Therefore, it will be possible to check the validity of the value calculated for $F_{eq-down}$.

Then, Equation 32 gives:

$$F_{D/slope} = (125)(h)(1) + 5,448.75 \sin 18.435^\circ + 455.00 = 125h + 1,723.05 + 455.00 \quad (43)$$

hence:

$$F_{D/slope} = 125h + 2,178.05 \quad (44)$$

Then, the factor of safety is obtained by combining Equations 30, 41 and 43, which gives:

$$FS_{down} = \frac{159.95h + 2,360.26 + T}{125h + 2,178.05} \quad (45)$$

The values of the factor of safety calculated using Equation 45 with $T = 0$ are given in Table 6. The values of the slope height, h , considered in Table 6 are from 3.4 ft to 60 ft (the maximum slope height, as indicated in Section 3.2.3). The minimum slope height considered, 3.4 ft, corresponds to the length of the tracks of the bulldozer (10.7 ft):

$$h = L \sin \beta \quad (46)$$

hence:

$$h = (10.7) \sin 18.435^\circ = 3.4 \text{ ft} \quad (47)$$

It appears in Table 6 that the calculated values of the factor of safety, FS_{down} , are greater than one. Therefore, no tension is calculated in the geosynthetics located above the slip surface, i.e. the geocomposite (which corresponds to $T = 0$ in Equation 45). The fact that the calculated values of the factor of safety, FS_{down} , are greater than one is consistent with the fact that no slope failure was observed during construction. It should be noted that, if the bulldozer had braked instead of just decelerating, $F_{eq-down}$ would have been greater than 455 lbs/ft (given by Equation 42) and, therefore, the term 2,178.05 in Equation 45 would have been greater, which would have decreased the factor of safety. This confirms that it was important to indicate to the bulldozer operators that they were not authorized to brake when moving downslope.

Second, the case of the bulldozer moving upslope is considered. It is assumed that the blade is perpendicular to the slope ($\omega = 90^\circ$). The value of the passive earth pressure coefficient, K_p , depends on the following parameters: the slope angle of the soil being pushed (assumed equal to the cover system slope angle, β); the blade inclination, ω ; the internal friction angle of the soil, ϕ ; and the interface friction angle between the soil and the blade, α . Values of the passive earth pressure coefficient, K_p , can be found in published tables (Caquot et al., 1973). For $\beta = \omega = 18.435^\circ$ and $\phi = 29.8^\circ$, K_p varies from 3 for an extremely smooth blade ($\alpha = 0^\circ$) to 7 for an extremely rough blade ($\alpha = \phi$). As a result, $K_p \cos \alpha$ varies from 3 to 6. An average value of 4.5 is used below.

It is also assumed that the thickness of soil that is pushed by the bulldozer blade above the first lift is 1 ft. Then, Equation 38 gives:

$$F_{bla} = (1/2)(125)(1)^2(11)(4.5) \sin 90^\circ \left[\max \left(\frac{1}{10.3+1} + \frac{1}{2(3+1)} \right) \right] = 386.72 \text{ lb/ft} \quad (48)$$

It is assumed that the acceleration in the upslope direction is negligible. Therefore:

$$F_{eq-up} = F_{bla} = 386.72 \text{ lb/ft} \quad (49)$$

Then, Equation 32 gives:

$$F_{D/slope} = (125)(h)(1) + 5,448.75 \sin 18.435^\circ + 386.72 = 125h + 1,723.05 + 386.72 \quad (50)$$

hence:

$$F_{D/slope} = 125h + 2,109.77 \quad (51)$$

Then, the factor of safety is obtained by combining Equations 30, 41 and 51, which gives:

$$FS_{up} = \frac{159.95h + 2,360.26 + T}{125h + 2,109.77} \quad (52)$$

The values of the factor of safety, FS_{up} , calculated using Equation 52 with $T = 0$ are given in Table 6. It appears in Table 6 that the calculated values of the factor of safety, FS_{up} , are greater than one. Therefore, no tension is calculated in the geosynthetics located above the slip surface, i.e. the geocomposite (which corresponds to $T = 0$ in Equation 52).

The fact that the calculated values of the factor of safety, FS_{down} , are greater than one is consistent with the fact that no slope failure was observed during construction. This indicates that the assumptions made for the evaluation of F_{eq} were appropriate.

It appears in Table 6 that the effect of the considered bulldozer on the stability of the slope is not negligible: the calculated factor of safety of the slope (1.32 without equipment) is 1.15 with bulldozers working in the upslope direction and 1.12 with bulldozers working in the downslope direction. The effect of construction equipment on slope stability could have been even greater if the bulldozer operators had been authorized to push soil downslope and to brake as the bulldozers moved downslope. The factor of safety calculated using Equation 45 with $T = 0$ would then have been lower than one and the value of the tension, T , calculated using Equation 45 with $FS = 1.0$ would then have been greater than zero. It is important to note that the calculated tension, T , would have been the tension in the geocomposite, not the geomembrane.

It should be noted that the calculated factor of safety would be 1.28 if the slope had an infinite length, which is consistent with Equation 29 because both the influences of the toe buttressing effect and the equipment are negligible when the slope length (or height) is infinite.

3.2.5 Conclusion from Limit Equilibrium Analyses

As indicated in Section 3.2.1, limit equilibrium analyses are the usual analyses performed for evaluating the stability of a slope. The limit equilibrium analyses presented herein show that the factor of safety of the side slopes of the considered landfill cover is always greater than one without any contribution from the geosynthetics (whether located above or below the slip surface), and in particular from the geomembrane, in all of the considered cases (general case with no seepage forces and no equipment working on the slope, case with seepage forces, and case with equipment working on the slope). Therefore, it is clear that the geomembrane tension does not contribute to the stability of the side slopes of the considered cover system. Therefore, it is possible to conclude, based on the limit equilibrium analyses presented in Section 3.2, that the stability of the side slopes of the considered cover system is not affected by the geomembrane seams. In other words, the limit equilibrium analyses presented in Section 3.2 show that the fact that some of the geomembrane seams located on the side slopes across the direction of

the slope may have a shear strength of 65 lb/in. instead of 74 lb/in. has no impact on the stability of these slopes.

Furthermore, it is important to note that the geomembrane is below the potential slip surface in all of the cases considered in the analyses presented herein. Therefore, even if the factor of safety had been less than one, no tension would have been calculated in the geomembrane.

Since the limit equilibrium analyses do not show any contribution of the geomembrane tension to the stability of the slope, these limit equilibrium analyses do not lead to any strains or stresses in the geomembrane. However, this does not necessarily mean that the tension of the geomembrane is zero because, as pointed out in Section 3.1.1, it is conceivable that a weak geomembrane (such as a geomembrane including weak seams) could rupture, even though the slope is stable, as a result of the displacements that are required to mobilize shear strength. The calculations presented in Section 3.3 are an attempt to evaluate the geomembrane tension.

3.3 Evaluation of Geosynthetic Tension

3.3.1 Discussion of Tensions in the Geosynthetics on a Slope

In limit equilibrium analyses (i.e. in the analyses presented in Section 3.2), three mechanisms are involved, as pointed out in Section 3.2.3, and it is implicitly assumed that these three mechanisms are mobilized in the following order: first, the interface shear strength; second the toe buttressing effect; and, third, the tension in the geosynthetics located above the potential slip surface. Therefore, the tension in the geosynthetics located above the potential slip surface is considered to be zero in limit equilibrium analyses if the calculated factor of safety based on the first two mechanisms (i.e. the interface shear strength and the toe buttressing effect) is greater than one. Furthermore, it is implicitly assumed that the tension in the geosynthetics located below the potential slip surface is zero, regardless of the value of the factor of safety of the slope. What happens in a slope in reality is far more complex because some displacement of some of the components of a cover system is required to mobilize the various strengths that contribute to stability: (i) the interface shear strengths that contribute to the first mechanism; (ii) the soil internal shear strength that contributes to the second mechanism; and (iii) the geosynthetic tension that contributes to the third mechanism. It is quite possible that, as a

result of these displacements, some of the geosynthetics the tension of which can be considered zero in limit equilibrium analyses (even geosynthetics located below the slip surface) are in fact subjected to some tension. An extreme case, as pointed out at the end of Section 3.2, is the case where a weak geomembrane (such as a geomembrane including weak seams) could rupture, even though the slope is stable, as a result of the displacements that are required to mobilize shear strength. Analyses presented in Section 3.3 will show that such displacements may occur in the considered landfill cover, but lead to a rather small tension in the geomembrane, which has no significant impact on the geomembrane and its seams.

3.3.2 Approach and Cases Considered

It should be noted that the evaluation of tensions and strains in the geosynthetics included in a cover system is extremely complex and, as a result, is virtually never done when the stability of a slope is analyzed. A few papers have been published on the subject, some pointing out errors in previously published papers. Preliminary calculations performed by the author of this report for the considered landfill cover system have shown that a relatively simple approach could be used considering the fact that, in the considered cover system, the potential slip surface is clearly identified (as shown in Section 3.2). Also, the approach can be relatively simple herein since the goal of the calculations is limited: the tensions and strains are not calculated in all of the geosynthetics, but only in the geomembrane.

Two cases are discussed hereafter: the case where no equipment loading is considered; and the case where equipment loading is considered.

3.3.3 Case Where no Equipment Loading is Considered

The cause of slope instability is gravity. In a cover system, gravity is essentially applied to the soil layer, as it is the only component of the cover system located above the potential slip surface that has a significant mass (i.e. all geosynthetics have a mass that is negligible compared to that of the soil layer). Therefore, any movement of the slope starts with a movement of the soil layer. In virtually all cases, experience shows that the displacement required to mobilize the interface shear strengths is of the order of 0.1 in. whereas the displacement required to mobilize the toe buttressing effect is of the order of 1 in. or more. Therefore, the interface shear strengths that are involved in the stability of a slope are mobilized before the toe buttressing effect is mobilized. Also, in the case of the cover system considered herein, the potential slip surface is above the geomembrane;

therefore, the geomembrane tension cannot contribute to the stability of the slope. The contribution to slope stability of the geocomposite located above the potential slip surface is neglected, which is slightly conservative. Therefore, the only resistance to slope movement to be considered is generated by interface shear strength. However, it is important to note that, even though the geomembrane is under the potential slip surface and its tension does not contribute to slope stability, it may be affected by the movement of the cover system. The mobilization of the interface shear strength along the upper face of the geomembrane does not require any movement of the geomembrane: it only requires the soil layer to move with respect to the geomembrane. In contrast, the mobilization of the interface shear strength along the lower face of the geomembrane requires a movement of the geomembrane. If the geomembrane is anchored at the top of the slope, the movement of the geomembrane results in a tension in the geomembrane.

In the analysis that follows, the geomembrane is assumed to be anchored at the top of the slope. This is the case in most of the side slopes of the considered cover (see Section 1.2.2), and it is a conservative assumption in the case of those of the side slopes where the geomembrane is not anchored at the top, because the anchorage at the top causes the tension in the geomembrane to be greater than in the absence of anchorage.

The situation at equilibrium is illustrated in Figure 8a. The interface shear strength below the geomembrane is fully mobilized between $x = 0$ and $x = x_m$ (where the displacement, u , is equal to u_m , the displacement required to fully mobilize the interface friction angle) and partly mobilized from $x = x_m$ to $x = L$.

Since the geomembrane is anchored at the top of the slope, its displacement is zero at the top of the slope. The soil that moves causes the geomembrane to move until the displacement of the geomembrane at the toe of the slope is equal to the displacement required to mobilize the interface shear strength along the lower face of the geomembrane. At that point, the geomembrane ceases to move at the toe of the slope, but continues to move above the toe of the slope until the interface shear strength developed along the lower face of the geomembrane is equal to the interface shear strength developed along the upper face of the geomembrane. This situation can be quantified using the following equation:

$$L \tan \delta_A = x_m \tan \delta_B + \int_{x_m}^L \tan \delta_{Bm} dx \quad (53)$$

where: L = length of slope; x_m = length of slope along which the interface friction angle is fully mobilized (i.e. length of slope along which the geomembrane displacement is equal to the displacement required to mobilize the interface friction angle below the geomembrane); δ_A = interface friction angle along the upper face of the geomembrane; δ_B = interface friction angle along the lower face of the geomembrane; and δ_{Bm} = mobilized value of the interface friction angle along the lower face of the geomembrane in the portion of the slope where the displacement of the geomembrane is less than the value required to mobilize the interface friction angle. It is assumed that the mobilized value of the interface friction (i.e. $\tan \delta_{Bm}$) is proportional to the displacement of the geomembrane with respect to the underlying material, which is a good approximation of test results. This is expressed as follows:

$$\tan \delta_{Bm} = \frac{u}{u_m} \tan \delta_B \quad (54)$$

where: u = displacement of the geomembrane with respect to the underlying material; and u_m = displacement required to fully mobilize the interface friction angle below the geomembrane. Combining Equations 53 and 54 gives:

$$L \tan \delta_A = x_m \tan \delta_B + \tan \delta_B \int_{x_m}^L \frac{u}{u_m} dx \quad (55)$$

To solve Equation 55, it is necessary to know the geomembrane displacement, u . At this point, it is tempting to make the simple assumption that the displacement decreases linearly between $u = u_m$ for $x = x_m$ and $u = 0$ for $x = L$. However, this would result in an abrupt change in the geomembrane strain at $x = x_m$ (i.e. between a zero strain for $x < x_m$ and a constant strain for $x > x_m$), which is unrealistic. Furthermore this would lead to unconservative (i.e. small) values of the geomembrane strain, as shown by preliminary calculations made by the author of this report, while preparing this report. It is, therefore, preferable to assume that the geomembrane strain increases progressively (for example, linearly, as in Figure 8b) from $x = x_m$ to $x = L$, hence:

$$\varepsilon = \left(\frac{x - x_m}{L - x_m} \right) \varepsilon_{max} \quad (56)$$

The following relationship exists between the displacement and the strain, since the strain is the spatial derivative of the displacement (see Section 1.2.5):

$$u = u_m - \int_{x_m}^x \varepsilon \, dx \quad (57)$$

Combining Equations 56 and 57 gives:

$$u = u_m - \frac{\varepsilon_{max}}{L - x_m} \int_{x_m}^x (x - x_m) \, dx \quad (58)$$

hence:

$$u = u_m - \frac{(x - x_m)^2 \varepsilon_{max}}{2 (L - x_m)} \quad (59)$$

In particular, for $x = L$, $u = 0$ since the geomembrane is anchored, hence:

$$\varepsilon_{max} = \frac{2 u_m}{L - x_m} \quad (60)$$

Combining Equations 59 and 60 gives:

$$\frac{u}{u_m} = 1 - \left(\frac{x - x_m}{L - x_m} \right)^2 \quad (61)$$

This parabolic distribution of the displacement is illustrated in Figure 8c.

Knowing u from Equation 61, it is then possible to solve Equation 55. Combining Equations 55 and 61 gives:

$$L \tan \delta_A = x_m \tan \delta_B + \tan \delta_B \int_{x_m}^L dx - \frac{\tan \delta_B}{(L - x_m)^2} \int_{x_m}^L (x - x_m)^2 \, dx \quad (62)$$

hence:

$$L \tan \delta_A = L \tan \delta_B - \frac{(L - x_m) \tan \delta_B}{3} \quad (63)$$

hence:

$$\frac{x_m}{L} = \frac{3 \tan \delta_A}{\tan \delta_B} - 2 \quad (64)$$

Combining Equations 60 and 64 gives:

$$\epsilon_{max} = \frac{2 u_m}{3L \left(1 - \frac{\tan \delta_A}{\tan \delta_B} \right)} \quad (65)$$

Using in Equation 65 the relationship that exists between the length and the height of the slope (Equation 46) gives:

$$\epsilon_{max} = \frac{2 u_m \sin \beta}{3h \left(1 - \frac{\tan \delta_A}{\tan \delta_B} \right)} \quad (66)$$

It should be noted that Equation 66 is only applicable when the soil layer has been placed to the level of the anchor trench. During construction, i.e. when there is a significant distance between the top of the soil layer and the top of the geomembrane (i.e. the anchor trench), the length of the geomembrane available for stretching to absorb the displacement required for mobilizing the interface friction angle is so large that the geomembrane strain and tension are virtually zero. Therefore, the most critical location for a seam that is oriented across the slope direction is at the top of the slope, near the anchor trench. Accordingly, numerical applications of Equation 66 must be done for the full height of the slope. In the case of the considered cover system, with $h = 60$ ft, $\beta = 18.435^\circ$, $\delta_A = 23.1^\circ$, $\delta_B = 26.4^\circ$, and $u_m = 0.2$ in. (according to the shear stress-displacement curves presented in Appendix 5), Equation 66 gives:

$$\epsilon_{max} = \frac{2(0.2)(\sin 18.435^\circ)}{3(60 \times 12) \left(1 - \frac{\tan 23.1^\circ}{\tan 26.4^\circ} \right)} = 0.0004 = 0.04\% \quad (67)$$

It appears that the geomembrane strain thus calculated is extremely small. Considering an initial modulus of the geomembrane of approximately 50 lb/in. (see Figure 1), this strain corresponds to a tension of 0.02 lb/in., which is absolutely negligible with respect to the geomembrane seam shear strength, whether it is 74 lb/in. (the specified value) or 65 lb/in. (the minimum value measured for some of the seams). It should also be noted that the displacement associated with this strain should not damage the geomembrane surface since the magnitude of the displacement is small (0.2 in. maximum) and the materials in contact with both faces of the geomembrane are geotextiles, which should not scratch the geomembrane surface.

3.3.4 Case Where Equipment Loading is Considered

When the bulldozer pushes soil in the upslope direction, it needs to mobilize some shear strength, in addition to the shear strength already mobilized to ensure the slope stability before the bulldozer starts pushing the soil. Some movement of some components of the cover system on the slope is required to mobilize this additional shear strength. The required movement is very small if the stability of the slope is completely ensured by interface shear strength, and is larger if the stability of the slope relies partly on the toe buttressing effect. If the toe buttressing effect is neglected in Equation 41, the resisting force becomes:

$$F_{R/slope} = 159.95 h + 2,204.82 + T \quad (68)$$

Therefore, Equation 52 becomes the following equation for the case where the toe buttressing effect is not taken into account:

$$FS_{up} = \frac{159.95 h + 2,204.82 + T}{125 h + 2,109.77} \quad (69)$$

The factor of safety calculated using Equation 69 (with $T = 0$, i.e. not including the tension in the geocomposite located above the potential slip surface) is 1.08 for the smallest slope ($h = 3.4$ ft, as explained after Equation 45). Based on this value, it may be concluded that the stability of the bulldozer pushing soil on the slope requires only to mobilize the interface shear strength and does not require the mobilization of the toe buttressing effect. Therefore, the required displacement of the geomembrane is only 0.2 in., as indicated in Section 3.3.3 for the case where there is no bulldozer. To calculate the strain in the geomembrane, it is necessary to know the length of geomembrane that is free to move. Considering that the geomembrane may be somehow anchored by the weight of the pile of soil being pushed, the length of geomembrane that is free to move may be short. However, even if the length of geomembrane that is free to move is only 3 ft, which seems very short (and therefore, very conservative), the resulting strain in the geomembrane is $0.2/36 = 0.006 = 0.6\%$, which is very small.

3.3.5 Conclusions from Geosynthetic Tension Calculations

The calculations presented in Section 3.3 show that the strain and tension in the geomembrane are very small in the cases considered, which are representative of actual situations in the field. The resulting tension levels in the seams are very small and are

negligible with respect to the seam shear strength, whether it is 74 lb/in. (the specified value) or 65 lb/in. (the minimum value measured for some of the seams).

3.4 Conclusions Regarding Slope Stability

The limit equilibrium analyses presented in Section 3.2 show that, based on the shear strengths of the cover components measured in laboratory tests, the potential slip surface is above the geomembrane and the factor of safety of the side slopes is greater than one in all of the considered cases, which were selected to be representative of actual situations in the field. This shows that the tensile characteristics of the geomembrane have no impact on the factor of safety of the side slopes. Therefore, the stability of the side slopes is not affected by the shear strength of the geomembrane seams. In other words, the limit equilibrium analyses presented in Section 3.2 show that the fact that some of the geomembrane seams have a shear strength less than the specified value has no impact on the stability of the side slopes of the considered landfill cover.

The geomembrane tension calculations presented in Section 3.3 show that the tension in the geomembrane generated by the displacements of some components of the cover system required to mobilize the interface shear strengths needed to ensure slope stability are very small. The tensions thus calculated are very small compared to the shear strength of the geomembrane seams. As a result, there is virtually no difference, from this viewpoint, between the seams that have a shear strength of 74 lb/in. (the specified value) or 65 lb/in. (the minimum value measured for some of the seams).

4 CONCLUSIONS

The analyses presented in Section 2 evaluate the geomembrane resistance to localized subsidence. Localized subsidence of the waste underneath the geomembrane, if it happens, induces tension in the geomembrane. Localized subsidence is probably the type of mechanical action that is the most likely to cause strains and tensions in the geomembrane. A wide range of cases were considered in Section 2, from the most realistic cases to a limit case that is considered unrealistic, a deep cavity with a diameter of 6 ft (see Sections 1.2.3 and 2.1.5). The analyses presented in Section 2 show that, from the viewpoint of resistance to localized subsidence, there is no significant difference between the performance of the geomembrane with seams that meet the shear strength specification (74 lb/in.) and the performance of the geomembrane with seams that have a shear strength of 65 lb/in. Furthermore, Tables 3 and 4 show that, in all the cases

analyzed in Section 2, the calculated factor of safety of the geomembrane with those seams is greater than 1.4, which is greater than 1.3, a value that is generally considered satisfactory for this type of situation.

The analyses presented in Section 3 evaluate the stability of the side slopes of the considered cover system and the tension in the geomembrane that results from displacements of some of the components of the cover system that are required to reach equilibrium. The slope stability calculations show that the tensile characteristics of the geomembrane have no impact on the factor of safety of the side slopes. Based on the results of these analyses, it may, therefore, be concluded that the stability of the side slopes is not affected by the shear strength of the geomembrane seams. In other words, the analyses presented in Section 3 show that the fact that some of the geomembrane seams have a shear strength less than the specified value has no impact on the stability of the side slopes of the considered landfill cover. Furthermore, the geomembrane tension calculations presented in Section 3 show that the tension in the geomembrane generated by the displacements of some components of the cover system required to mobilize the interface shear strengths needed to ensure slope stability is very small compared to the shear strength of the geomembrane seams. As a result, there is virtually no difference, from this viewpoint, between the seams that have a shear strength of 74 lb/in. (the specified value) and the seams that have a shear strength of 65 lb/in. (the minimum value measured for some of the seams).

As indicated in the introduction of this report, localized subsidence and slope stability are the two mechanical actions most likely to induce tensions in the geomembrane component of the considered cover system. The impact on the performance of the geomembrane of these two types of mechanical actions was analyzed in this report in a variety of cases that were selected to be representative of actual field situations. The analyses presented in this report show that, in the case of the considered landfill cover, stresses induced in the geomembrane by localized subsidence are far greater than the stresses resulting from movement of the components of the cover system along the side slopes. Based on the analyses presented in this report, it may be concluded that the performance of the geomembrane is not significantly affected by the fact that some of its seams have a shear strength that does not meet the specifications. In particular, the factors of safety for all of the considered scenarios are sufficient. Therefore, the seams are of sufficient quality to meet the intent of the design. Since any attempt to redo the seams

would require excavations that are likely to damage the geomembrane, it is concluded that it is much preferable to accept the seams as they are.

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NOTATIONS

a_A	=	interface adhesion along a slip surface located above the geomembrane
a_B	=	interface adhesion along a slip surface located below the geomembrane
B_{bla}	=	width of the bulldozer blade
B_{eq}	=	total width of equipment footprint (i.e. from the left of the left track to the right of the right track)
B_{tra}	=	width of a track
c	=	cohesion of the soil located above the geomembrane
d	=	diameter of the depressed area
D	=	thickness of soil pushed by the blade
$F_{accel/decel}$	=	force generated by acceleration or deceleration of equipment
$F_{D/slope}$	=	projection on the slope of the driving forces
F_{Bla}	=	force applied by the bulldozer blade to the soil being pushed
F_{decel}	=	force generated by deceleration of equipment
F_{eq}	=	force per unit width parallel to the slope and oriented downward that represents either: (i) deceleration or braking of equipment moving downslope; or (ii) acceleration of equipment moving upslope and/or reaction of the soil pushed by the equipment moving upslope
F_{eq-up}	=	force generated by equipment moving upslope
$F_{eq-down}$	=	force generated by equipment moving downslope
$F_{R/slope}$	=	projection on the slope of the resisting forces

FS	=	factor of safety
FS_A	=	factor of safety for a slip surface located above the geomembrane
FS_B	=	factor of safety for a slip surface located below the geomembrane
FS_{down}	=	factor of safety in the case of a bulldozer moving downslope
FS_{up}	=	factor of safety in the case of a bulldozer moving upslope
$f(\epsilon)$	=	implicit function of ϵ
g	=	acceleration due to gravity (32.2 ft/s^2)
G_s	=	specific gravity of the soil particles
h	=	height of slope
K_p	=	coefficient of passive pressure of the soil pushed by the blade
L	=	length of slope
$\min(FS)$	=	lower boundary of the factor of safety
p	=	pressure applied by the soil layer
T	=	geosynthetic tension above the slip surface
t	=	soil layer thickness
t_w	=	thickness of flow along the slope
t_w^*	=	thickness of flow at the toe of the slope
$\bar{t}$	=	time required to accelerate or decelerate from speed V_1 to speed V_2
u	=	displacement of the geomembrane with respect to the underlying material
u_m	=	displacement required to fully mobilize the interface friction angle below the geomembrane
V_1	=	speed of equipment before acceleration or deceleration (or braking)
V_2	=	speed of equipment after acceleration or deceleration (or braking)
V_{eq}	=	vertical force per unit width due to the weight of the equipment
w	=	soil water content
W_{eq}	=	weight of equipment per unit width
x	=	distance over which the acceleration or deceleration takes place (i.e. distance traveled by the equipment during the time $\bar{t}$)
x_m	=	length of slope along which the interface friction angle is fully mobilized (i.e. length of slope along which the geomembrane displacement is equal

to the displacement required to mobilize the interface friction angle below the geomembrane):

y	=	the deflection of the geomembrane
α	=	interface friction angle between the soil and the bulldozer blade
β	=	slope angle
Γ	=	acceleration or deceleration of the equipment
γ	=	unit weight of the soil located above the geomembrane
γ_b	=	buoyant soil unit weight
γ_d	=	dry soil unit weight
γ_{sat}	=	saturated soil unit weight
γ_w	=	unit weight of water
δ	=	interface friction angle
δ_A	=	interface friction angle along a slip surface located above the geomembrane; also, interface friction angle along the upper face of the geomembrane
δ_B	=	interface friction angle along a slip surface located below the geomembrane; interface friction angle along the lower face of the geomembrane
δ_{Bm}	=	mobilized value of the interface friction angle along the lower face of the geomembrane in the portion of the slope where the displacement of the geomembrane is less than the value required to mobilize the interface friction angle
ϵ	=	geomembrane strain
ϕ	=	internal friction angle of the soil located above the geomembrane
ω	=	angle of the bulldozer blade with the slope

Table 1. Geomembrane subsidence over a cavity.

Diameter of cavity d (ft)	Geomembrane strain ϵ (%)	Geomembrane deflection y (in.)	Geomembrane tension T (lb/in.)	Lower boundary of the factor of safety		
				Geomembrane	74 lb/in. seam	65 lb/in. seam
1	4	1.5	14.4	3.75	3.11	2.89
2	8	4.2	20.0	2.70	2.24	2.08
3	12	7.8	25.9	2.08	1.73	1.60
4	18	12.7	30.0	1.80	1.49	1.39
5	26	19.5	34.4	1.59	1.32	1.22
6	35	27.4	39.0	1.38	1.15	1.06

Note: The above lower boundaries do not take into account the strength of the geotextiles. Factors of safety (including the strength of the geotextiles and the strength of the geomembrane) are presented in Table 3.

Table 2. Geomembrane subsidence over a 2 ft deep depression.

Diameter of cavity d (ft)	Geomembrane strain ϵ (%)	Geomembrane deflection y (in.)	Geomembrane tension T (lb/in.)	Lower boundary of the factor of safety		
				Geomembrane	74 lb/in. seam	65 lb/in. seam
1.0	4	1.5	14.4	3.75	3.11	2.89
2.0	8	4.2	20.0	2.70	2.24	2.08
3.0	12	7.8	25.9	2.08	1.73	1.60
4.0	18	12.7	30.0	1.80	1.49	1.39
5.0	26	19.5	34.4	1.59	1.32	1.22
5.8	32	24.0	38.0	1.42	1.18	1.09
6.0	27	24.0	36.0	1.50	1.25	1.16
7.0	21	24.0	33.0	1.64	1.36	1.26
8.0	16	24.0	30.0	1.80	1.49	1.39
9.0	12	24.0	27.0	2.00	1.66	1.54

Note: The above lower boundaries do not take into account the strength of the geotextiles. Factors of safety (including the strength of the geotextiles and the strength of the geomembrane) are presented in Table 4.

Table 3. Factors of safety for the localized subsidence of the cover system over a cavity.

Diameter of cavity d (ft)	Geomembrane strain ϵ (%)	Geomembrane deflection y (in.)	Geomembrane tension T (lb/in.)	Factor of safety		
				Geomembrane	74 lb/in. seam	65 lb/in. seam
1	4	1.5	14.4	>3.75	>3.11	>2.89
2	8	4.2	20.0	>2.70	>2.24	>2.08
3	12	7.8	25.9	2.70	2.35	2.22
4	18	12.7	30.0	2.34	2.03	1.93
5	26	19.5	34.4	2.07	1.80	1.70
6	35	27.4	39.0	1.79	1.56	1.47

Table 4. Factors of safety for the localized subsidence of the cover system over a 2 ft deep depression.

Diameter of cavity d (ft)	Geomembrane strain ϵ (%)	Geomembrane deflection y (in.)	Geomembrane tension T (lb/in.)	Factor of safety		
				Geomembrane	74 lb/in. seam	65 lb/in. seam
1.0	4	1.5	14.4	>3.75	>3.11	>2.89
2.0	8	4.2	20.0	>2.70	>2.24	>2.08
3.0	12	7.8	25.9	2.70	2.35	2.22
4.0	18	12.7	30.0	2.34	2.03	1.93
5.0	26	19.5	34.4	2.07	1.80	1.70
5.8	32	24.0	38.0	1.85	1.61	1.52
6.0	27	24.0	36.0	1.95	1.70	1.61
7.0	21	24.0	33.0	2.13	1.85	1.75
8.0	16	24.0	30.0	2.34	2.03	1.93
9.0	12	24.0	27.0	2.60	2.26	2.14

Table 5. Material properties used in slope stability analysis.

Interface	Interface friction angle δ (°)	Interface adhesion a (lb/ft ²)
Cover soil / Geocomposite	36.3	12
Cover soil / Geotextile	36.2	0
Geocomposite / Geomembrane (embossed)	23.1	14
Geonet / Geomembrane (smooth)	12.1	6
Geonet / Geotextile	15.4	0
Geomembrane (embossed) / Geotextile	26.4	124
Geomembrane (smooth) / Geotextile	21.4	15

Notes: The measured values of the peak and residual values of the interface friction angle and adhesion were very close and, to be conservative, the smaller value (i.e. generally the residual value) for each of the considered interface was selected and is reported in the above table. The tabulated values are from Appendix 5.

Table 6. Factor of safety as a function of slope height for the case where construction equipment is used on the slope.

Slope height h (ft)	Factor of safety	
	Equipment moving downslope FS_{down}	Equipment moving upslope FS_{up}
3.4	1.12	1.15
10.0	1.16	1.18
20.0	1.19	1.21
60.0	1.24	1.24
∞	1.28	1.28

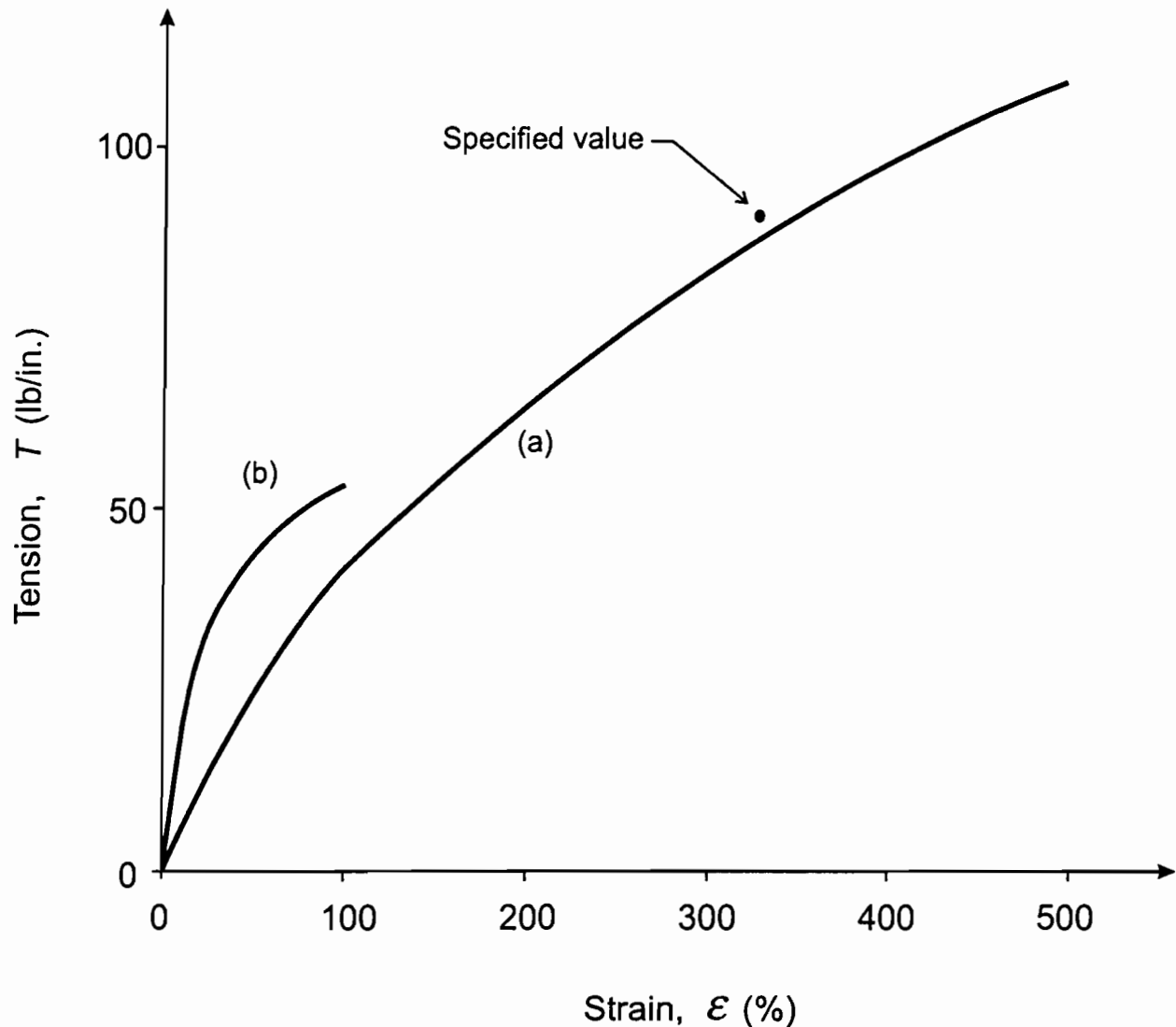


Figure 1. Average tension-strain curves for the smooth PVC geomembrane: (a) tension-strain curve obtained in a uniaxial tensile test; (b) tension-strain curve obtained in a multi-axial tensile test.

Note: The curve for the uniaxial tensile test was obtained from the data regarding the tensile modulus at 100% strain, and the tension and strain at failure which can be found in Appendix 1. The curve for the multi-axial tensile test was obtained by simplifying the stress strain curve for the multi-axial test performed on 22 January 1998 (see Appendix 2) and converting its ordinate from stress to tension. The specified value is a peak tension of at least 92 lb/in. and a strain at break of at least 325%.

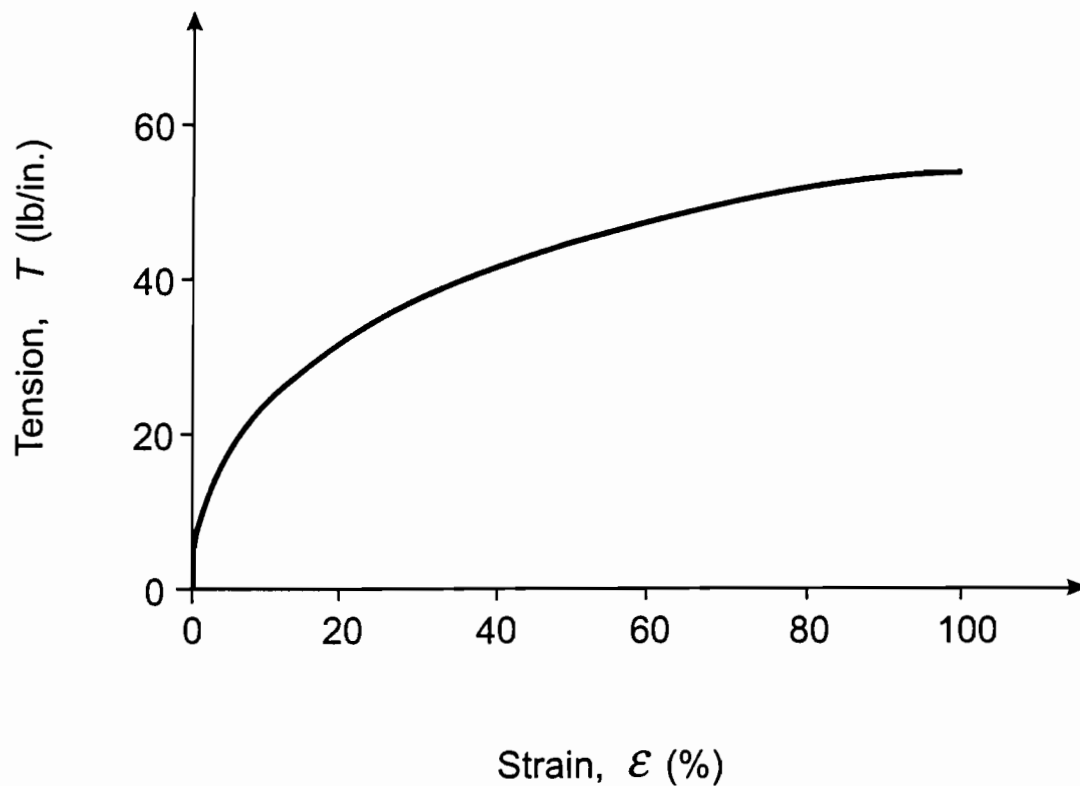


Figure 2. Tension strain curve of the smooth PVC geomembrane obtained in a multi-axial tensile test.

Note: The curve was obtained by simplifying the stress strain curve for the multi-axial test performed on 22 January 1998 (see Appendix 2) and converting its ordinate from stress to tension. This curve is identical to Curve (b) shown in Figure 1, but at a different scale.

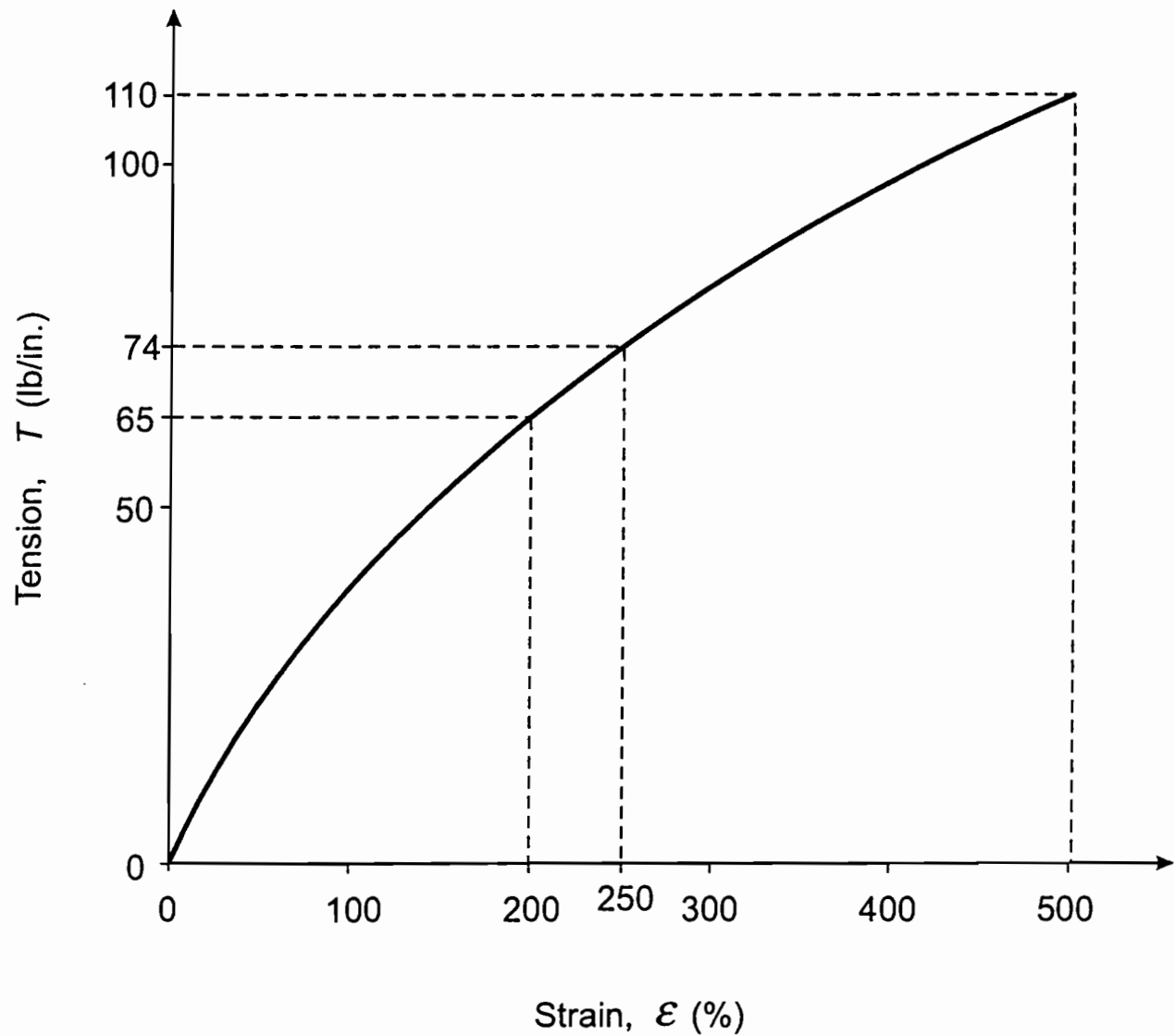


Figure 3. Tension strain curve of the smooth PVC geomembrane obtained in a uniaxial tensile test.

Note: This curve is identical to Curve (a) shown in Figure 1.

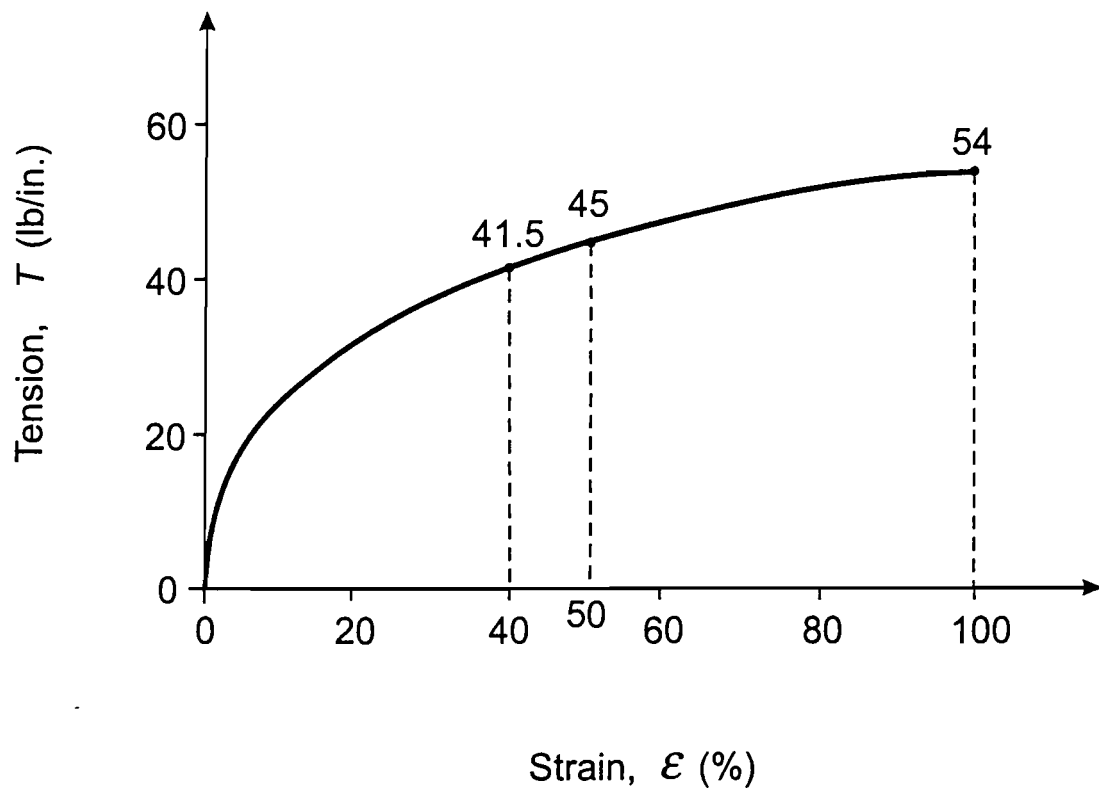


Figure 4. Values of the geomembrane tension that correspond to strains of 50% (corresponding to a seam with a shear strength of 74 lb/in.) and 40% (corresponding to a seam with a shear strength of 65 lb/in.).

Note: The tension-strain curve shown above is identical to the curve shown in Figure 2.

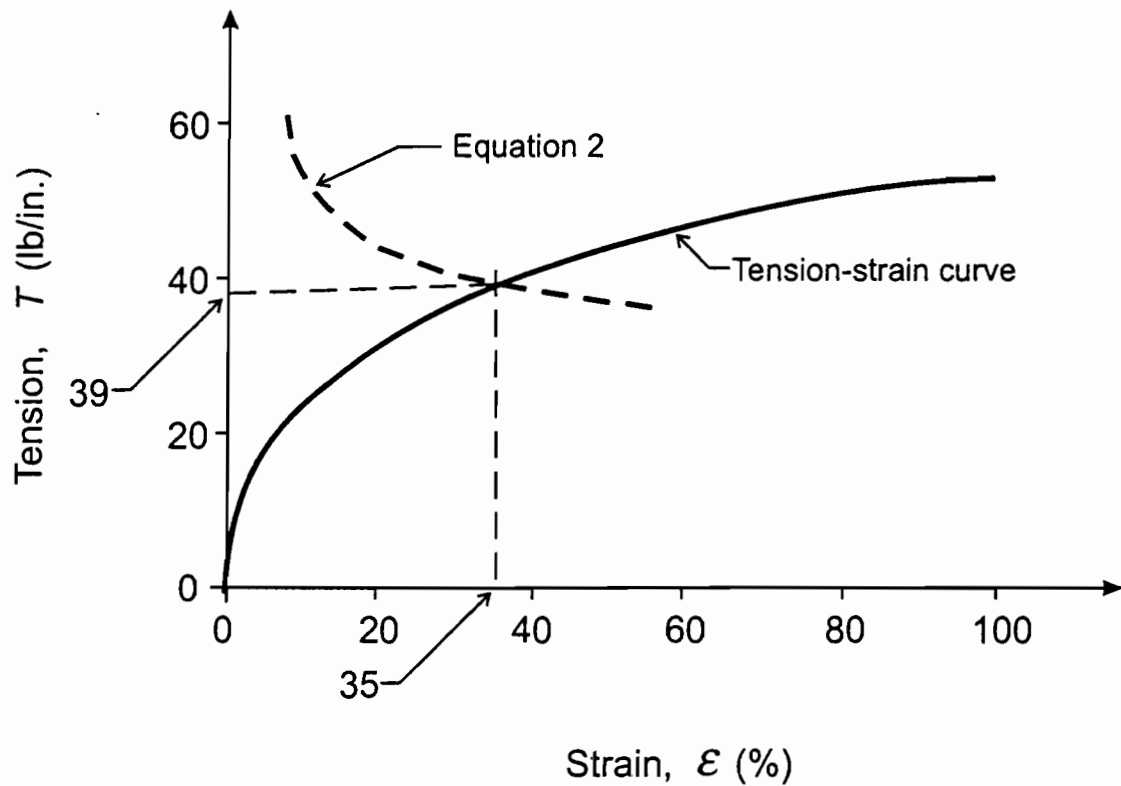


Figure 5. Determination of the geomembrane tension that is on the tension-strain curve and meets the equilibrium conditions.

Note: The tension-strain curve is identical to the curve shown in Figure 2.

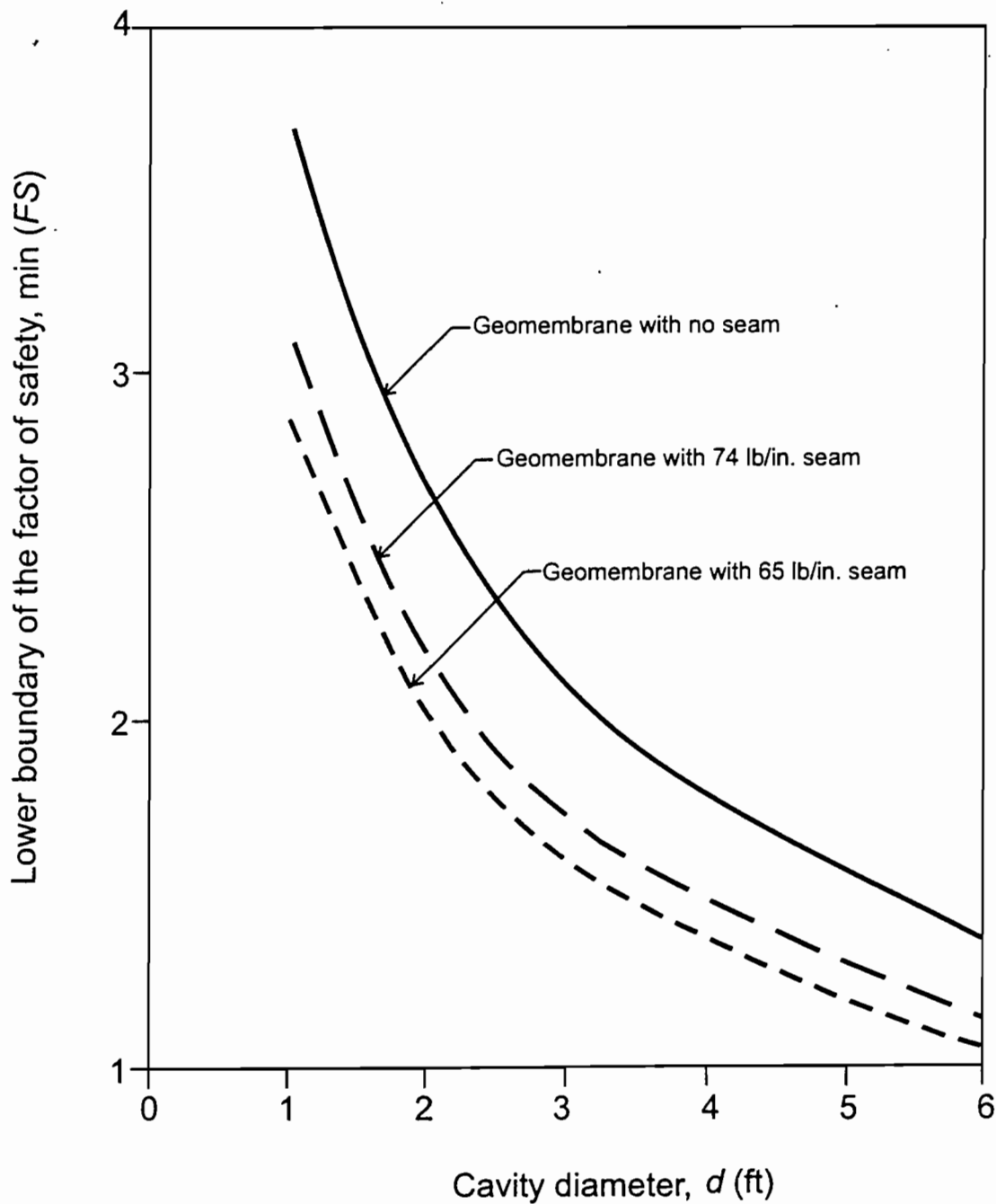


Figure 6. Lower boundary of the factor of safety of the geomembrane bridging a cavity as a function of the cavity diameter.

Note: The values presented graphically above are also presented in Table 1.

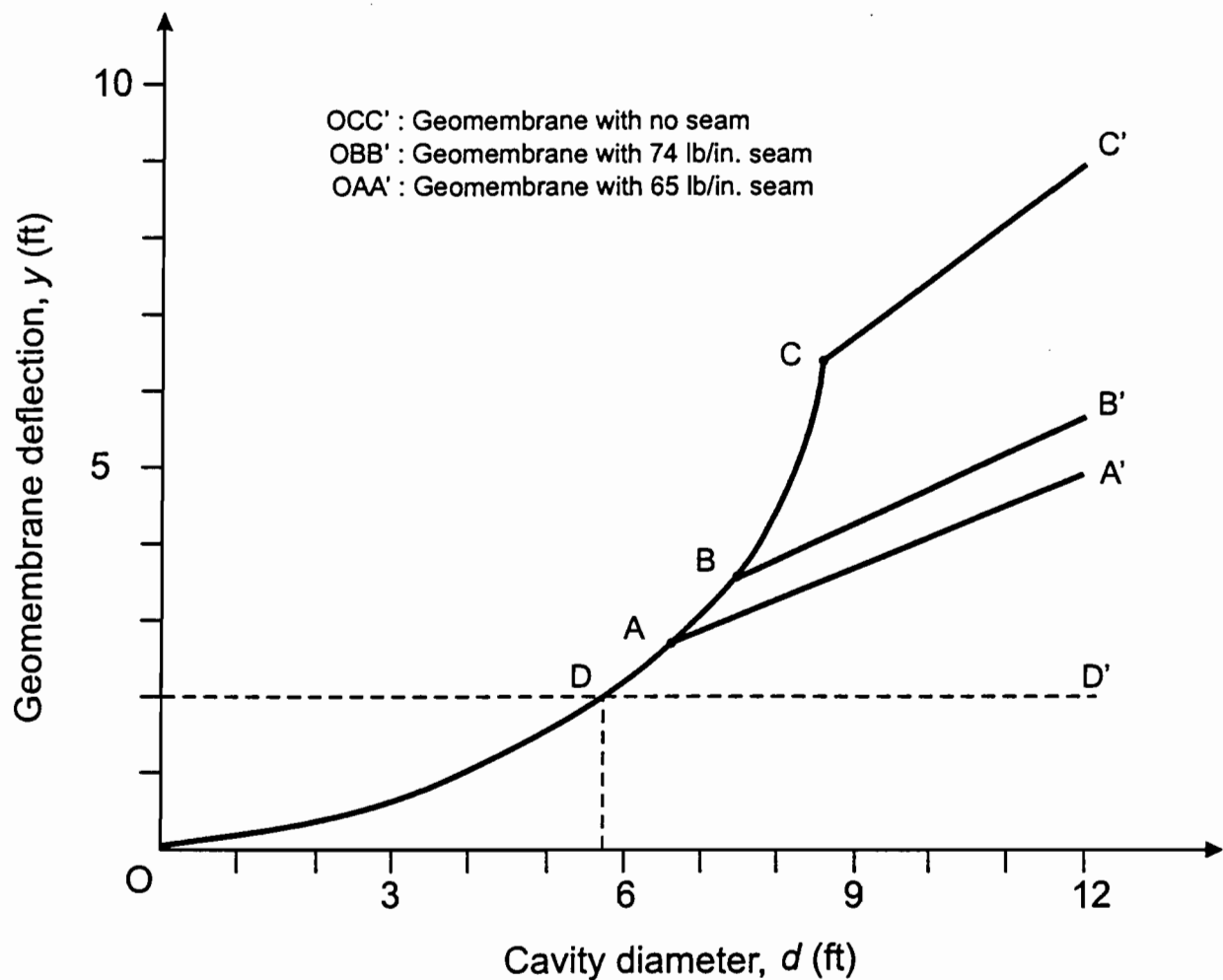


Figure 7. Relationship between geomembrane deflection and cavity diameter in the case where the geomembrane deflection is imposed.

Note: The straight lines AA', BB' and CC' would pass through the origin of the axes if they were extended. The factor of safety is greater than one under the curve for the considered geomembrane, i.e. Curve OCC' for the hypothetical geomembrane without seam, Curve OBB' for the geomembrane with a seam having a shear strength of 74 lb/in., and Curve OAA' for the geomembrane with a seam having a shear strength of 65 lb/in.

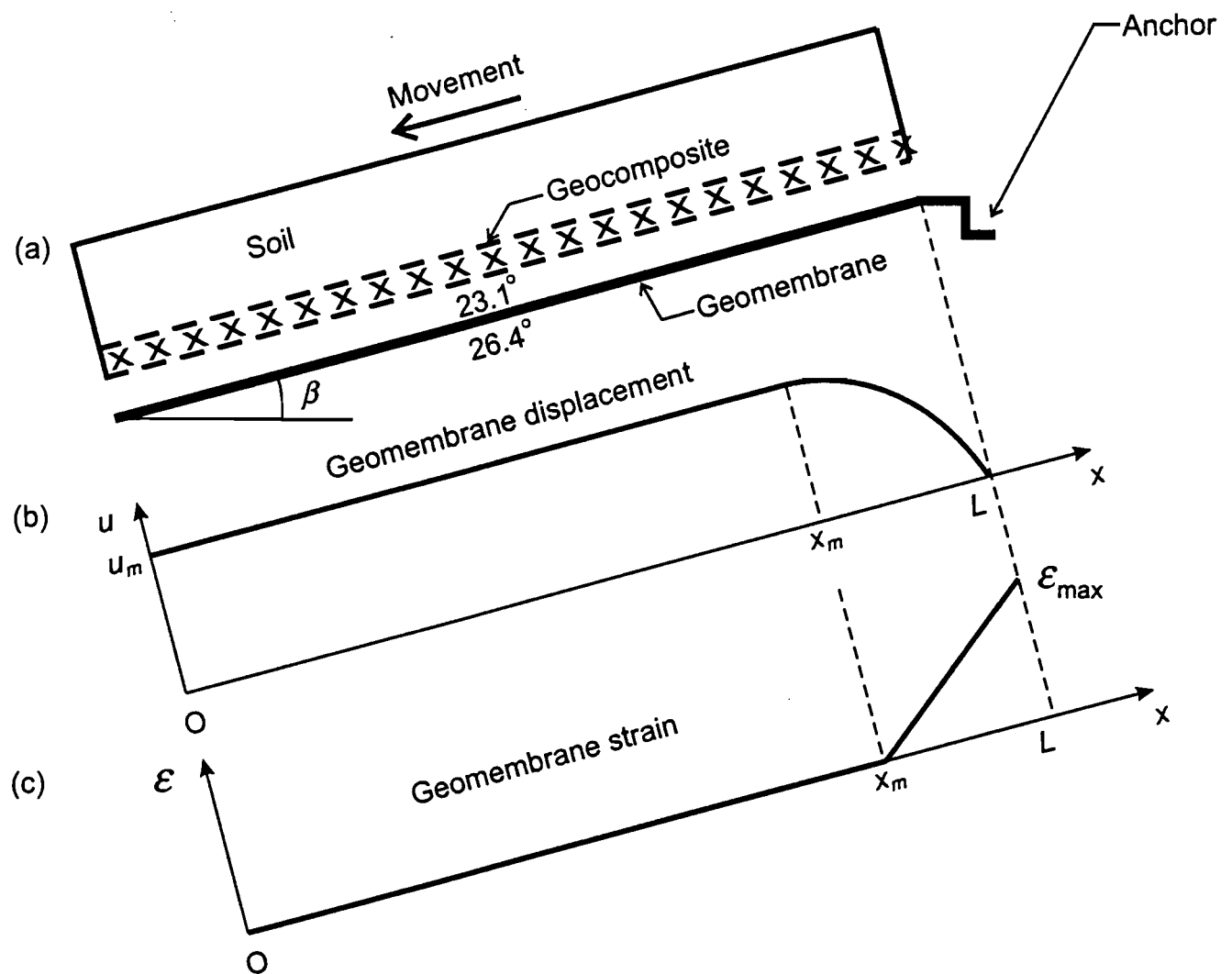


Figure 8. Strain and displacement in geomembrane resulting from displacement required to mobilize interface shear strength: (a) anchored geomembrane in contact with soil layer (including geocomposite) moving with respect to the geomembrane; (b) geomembrane strain; (c) geomembrane displacement.

APPENDIX 1

REVIEW OF DESTRUCTIVE TESTS ON SEAMS



Roy F. Weston of New York, Inc.
130 West 30th Street
New York, New York 10001-4004
212-502-7800 • Fax 212-502-7801

29 April 1999

Mr. John Helmeset, P.E.
Project Manager
Bureau of Construction Services
Division of Environmental Remediation
New York State Department of Environmental Conservation
50 Wolf Road, Room 267
Albany, NY 12233-7010

Sent via Overnight Mail

**Re: Geomembrane destructive testing by NTH – Archive Samples
TRI/Environmental, Inc. letter dated 16 December 1998
Laboratory Services Agreement No. LL-2339-K3
Clarkstown Landfill Remediation
RFW Project No. 03228-018-001-3001**

Dear Mr. Helmeset:

Roy F. Weston of New York, Inc. (WESTON) herewith attaches a letter from TRI/Environmental, Inc. (TRI) dated 16 December 1998, regarding their review of the NTH Consultants, Ltd. (NTH) test results of archived geomembrane samples as presented in a report dated 02 December 1998.

Both the TRI letter and NTH report referenced above are attached here for review and further discussion related to the testing results of the field constructed PVC geomembrane seams at the Clarkstown Landfill.

If you have any questions or comments, please call me at (212) 502-7822.

Very truly yours,

ROY F. WESTON OF NEW YORK, INC.

Neil C. Nowak, P.E.
Project Manager

Attachments

cc: L. Kalarickal – Town of Clarkstown
D. Bauer, T. Leonard, J. Ryan, File – WESTON



New York State Department of Environmental Conservation

Division of Environmental Remediation

Bureau of Construction Services, Room 267

50 Wolf Road, Albany, New York 12233-7010

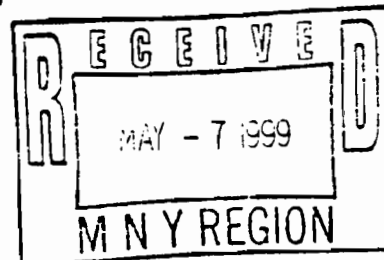
Phone: (518) 457-9280 • FAX: (518) 457-7743

Website: www.dec.state.ny.us



John P. Cahill
Commissioner

MAY 04 1999



Mr. Neil Nowak
Roy F. Weston
130 W. 30th Street
12th Floor
New York, New York 10001

Dear Mr. Nowak:

Re: Site No. 3-44-001
Clarkstown Landfill

Our staff has received and reviewed your letter of April 29, 1999. Enclosed with that letter were the Geosynthetic Material Test Results performed on the archive samples from the geomembrane installed as part of the remedial capping system at the Clarkstown Landfill Inactive Hazardous Waste Disposal Site, State Registry Identification Number 3-44-001. A summary letter and analysis by Mr. Richard Thomas of TRI is also included with this data.

The summary letter provided by Mr. Thomas makes the recommendation that the seams be accepted in place due to the difficulty associated with the excavation and repair of these seams. This recommendation appears to be based upon two conclusions. First, it would be nearly impossible to repair these seams without compromising the long term performance of this cap. Secondly, that even though several of the samples did not meet the standard specified in the contract for shear strength, the data indicates a favorable situation for the long term performance of this cap. Among these favorable conditions are the high peel strengths in all of the samples, the low standard deviations among the samples, the desirability for a high peel strength in caps, the closeness of the shear values to the standard, the basis of the shear value standard as an industrial standard based on seaming technology in contrast to an engineering requirement, and the inverse relationship of shear strength to peel strength for seams made by modern wedge welding equipment for PVC geomembranes.

It is the Department's understanding that this letter reflects Weston's recommendation with respect to the quality of the seams. Although the Department agrees with the merit of the arguments presented, we must request that Roy F. Weston,

Mr. Neil Nowak

Page 2

the engineer, provide a certification that the presented information is representative of Weston's recommendation, the seams are of a sufficient quality to meet the design intent, and these seams will still perform as intended. It is preferable to receive this certification now in order to close out this issue rather than wait for the final certification report to be completed. We will also require the identification of the location of these seams and a narrative of the deviation from the standards and specifications for these seams in the final certification report.

The Department also requests the project be credited with the costs associated with the geomembrane testing performed by M&T. They appear to have failed to perform as required by their contract, as such, their costs and any subsequent costs associated with this failure should not be borne by the State of New York.

As always, please feel free to contact myself or the project manager, Mr. John Helmeset, should you have any questions or wish to discuss this issue further. Both of us may be reached at (518) 457-9285.

Sincerely,

A handwritten signature in cursive script, reading "Robert C. Knizek".

Robert C. Knizek, P.E.
Chief, Eastern Field Services Section
Bureau of Construction Services
Division of Environmental Remediation



December 16, 1998

Mr. Neil Nowak
Roy F. Weston of New York, Inc.
130 West 30th Street
New York, New York 10001

**Re: Review of Destructive Seam Results for
Town of Clarkstown - Clarkstown Sanitary Landfill Capping**

Dear Mr. Nowak,

I have carefully reviewed the results generated by NTH on the archived seams from this project. As you know, 136 samples were tested for both peel strength and shear strength. Of these, 30 samples were found to be below the specified value for shear strength. The required value is 74 ppi with 4 of 5 specimens meeting this requirement. This requirement comes directly from the National Sanitation Standard 54. This standard was developed in the early 1980's and the most recent revision was published in 1993. It was written for landfill bottom liners and has been naturally adopted for caps.

This letter will contain sections discussing the consequences of a repair project, the significance of peel and shear strength over the lifetime of the cap, a detailed analysis of all the sub-standard seams, and my recommendations for future activities concerning this site. To me, the main question here concerns the best solution to ensure that the cap exceeds its intended performance for the lifetime of the site.

CONSEQUENCES OF A SEAM REPAIR PROJECT

It is my opinion that it would be nearly impossible to repair these seams without compromising the long term performance of this cap. This statement is based on several years of experience with installation damage assessment testing. These experiments are designed to determine the damage caused by the installation process. Samples are installed, covered, and then loaded with heavy equipment to simulate the installation process. Invariably, we find that the act of unearthing the samples causes more damage than the installation process itself. We spent nearly one year developing ways to uncover samples with minimal damage. It is not an easy task. Additionally, we know the exact location of our material and the samples are only 1 m² in size. There are many difficulties associated with trying to locate and uncover these seams.

Then, the seams would have to be cut out and repaired. This again would be difficult primarily because of the contamination from the soil cover. The surface of the membrane appears smooth to the naked eye, but it is actually quite rough on a microscopic scale. Therefore, adequate cleaning is nearly impossible. Any residual soil will both compromise the resulting peel strength of the seam and reduce its ultimate service lifetime. One important consideration for PVC seams is their peel strength.



If they can peel relatively easily in the short term, it is likely that they will peel over the long term, if they are loaded in a peel mode with a load approaching their peel strength. After the liner is repaired, the other geosynthetics and the soil cover also need to be repaired. There is a risk in rebuilding a section of the soil cover. A mismatch in soil properties could easily produce preferential flows patterns over the life of the cover. Therefore, I feel strongly that the repair of these seams should be avoided if all the parties can feel comfortable with the long term quality of the project.

SIGNIFICANCE OF PEEL AND SHEAR STRENGTH IN LINERS AND CAPS

The NSF-54 requirements for peel and shear strength of seams are 10 ppi and 74 ppi, respectively, for 40 mil PVC. These values were selected based on available seaming technology and were not engineering requirements. The industry has felt comfortable with the low peel requirement for landfill bottom liners because the seams will naturally be primarily loaded in a shear mode, if there is any load at all. Therefore, the shear strength is more important than the peel strength in bottom liners.

However, this is not true for caps because of differential settlement. It is well known that a landfill mass will settle in an uncontrolled and unpredictable manner. Therefore, it is likely that the installed seams in a cap will be subjected to both peel and shear deformations. This means that the peel strength has increasing importance. If the peel strength were 10 ppi, a load of this kind in a cap could create a situation where the seam would peel apart over time. In this case, the actual shear strength has little impact on the overall performance of the cap because shear values are typically much higher than peel values. It has been a common belief that seams with higher peel strength are preferable, even if the resulting shear strength is reduced. The best performing geomembrane cap will have a reasonable balance between shear strength and peel strength in order to accommodate both kinds of loads caused by settlement.

There is a trade-off between peel strength and shear strength with modern wedge welding equipment for PVC geomembranes. Higher peel strength values are obtained by higher roller pressure causing more plastic to flow. The natural result of higher roller pressure is a thickness reduction at the edge of the seam. This reduced thickness will compromise the shear strength because it is primarily a function of sheet thickness. I believe that this is what occurred in the Clarkstown Cap. The installation company was trying to maximize the peel strength values while keeping the shear strength just above the requirement of the specification. The following analysis will show that even though the shear strength of some of the specimens cut from the 30 samples was below 74 ppi, the seams were of consistent quality and the lower values were a result of reduced thickness. It was also seen that the peel strength values on this project are very high. This is a favorable situation when one considers the long term performance of this cap.

SUB-STANDARD SEAM ANALYSIS

A summary of the 30 seams with low shear strength is shown in Table 1. This provides the average peel strength, the average shear strength, and the number of the 5 specimens that were less than 74 ppi. The standard deviations of the averages are also presented as an indicator of the consistency of the results. Notice the high peel strength values and the small standard deviations for shear.



Table 1. Seams Below Specified Shear Strength

Seam Number	Average Peel Strength (ppi)	Average Shear Strength (ppi)	Number Specimens Below Requirement
DS-41	37.5 ± 3.1	70.5 ± 2.9	5
DS-58	29.4 ± 2.9	75.6 ± 3.7	2
DS-59	37.4 ± 6.8	73.0 ± 2.4	3
DS-105	37.6 ± 4.3	74.5 ± 2.3	2
DS-106	33.0 ± 9.4	74.4 ± 1.9	3
DS-111	22.7 ± 3.0	75.9 ± 5.4	2
DS-114	37.5 ± 5.1	72.7 ± 1.6	4
DS-118	35.2 ± 1.6	74.7 ± 6.6	3
DS-122	43.0 ± 1.9	65.9 ± 2.9	5
DS-124	49.6 ± 3.1	71.7 ± 1.8	5
DS-125	47.9 ± 3.0	72.9 ± 1.7	4
DS-126	43.6 ± 11	72.4 ± 2.0	3
DS-127	42.1 ± 4.4	68.0 ± 5.0	5
DS-128	45.2 ± 3.3	73.8 ± 5.6	4
DS-130	46.7 ± 3.9	74.8 ± 5.2	2
DS-132	43.2 ± 5.0	71.5 ± 6.8	2
DS-133	42.5 ± 9.5	73.0 ± 3.2	3
DS-135	33.5 ± 4.1	70.7 ± 3.0	4
DS-138	40.0 ± 2.5	73.0 ± 4.1	4
DS-139	36.5 ± 4.6	65.3 ± 4.2	5
DS-140	42.7 ± 4.5	68.3 ± 3.7	5
DS-141	37.7 ± 7.5	69.6 ± 5.1	3
DS-142	48.0 ± 2.7	67.1 ± 2.9	5
DS-143	50.8 ± 3.9	71.6 ± 2.0	5
DS-144	43.2 ± 4.5	67.3 ± 0.6	5
DS-146	37.8 ± 6.5	70.1 ± 2.2	5
DS-147	38.0 ± 5.3	71.2 ± 3.7	3
DS-151	43.0 ± 3.0	68.5 ± 4.8	4
DS-152	37.0 ± 6.8	75.4 ± 5.5	2
DS-156	45.7 ± 7.1	71.0 ± 3.6	4



The low standard deviations indicate that these seams are well made and are below the required value because of thickness reduction at the edge of the sheet. If they were poorly made, or if the low values were a result of overheating, one would expect to see high variability between specimens. This is a natural result of an uncontrolled process like poor workmanship or overheating. The consistency of these values is a very good sign.

The average shear strength values can be placed in three categories; those less than 70 ppi, those between 70 and 74 ppi, and those with strengths over 74 ppi. The breakdown is:

<70 ppi	8 samples,
70-74 ppi	15 samples,
>74 ppi	7 samples.

Additionally, of the 8 samples with average strengths less than 70 ppi, all are greater than 65 ppi.

The total of 111 specimens with sub-standard values were also analyzed. The distribution of individual shear strengths is shown in Figure 1. This shows a plot of Number of Specimens vs. Shear Strength.

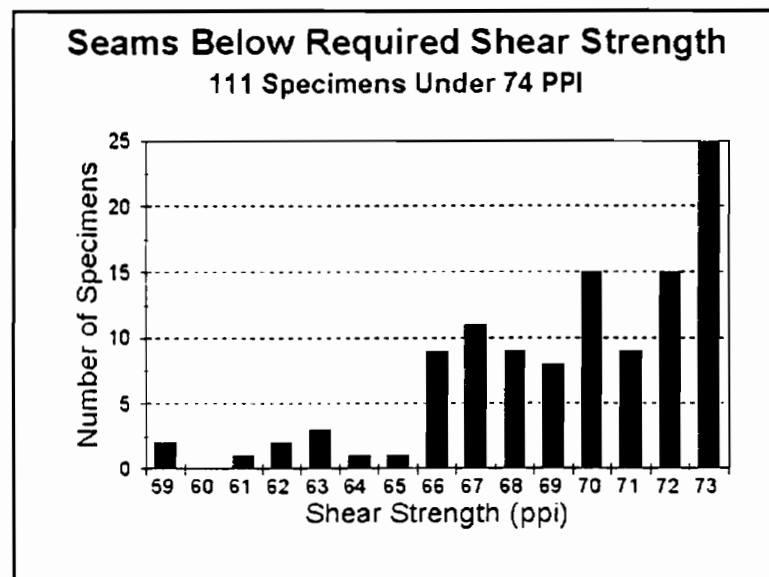


Figure 1. Distribution of Shear Strengths

These data can be summarized by examining the number of specimens as a function of their percentage of the 74 ppi minimum values. The results are in Table 2. This shows that 58% of the sub-standard specimens were within 5% of the standard value, 90% of the specimens were within 10% of the value, and all of the specimens were within 20% of the specified value.

Table 2. Seam Results as a Percentage of the Specified Value

Shear Strength (ppi)	Percentage of Specified Value	Number of Specimens	Percentage of All Specimens
59.2 - 62.9	80 - 85	5	4.5
63.0 - 66.6	85 - 90	5	4.5
67.0 - 70.3	90 - 95	37	33.3
70.4 - 74.0	95 - 100	64	57.7

Another way to consider these results is to back-calculate the thickness of the specimens based on their shear strength. This can be accomplished through the relationship shown in Figure 2.

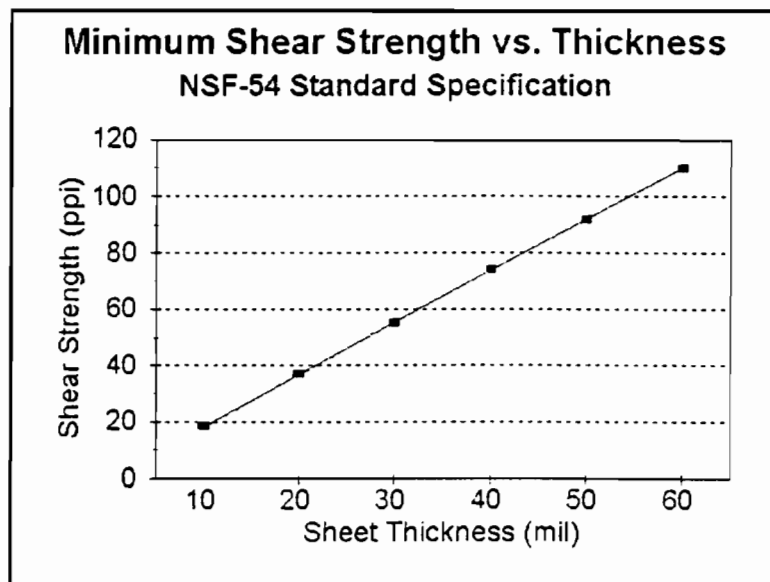


Figure 2. Minimum Shear Strength vs. Thickness

This plot was constructed from the minimum values for bonded shear strength from the NSF standard. This relationship was used to predict the thicknesses of the sub-standard seams. The results from this analysis are shown in Table 3.

This analysis shows that all of the seams are probably at least 32 mils thick and 87% of them are at least 36 mils thick. So, this analysis says that a small percentage of all of the seams made might be as thin as 32 mils.



Table 3. Seam Strengths Presented as Calculated Thicknesses

Calculated Thickness (mils)	Percentage of Minimum Thickness	Number of Specimens	Percentage of All Specimens
32 - 34	80 - 85	5	4.5
34 - 36	85 - 90	9	8.1
36 - 38	90 - 95	34	30.6
38 - 40	95 - 100	63	56.8

There is one more way to examine these results. This exercise involves relaxing the requirement of the specification in small steps and seeing the effect on the number of sub-standard seams. The following examples have been considered:

1. Per the specification - 4 of 5 specimens with 74 ppi shear strength.
2. The average value of the 5 specimens must be 74 ppi.
3. Reducing the requirement based on 38 mil sheet - 4 of 5 meeting 70 ppi.
4. Reducing the requirement based on 36 mil sheet - 4 of 5 meeting 66 ppi.

The resulting numbers of sub-standard seams is shown in Table 4.

Table 4. The Effect of Relaxing the Specification

Shear Strength Requirement	Number of Sub-Standard Samples
4 of 5 meeting 74 ppi	30
Average strength meeting 74 ppi	23
4 of 5 meeting 70 ppi	12
4 of 5 meeting 66 ppi	3

These results show that if we considered the required strength based on 36 mil sheet, all but 3 of the seams meet the requirement. Of the 3 samples remaining, the lowest value remaining after the 4 of 5 criteria is implemented is 64 ppi.

SUMMARY

The analysis of the sub-standard seams indicates that the lower strengths are caused by a thickness reduction at the edge of the seam. Every specimen tested was still about 50% stronger than the average peel strength of 40 ppi. During settlement, if loads on the sheet approach 40 ppi, the seams



will fail through a peeling failure before they fail in shear. This means that the peel strengths are the weak link and even though these seams did not meet the requirements of the specification, the lower values will not impact the performance of the cap. In fact, this is even a better situation than if all the shear strengths were met at the cost of lower peel values. Since peeling is the most likely mode of failure, it is much better to have higher peel values than higher shear values.

RECOMMENDATIONS

I strongly believe that this is a situation where it is better to leave well enough alone. The repair of the sub-standard seams is likely to cause more harm than good in the long term. Especially, since logic suggests that the most likely failure mode would be peeling and not shear fracture. Further, all of these seams have very high peel strength, relative to the required value of 10 ppi.

It may be of interest to estimate the possible loads and deformations that would occur during settlement. This could be done through an engineering analysis of the site. Since peel and shear requirements are not engineering properties, it would be valuable to estimate the magnitudes of deformations that would produce the types of loads needed to initiate failure. Or, one could estimate the loads produced through different settlement scenarios.

Sincerely,

A handwritten signature in dark ink, appearing to read "RWT", written over the typed name.

Richard W. Thomas, M.S.
Vice President and
Technical Director

APPENDIX 2

RESULTS OF UNIAXIAL TENSILE TESTS ON THE GEOMEMBRANE

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX	PRODUCT NUMBER	FR6C075-1 <i>Sample 6/16/96</i>
	ENVIR	TESTING RH/TEMP.	52% 23C		
SPEC.	THICKNESS (MM) WIDTH (IN) 1.026 92"			TEST METHOD REFERED TO	STANDARDS
ROLL #	1				
SPEC. GRAVITY	1.24				
THICKNESS	36.78			ASTM D-1593	40 ± 5%
100 % MOD LB/IN WIDTH	MD	39.63		30.08D-882A	36 MIN
	CD	36.96			36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	93.36		ASTM D-882A	92 MIN
	CD	92.85			92 MIN
ELONGATION RATE %	MD	344.5		ASTM D-882A	325 MIN
	CD	421.5			325 MIN
SHRINKAGE %	MD	-2.77		ASTM D-1204	-5.0 MAX
COLD CRACK	°c	PASS		ASTM D-1790	-29C
TEAR STRENGTH LB	MD	15.63		ASTM D-1004	10.0 MIN
	CD	15.12			10.0 MIN
TECHNICAL DEPEARTMENT OPINION	PASS				
SUPERVISOR	<i>C. L. L.</i>		TESTER	Lejdia	
DATE: 12-17-96					

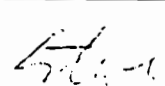
NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCIUX CA-02	PRODUCT CODE	PPIX				PRODUCT NUMBER	FR74189-2 <i>W17826</i>
	ENVIR	TESTING RH/TEMP	52% 23C					
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERED TO	STANDARDS
ROLL #	1		5	10	15	20		
SPEC GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	39.78		41.18	41.47	39.88	40.07	ASTM D- 1595	40±5%
100 % MOD LB/IN WIDTH	MD	38.78	37.12	43.32	37.36	40.61	ASTM D- 8822	16 MIN
	CD	37.45	36.22	37.05	36.85	38.19		16 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	198.6	99.20	103.3	104.2	102.3	ASTM D 8822	92 MIN
	CD	95.85	92.32	99.21	100.0	98.36		92 MIN
ELONGATION RATE %	MD	437.5	411.6	404.4	473.5	456.6	ASTM D- 8822	150 MIN
	CD	518.5	498.5	483.6	517.0	505.6		150 MIN
SHRINKAGE %	MD	-2.07	-2.15	2.43	-2.00	-2.08	ASTM D- 1234	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1797	-29°C
TEAR STRENGTH LB	MD	17.36	17.45	17.85	17.53	18.15	ASTM D 1034	10.0 MIN
	CD	17.22	17.17	17.05	17.11	17.04		10.0 MIN
VOLATILE LOSS %	-0.61		-0.44	-0.39	-0.40	-0.47	ASTM D1234-A	-0.5 MAX
WATER EXTRACTION %	0.12		0.22	0.30	0.27	-0.31	ASTM D- 1081-A	0.15 MAX
HYDROSTATIC RESISTANCE LB/IN	PASS		PASS	PASS	PASS		ASTM D- 751A	87 MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS		ASTM D 3013A	PERMANENTLY 2.5% MAX. IN AREA 1.5% MAX. IN CONCENTRATIONS
	CD	PASS	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	<i>561-4</i>				TESTER		DATE	
DATE 04 29 97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR74189-2
	ENVIR	TESTING RH/TEMP.	52± 23C					W17B21
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERED TO	STANDARDS
ROLL #	25		30	35	40	45		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	39.70		40.00	39.17	39.99	40.47	ASTM D-1593	40±5%
100 % MOD LB/IN WIDTH	MD	40.61	41.36	38.25	36.56	39.84	ASTM D-882A	36 MIN
	CD	38.11	38.05	36.26	36.45	39.55		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	100.1	98.90	101.4	104.5	105.5	ASTM D-882A	92 MIN
	CD	95.61	96.62	95.25	95.10	97.36		92 MIN
ELONGATION RATE %	MD	460.3	445.5	485.2	491.3	414.4	ASTM D-882A	350 MIN
	CD	511.2	507.6	510.6	506.6	476.6		350 MIN
SHRINKAGE %	MD	-2.11	-2.10	-2.22	-2.14	-2.05	ASTM D-1204	-5.0 MAX
COLD CRACK	°C	PASS	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C
TEAR STRENGTH LB	MD	16.63	17.45	17.63	17.45	17.96	ASTM D-1004	10.0 MIN
	CD	17.11	17.07	17.14	17.22	17.07		10.0 MIN
VOLATILE LOSS %	-0.33		-0.41	-0.48	-0.42	-0.39	ASTM D1203-A	-0.5 MAX
WATER EXTRACTION %	-0.18		-0.22	-0.23	0.26	-0.21	ASTM D-3083-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	pass	ASTM D-751A	82 MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS		ASTM D-3083A	DECREASE IN STRENGTH IN BURIAL TEST INCREASE IN STRENGTH IN BURIAL TEST
	CD	PASS	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OP. SIGN	PASS							
SUPERVISOR					TESTER		Location	
DATE: 1-18-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA 92	PRODUCT CODE	PPTX				PRODUCT NUMBER	PK 4189-2 <i>W17B26</i>
	ENVIR	TESTING RH/TEMP.	52% 24C					
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 9.2"				TEST METHOD REFERRED TO	STANDARDS
KOLL 2	50		55	60	65	70		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	40.15		40.51	40.27	40.63	40.61	ASTM D- 1593	40.51
100 Y MOD LB/IN WIDTH	MD	37.36	45.52	51.06	50.75	51.22	ASTM D- 882A	36 MIN
	CD	36.41	44.53	49.25	50.05	51.06		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	102.2	114.5	112.2	116.5	115.6	ASTM D- 882A	92 MIN
	CD	97.80	111.0	112.5	112.6	111.0		92 MIN
ELONGATION RATE %	MD	466.5	478.6	459.6	456.6	476.6	ASTM D- 882A	350 MIN
	CD	420.5	482.2	445.6	488.5	479.4		350 MIN
SINKAGE %	MD	-2.85	2.49	-2.58	-2.22	-2.17	ASTM D- 1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1204	-29°C
TEAR STRENGTH LB	MD	17.63	18.25	18.05	17.96	18.12	ASTM D- 1004	10.0 MIN
	CD	17.00	17.17	17.33	17.25	17.31		10.0 MIN
VOLATILE LOSS %	-0.47		0.44	0.19	-0.16	-0.40	ASTM D1203 A	-0.5 MAX
WATER EXTRACTION %	-0.22		0.26	-0.10	0.33	-0.11	ASTM D- 3083 A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ IN	PASS		PASS	PASS	PASS	PASS	ASTM D- 2761A	82 MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D- 1083A	+ SWELLING FACTOR 2% MAXIMUM AT EPL77 + REDUCE ALL 100% CONTRASTION
	CD	PASS	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	<i>[Signature]</i>				TESTER		DATE	
DATE: 04-24-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA 02	PRODUCT CODE	PPTX				PRODUCT NUMBER	PR74189 2
	ENVIR	TESTING RH/TEMP	121 230					6/17/96
SPEC.	THICKNESS (MM) 2.026		WIDTH (IN) 9.0"				TEST METHOD REFERRED TO	STANDARDS
ROLL #	75		80	85	90	95		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	39.63		39.96	39.36	39.45	40.00	ASTM D-1593	40±5%
100 % MOD LB/IN WIDTH	MD	42.36	51.52	46.79	47.45	50.12	ASTM D-882A	16 MIN
	CD	40.16	45.05	45.78	43.78	44.63		16 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	115.5	116.6	112.7	105.5	112.3	ASTM D-882A	92 MIN
	CD	104.5	100.6	100.3	102.1	105.3		92 MIN
ELONGATION RATE %	MD	117.5	155.5	117.6	458.6	460.6	ASTM D-882A	350 MIN
	CD	450.5	680.5	467.7	477.6	480.3		350 MIN
SHRINKAGE %	MD	2.64	2.78	-2.54	-2.55	-2.63	ASTM D-1704	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D-1700	25°C
TEAR STRENGTH LB	MD	17.58	17.12	17.05	17.05	17.12	ASTM D-1004	10.0 MIN
	CD	17.05	16.99	16.98	17.01	17.08		10.0 MIN
VOLATILE LOSS %	-0.11		-0.48	0.38	0.44	-0.41	ASTM D1203-A	-0.5 MAX
WATER EXTRACTION %	-0.12		0.14	-0.16	-0.22	-0.21	ASTM D-1083-A	0.35 MAX
HYDROSTATIC RESISTANCE LB/50 IN.	PASS		PASS	PASS	PASS	PASS	ASTM D-1512	82 MIN
SOIL BURIAL & CHANGE MAX IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D-1081A	1. HEAVING FACTOR
	CD	PASS	PASS	PASS	PASS	PASS		1. PENETRATION AT
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	<i>[Signature]</i>				TESTER		Lentia	
DATE 04-04-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEMEX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR74189 2 <i>W17B26</i>
	ENVIR	TESTING PH/TEMP	52A 23C					
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERRED TO	STANDARDS
ROLL #	100		105	110	115	120		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	40.36		39.36	40.12	40.05	40.50	ASTM D 1523	40.15
100 % MOD LB/IN WIDTH	MD	41.12	40.63	42.12	40.61	39.63	ASTM D- 882A	36 MIN
	CD	38.61	36.61	40.00	38.61	39.11		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	105.5	100.3	99.63	98.52	101.1	ASTM D- 882A	92 MIN
	CD	100.3	98.61	97.52	98.12	98.33		92 MIN
ELONGATION RATIO %	MD	433.3	425.6	430.3	441.3	458.3	ASTM D- 882A	350 MIN
	CD	442.3	352.3	469.3	477.6	474.1		350 MIN
SHRINKAGE %	MD	-3.50	-2.52	-2.88	-2.96	-3.12	ASTM D- 1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1790	-25°C
TEAR STRENGTH LB	MD	17.82	17.66	17.78	17.25	17.36	ASTM D- 1004	10.0 MIN
	CD	17.22	17.05	17.12	17.04	17.11		10.0 MIN
VOLATILE LOSS %	0.47		0.33	0.40	0.42	0.46	ASTM D1203-A	0.5 MAX
WATER EXTRACTION %	0.11		0.14	0.25	0.10	0.33	ASTM D- 3081-A	0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	PASS	ASTM D- 751A	82 MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D 3083A	1.0 INCHES 2.0 INCHES 3.0 INCHES 4.0 INCHES 5.0 INCHES 6.0 INCHES 7.0 INCHES 8.0 INCHES 9.0 INCHES 10.0 INCHES 11.0 INCHES 12.0 INCHES 13.0 INCHES 14.0 INCHES 15.0 INCHES 16.0 INCHES 17.0 INCHES 18.0 INCHES 19.0 INCHES 20.0 INCHES 21.0 INCHES 22.0 INCHES 23.0 INCHES 24.0 INCHES 25.0 INCHES 26.0 INCHES 27.0 INCHES 28.0 INCHES 29.0 INCHES 30.0 INCHES 31.0 INCHES 32.0 INCHES 33.0 INCHES 34.0 INCHES 35.0 INCHES 36.0 INCHES 37.0 INCHES 38.0 INCHES 39.0 INCHES 40.0 INCHES 41.0 INCHES 42.0 INCHES 43.0 INCHES 44.0 INCHES 45.0 INCHES 46.0 INCHES 47.0 INCHES 48.0 INCHES 49.0 INCHES 50.0 INCHES 51.0 INCHES 52.0 INCHES 53.0 INCHES 54.0 INCHES 55.0 INCHES 56.0 INCHES 57.0 INCHES 58.0 INCHES 59.0 INCHES 60.0 INCHES 61.0 INCHES 62.0 INCHES 63.0 INCHES 64.0 INCHES 65.0 INCHES 66.0 INCHES 67.0 INCHES 68.0 INCHES 69.0 INCHES 70.0 INCHES 71.0 INCHES 72.0 INCHES 73.0 INCHES 74.0 INCHES 75.0 INCHES 76.0 INCHES 77.0 INCHES 78.0 INCHES 79.0 INCHES 80.0 INCHES 81.0 INCHES 82.0 INCHES 83.0 INCHES 84.0 INCHES 85.0 INCHES 86.0 INCHES 87.0 INCHES 88.0 INCHES 89.0 INCHES 90.0 INCHES 91.0 INCHES 92.0 INCHES 93.0 INCHES 94.0 INCHES 95.0 INCHES 96.0 INCHES 97.0 INCHES 98.0 INCHES 99.0 INCHES 100.0 INCHES
	CD	PASS	PASS	PASS	PASS	PASS		
TECHNICAL DEVELOPMENT OPINION	PASS							
SUPERVISOR	<i>Lyne</i>				TESTER		1-1-1-1	
DATE: 04-29-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEMEX CA-07	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR74189-2 <i>W17B26</i>	
	ENVIR	TESTING RH/TEMP.	523 230						
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERED 10	STANDARDS	
ROLL #	125		130	135	140	145			
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24			
THICKNESS	38.70		40.16	40.26	40.36	40.33	ASTM D- 1593	40±5%	
100 & MOD LB/IN WIDTH	MD	39.05	40.74	38.44	41.78	40.33	ASTM D- 882A	36	MTN
	CD	36.15	36.25	37.52	38.21	38.12		36	MTN
TENSILE STRENGTH LB/IN WIDTH	MD	192.1	195.5	194.5	196.2	198.6	ASTM D- 882A	92	MTN
	CD	190.1	97.63	94.63	100.0	101.2		92	MTN
ELONGATION RATE %	MD	165.5	437.5	422.1	457.6	460.6	ASTM D- 882A	350	MTN
	CD	527.5	156.6	180.6	475.6	440.6		350	MTN
SHRINKAGE %	MD	-2.85	-2.47	-2.33	-2.21	-3.08	ASTM D- 1204	-5.0	MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1790	-22°C	
TEAR STRENGTH LB	MD	18.63	18.63	18.45	18.33	18.76	ASTM D- 1004	10.0	MTN
	CD	17.66	17.78	17.45	17.21	17.08		10.0	MTN
VOLATILE LOSS %	-0.12		-0.45	-0.44	-0.41	-0.13	ASTM D- 1204 A	-0.5	MAX
WATER EXTRACTION %	-0.12		-0.16	-0.17	-0.15	-0.11	ASTM D- 3083 A	-0.15	MAX
HYDROSTATIC RESISTANCE LB/SQ IN.	PASS		PASS	PASS	PASS	PASS	ASTM D- 751A	80	MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D- 3083A	1. MAX. CHANGE FACTOR 2. ELONGATION OF STRETCH 3. MAX. LOSS OF ELONGATION	
	CD	PASS	PASS	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OFFICE	PASS								
SUPERVISOR	<i>Stier</i>				10/1/97				
DATE: 09/29/97									

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR74189-2 <i>W17B26</i>
	ENVIR	TESTING RH/TEMP.	52% 23C					
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERRED TO	STANDARDS
ROLL #	150		155	160	165	170		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	38.84		40.34	39.40	41.11	40.63	ASTM D- 1505	40±5%
100 % MOD TAP/IN WIDTH	MD	40.88	42.41	38.60	48.33	49.12	ASTM D- 882A	36 MIN
	CD	37.54	41.45	36.52	36.83	37.99		36 MIN
TENSILE STRENGTH 141/IN WIDTH	MD	104.5	108.1	106.6	112.1	111.3	ASTM D- 882A	92 MIN
	CD	95.33	102.2	96.63	98.78	99.12		92 MIN
ELONGATION RATE %	MD	461.5	447.5	392.5	431.6	400.7	ASTM D- 882A	150 MIN
	CD	464.5	499.5	464.5	456.6	466.1		150 MIN
SHRINKAGE %	MD	-2.78	-2.47	-2.96	-2.61	-3.00	ASTM D- 1204	-4.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1790	-29°C
TEAR STRENGTH LB	MD	18.12	17.25	18.45	18.63	18.48	ASTM D- 1004	10.0 MIN
	CD	17.44	17.08	17.11	17.27	17.01		10.0 MIN
VOLATILE LOSS %	0.33		-0.41	-0.46	-0.45	-0.40	ASTM D1201 A	-0.5 MAX
WATER EXTRACTION %	-0.18		-0.16	-0.20	-0.22	-0.19	ASTM D 3043-A	0.35 MAX
HYDROSTATIC RESISTANCE LB/50 IN.	PASS		PASS	PASS	PASS	PASS	ASTM D 751A	82 MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PAS	ASTM D 3083A	1. UNCLARIN FACTOR 2. ELONGATION AT BREAK 3. MODULUS AT 100% ELONGATION
	CD	PASS	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	<i>Steve</i>			TESTER				
DATE 12-24-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA 02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR/4189 2 <i>W17026</i>
	ENVIR	TESTING RH/TEMP.	514 23C					
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERED TO	STANDARDS
ROLL #	175		180	185	190	195		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	40.46		40.44	40.22	40.12	40.04	ASTM D- 1597	40±5%
100% MOD LR/IN WIDTH	MD	40.25	38.63	41.50	42.53	41.10	ASTM D- 882A	14 MIN
	CD	39.44	36.18	36.96	37.45	38.00		36 MIN
TENSILE STRENGTH LR/IN WIDTH	MD	107.5	105.5	101.2	106.6	105.5	ASTM D- 882A	92 MIN
	CD	96.63	99.12	100.0	105.6	100.1		92 MIN
ELONGATION RATE %	MD	365.6	496.6	485.6	514.6	488.6	ASTM D- 882A	350 MIN
	CD	475.5	508.6	511.2	548.6	425.6		350 MIN
SHRINKAGE %	MD	-3.00	3.25	3.08	-2.88	-3.13	ASTM D- 1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1750	-23°C
TEAR STRENGTH LB	MD	17.85	17.53	17.45	18.00	17.69	ASTM D- 1004	10.0 MIN
	CD	17.22	16.95	16.88	15.78	16.71		10.0 MIN
VOLATILE LOSS %	-0.11		0.42	0.45	-0.43	-0.41	ASTM D1703-A	0.5 MAX
WATER EXTRACTION %	-0.11		-0.18	-0.22	-0.21	-0.24	ASTM D- 3083-A	0.15 MAX
HYDROSTATIC RESISTANCE LR/SQ IN	PASS		PASS	PASS	PASS	PASS	ASTM D- 751A	82 MIN
SOIL BURIAL & CHANGE MAX IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D- 3083A	1. DEFORMATION FACTOR 2. DEFORMATION AT BREAK 3. BURIAL AT 100% DEFORMATION
	CD	PASS	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	<i>Steve</i>			TESTER		10/1/97		
DATE 04-29-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR74189-2 <i>W/7B26</i>
	ENVIR	TESTING RM/TEMP.	521 23C					
SPFC	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERRED TO	STANDARDS
ROLL #	200		205	210	215	220		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	39.45		40.00	39.63	39.45	40.53	ASTM D-1593	40±5%
100% MOD LB/IN WIDTH	MD	43.13	44.16	42.92	43.95	44.12	ASTM D-882A	16 MIN
	CD	16.63	38.12	37.45	36.63	37.45		16 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	101.6	105.5	105.2	100.6	105.6	ASTM D-882A	92 MIN
	CD	95.52	97.63	96.63	99.12	94.63		92 MIN
ELONGATION RATE %	MD	455.6	477.5	485.5	480.6	478.6	ASTM D-882A	350 MIN
	CD	455.6	510.6	505.2	499.6	480.6		350 MIN
SHRINKAGE %	MD	-2.85	-2.74	-2.58	-2.99	-3.01	ASTM D-1294	-5.0 MAX
COLD CRACK	CD	PASS	PASS	PASS	PASS	PASS	ASTM D-1796	-24°C
TEAR STRENGTH LB	MD	18.00	17.60	17.90	17.45	17.22	ASTM D-1004	10.0 MIN
CD	17.05	17.08	17.25	17.12	17.01	10.0 MIN		
VOLATILE LOSS %	0.44		-0.41	-0.43	-0.39	0.36	ASTM D1723 A	0.5 MAX
WATER EXTRACTION %	-0.22		-0.25	0.21	0.21	-0.10	ASTM D-1043-A	0.35 MAX
HYDROSTATIC RESISTANCE HR/50 LB	PASS		PASS	PASS	PASS	PASS	ASTM D-2512	82 MIN
ROTD BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D-3043A	1.0% MINIMUM 2.0% MAXIMUM AT 100°C 1.0% MINIMUM 2.0% MAXIMUM
	CD	PASS	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS							
APPROVED	<i>Steve</i>				TESTED		DATE	
DATE 04 29 97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FK74189-2 W17B26
	ENVIR	TESTING RH/TEMP.	524 23C					
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERED TO	STANDARDS
ROLL #	225		230	235	240	245		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	39.96		39.78	39.45	39.22	39.78	ASTM D- 1593	40±5%
100 % MOD LB./IN WIDTH	MD	39.63	39.52	36.52	38.05	39.63	ASTM D- 882A	36 MIN
	CD	36.63	36.12	36.44	36.85	36.05		36 MIN
TENSILE STRENGTH LB./IN WIDTH	MD	100.8	98.05	100.3	95.63	96.78	ASTM D- 882A	92 MIN
	CD	99.63	93.63	94.52	94.63	93.93		92 MIN
ELONGATION RATE %	MD	466.5	500.5	422.5	422.5	436.3	ASTM D 882A	350 MIN
	CD	508.5	525.5	516.6	577.6	406.6		350 MIN
SHRINKAGE %	MD	-2.22	-2.63	-2.78	-2.45	-3.13	ASTM D- 1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1790	-29°C
TEAR STRENGTH LB	MD	18.12	18.36	18.25	19.00	18.36	ASTM D- 1004	10.0 MIN
	CD	17.33	17.45	17.63	17.77	17.28		10.0 MIN
VOLATILE LOSS %	-0.44		-0.40	-0.42	-0.46	-0.44	ASTM D1703-A	-0.5 MAX
WATER EXTRACTION %	-0.18		0.22	-0.19	-0.20	0.26	ASTM D- 1081-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	PASS	ASTM D- 751A	82 MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D 3033A	1. BREAKING FACTOR 2. CHANGE IN AT RIZAK 3. CHANGE IN TENS ELONGATION
	CD	PASS	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	Steve				TESTER		Leydia	
DATE ON 05-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR74109-2 <i>1017826</i>
	ENVIR	TESTING RH/TEMP.	52% 23C					
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERRED TO	STANDARDS
ROLL #	250		255	260	265	270		
SPEC. GRAVITY	1.24		1.24	1.24	1.24	1.24		
THICKNESS	39.89		40.01	40.66	39.54	40.00	ASTM D 1541	40+5%
100 % MOD LB/IN WIDTH	MD	39.70	38.63	39.63	40.00	40.12	ASTM D- 882A	36 MIN
	CD	38.63	37.52	36.96	37.45	38.00		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	108.5	108.6	105.5	102.3	100.8	ASTM D- 882A	92 MIN
	CD	100.3	103.1	99.63	98.63	97.52		92 MIN
ELONGATION RATE %	MD	536.5	505.5	511.2	525.5	513.3	ASTM D- 882A	150 MIN
	CD	551.5	536.5	534.3	540.6	533.3		150 MIN
SHRINKAGE %	MD	-2.25	-2.10	-2.77	-2.63	2.45	ASTM D- 1204	5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	PASS	ASTM D- 1790	29°C
TEAR STRENGTH LB	MD	18.33	18.78	18.69	18.45	18.22	ASTM D- 1004	10.0 MIN
	CD	17.36	17.63	17.78	17.25	17.18		10.0 MIN
VOLATILE LOSS %	-0.42		-0.46	-0.44	-0.40	-0.41	ASTM D1703-A	-0.5 MAX
WATER EXTRACTION %	-0.18		-0.10	-0.22	-0.25	0.26	ASTM D- 3083-A	0.35 MAX
HYDROSTATIC RESISTANCE LB/SC. IN.	PASS		PASS	PASS	PASS	PASS	ASTM D- 751A	82 MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D 3083A	1. REFRACTING INDEX 2. ELONGATION AT BREAK 3. TENSILE AT 200% ELONGATION
	CD	PASS	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	<i>Stur</i>				TESTED		DATE	
DATE 04 29 97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHELUX CA-02	PRODUCT CODE	PPTX	PRODUCT NUMBER	FR74189-2 6117826
	ENVIR.	TESTING RM/TEMP.	52% 23C		
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"	TEST METHOD REFERED TO	STANDARDS
ROLL #	275				
SPEC. GRAVITY	1.24				
THICKNESS	40.45			ASTM D- 1593	40±5%
100 % MOD LB/IN WIDTH	MD	38.83		ASTM D- 882A	35 MIN
	CD	37.63			35 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	108.6		ASTM D- 832A	92 MIN
	CD	101.2			92 MIN
ELONGATION RATE %	MD	511.3		ASTM D- 832A	350 MIN
	CD	555.1			350 MIN
SHRINKAGE %	MD	-2.52		ASTM D- 1214	-5.0 MAX
COLD CRACK	%	PASS		ASTM D- 1790	-29°C
TEAR STRENGTH LB	MD	18.45		ASTM D- 1001	10.0 MIN
	CD	17.74			10.0 MIN
WATER ABSORPTION %	-0.41			ASTM D- 1113 A	-0.1 MAX
WATER PERMEATION %	-0.11			ASTM D- 1113 A	-0.35 MAX
HYDROSTATIC PRESSURE LB/IN ²	PASS			ASTM D- 1511	80 MIN
COIL ROLLING CHANGE MIN IN ORIGINAL UNIT	MD	34.7		ASTM D- 1132A	1.0 ± 0.2
	CD	34.7			1.0 ± 0.2
COIL ROLLING CHANGE MIN IN ORIGINAL UNIT	PASS				
6/10/80					

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1 <i>617627</i>
	ENVIR	TESTING RH/TEMP.	524 23C				
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERRED TO	STANDARDS
ROLL #	1		5	10	15		
SPEC. GRAVITY	1.24		1.24	1.24	1.24		
THICKNESS	40.05		41.14	40.26	40.05	ASTM D- 1591	40.51
100 % MOD LB/IN WIDTH	MD	42.08	41.78	44.64	45.20	ASTM D- 882A	15 MIN
	CD	40.03	39.98	40.26	43.52		16 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	115.2	119.1	115.5	113.3	ASTM D- 882A	92 MIN
	CD	114.6	109.6	115.0	112.4		92 MIN
ELONGATION RATE %	MD	511.8	500.6	500.2	471.6	ASTM D- 882A	350 MIN
	CD	571.8	539.5	546.6	489.6		350 MIN
SHRINKAGE %	MD	-2.66	-2.74	-2.33	-2.21	ASTM D- 1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	ASTM D- 1790	-29°C
TEAR STRENGTH LB	MD	18.00	18.63	18.25	18.38	ASTM D- 1001	10.0 MIN
	CD	17.52	17.58	17.21	17.65		10.0 MIN
VOATILE LOSS %	-0.42		0.46	-0.42	-0.44	ASTM D1203-A	-0.5 MAX
WATER EXTRACTION %	-0.25		-0.23	-0.25	-0.30	ASTM D- 3081-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ IN.	PASS		PASS	PASS	PASS	ASTM D 751A	82 MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D- 3081A	SEPARATING FACTOR 2 FIRMATION AT 9424P 1 MIN HOLD AT 1204 EQUILIBRIUM
	CD	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS						
SUPERVISOR	<i>[Signature]</i>			TESTER		DATE	

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NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA 92	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1
	ENVIR	TESTING RM/TEMP.	524 23C				617827
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERRED TO	STANDARDS
ROLL #	20	25	30	35			
SPEC GRAVITY	1.24	1.24	1.24	1.24			
THICKNESS	40.10	40.13	39.56	39.79	ASTM D-1553	40±5%	
100 % MOD LB/IN WIDTH	MD	42.78	46.66	42.21	41.38	ASTM D-882A	36 MIN
	CD	42.18	40.25	41.29	38.63		35 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	118.2	119.6	113.0	116.2	ASTM D-882A	92 MIN
	CD	106.6	109.6	112.0	106.6		92 MIN
ELONGATION RATE %	MD	489.6	525.8	498.8	517.6	ASTM D-882A	350 MIN
	CD	505.5	534.0	529.7	526.6		350 MIN
SIBRINKAGE %	MD	-2.45	-2.28	2.77	-2.36	ASTM D-1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C
TEAR STRENGTH LB	MD	18.11	18.25	18.45	18.78	ASTM D-1004	10.0 MIN
	CD	17.28	17.45	17.69	17.22		10.0 MIN
VOATILE LOSS %	-0.45	-0.42	-0.39	-0.40	ASTM D1203-1	-0.5 MAX	
WATER EXTRACTION %	-0.14	-0.22	-0.24	-0.19	ASTM D-1053 A	-0.35 MAX	
HYDROSTATIC RESISTANCE LB/SQ IN	PASS	PASS	PASS	PASS	ASTM D-751A	82 MIN	
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	ASTM D-1083A	PREMIXED FACTOR % ELONGATION AT BREAK 1.5% IN AT 100% ELONGATION	
	CD	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OPINION	PASS						
SUPERVISOR	<i>Leti</i>			TESTER	Lentia		
DATE 04 10 97							

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CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1	
	ENVIR.	TESTING RH/TEMP.	52% 23C				0517057	
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERED TO	STANDARDS	
ROLL #	40		45	50	55			
SPEC. GRAVITY	1.24		1.24	1.24	1.24			
THICKNESS	41.51		40.53	40.45	40.85	ASTM D-1593	40±5%	
100 % MOD LB/IN WIDTH	MD	45.26	44.10	45.45	47.24	ASTM D-882A	36	MIN
	CD	44.02	41.37	39.47	45.09		36	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	119.0	114.6	113.0	124.6	ASTM D-882A	92	MIN
	CD	114.5	108.6	100.0	117.6		92	MIN
ELONGATION RATE %	MD	493.6	490.5	358.6	493.6	ASTM D-882A	350	MIN
	CD	496.6	499.5	537.5	531.3		350	MIN
SHRINKAGE %	MD	-2.14	-2.25	-2.85	-2.17	ASTM D-1204	-5.0	MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C	
TEAR STRENGTH LB	MD	18.33	17.93	17.61	17.12	ASTM D-1004	10.0	MIN
	CD	17.00	17.12	17.15	17.28		10.0	MIN
VOLATILE LOSS %	-0.47		-0.44	-0.38	-0.37	ASTM D1203-A	-0.5	MAX
WATER EXTRACTION %	-0.17		-0.26	-0.25	-0.20	ASTM D-3043-A	-0.35	MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	ASTM D-751A	82	MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D-1533A	1.0 MIN. MAX. 1.0	
	CD	PASS	PASS	PASS	PASS		1.0 MIN. MAX. 1.0	
TECHNICAL DEPARTMENT SPECIFICATIONS	PASS							
SUPERVISOR	4.6.11			TESTER		DATE		
DATE 11-10-97								

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NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR74190-1 <i>017827</i>	
	ENVIR	TESTING RH/TEMP.	52% 23C						
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"				TEST METHOD REFERRED TO	STANDARDS	
ROLL #	60		65	70	75				
SPEC. GRAVITY	1.24		1.24	1.24	1.24				
THICKNESS	40.41		39.96	40.17	39.70		ASTM D-1593	40±5%	
100 % MOD LB/IN WIDTH	MD	43.56	48.58	45.13	44.12		ASTM D-882A	36	MIN
	CD	42.61	37.80	39.49	41.78			36	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	118.2	122.6	124.5	124.6		ASTM D-882A	92	MIN
	CD	113.8	108.3	115.5	110.3			92	MIN
ELONGATION RATE %	MD	489.6	509.6	514.5	509.6		ASTM D-882A	350	MIN
	CD	523.6	516.6	523.7	530.6			350	MIN
SHRINKAGE %	MD	-2.36	-2.28	-2.68	-2.89		ASTM D-1204	-5.0	MAX
COLD CRACK	°C	PASS	PASS	PASS	PASS		ASTM D-1790	-29°C	
TEAR STRENGTH LB	MD	17.96	17.58	17.55	17.28		ASTM D-1004	10.0	MIN
	CD	17.25	17.36	17.18	16.96			10.0	MIN
VOLATILE LOSS %	-0.46		-0.44	-0.46	-0.41		ASTM D1203-A	-0.5	MAX
WATER EXTRACTION %	-0.25		-0.30	-0.27	-0.29		ASTM D-3083-A	-0.35	MAX
HYDROSTATIC RESISTANCE LB./SQ. IN.	PASS		PASS	PASS	PASS		ASTM D-751A	82	MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS		ASTM D-3053A	IMPROVING FACT - CORROSION AT DEPTH 1 METER AT 100% SATURATION	
	CD	PASS	PASS	PASS	PASS				
TECHNICAL DEPARTMENT OPINION	PASS								
SUPERVISOR	<i>4-11</i>				TESTER		LOTTA		
DATE: 11 30 77									

Sheet 1

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1
	ENVIR	TESTING RH/TEMP.	52% 23C				IN 7027
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHODS REFERRED TO	STANDARDS
ROLL #	80	85	90	95			
SPEC. GRAVITY	1.24	1.24	1.24	1.24			
THICKNESS	40.75	40.31	39.78	40.37	ASTM D-1593	40.54	
100 % MCD LB/IN WIDTH	MD	43.25	40.85	37.63	40.21	ASTM D-882A	36 MIN
	CD	41.38	37.52	38.63	38.81		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	114.6	107.1	114.4	110.6	ASTM D-882A	92 MIN
	CD	113.0	97.80	101.1	105.6		92 MIN
ELONGATION RATE %	MD	491.2	388.6	501.5	465.5	ASTM D-882A	350 MIN
	CD	523.6	541.0	574.6	468.6		350 MIN
SHRINKAGE %	MD	-2.36	-2.28	-2.74	-2.33	ASTM D-1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C
TEAR STRENGTH LB	MD	18.00	18.25	18.36	18.12	ASTM D-1034	10.0 MIN
	CD	17.96	17.77	17.31	17.21		10.0 MIN
VOILATILE LOSS %	-0.47		-0.45	-0.42	-0.40	ASTM D1203 A	-0.5 MAX
WATER EXTRACTION %	-0.25		0.21	-0.29	-0.22	ASTM D-1083-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	ASTM D-751A	82 MIN
SOIL BURIAL & CHANGE MAX IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM E 3083A	1. BREAKING FORCE 2. ELONGATION AT BREAK 3. WEIGHTS AT 100% EXTENSION
	CD	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS						
SUPERVISOR	[Signature]			TESTER		LOAD	
DATE 04-10-97							

NAN YA PLASTICS CORPORATION, AMERICA

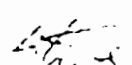
CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1 <i>1217B27</i>
	ENVIR	TESTING RETEMP.	52% 23C				
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERED TO	STANDARDS
ROLL #	100		105	110	115		
SPEC. GRAVITY	1.24		1.24	1.24	1.24		
THICKNESS	39.15		39.77	39.96	41.45	ASTM D-1593	40±5%
100 % MOD LB/IN WIDTH	MD	41.21	39.55	42.09	44.97	ASTM D-882A	36 MIN
	CD	36.63	36.57	37.80	42.96		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	113.6	113.3	111.3	117.6	ASTM D-882A	92 MIN
	CD	105.5	104.3	110.3	105.5		92 MIN
ELONGATION RATE %	MD	523.6	519.6	500.7	448.6	ASTM D-882A	350 MIN
	CD	541.5	541.6	569.6	528.1		350 MIN
SHRINKAGE %	MD	-2.71	-2.58	-2.33	-2.21	ASTM D-1204	-5.0 MAX
COLD CRACK	°c	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C
TEAR STRENGTH LB	MD	18.58	18.78	18.22	18.36	ASTM D-1004	10.0 MIN
	CD	17.11	17.25	17.38	17.48		10.0 MIN
VOLATILE LOSS %	-0.45		-0.41	-0.44	-0.46	ASTM D1203-A	-0.5 MAX
WATER EXTRACTION %	-0.16		-0.18	0.20	-0.22	ASTM D-3083-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	ASTM D-751A	82 MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D-3083A	1. BREAKING IN 2. TENSILE STRENGTH 3. ELONGATION 4. MODULUS 5. THERMAL STABILITY
	CD	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS						
APPROVED	<i>[Signature]</i>				TESTER	DATE	
DATE: 11-30-67							

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NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190 '1
	ENVIR	TESTING RH/TEMP.	521 23C				1017227
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERRED TO	STANDARDS
ROLL #	120	125	130	135			
SPEC. GRAVITY	1.24	1.24	1.24	1.24			
THICKNESS	40.13	40.10	40.00	41.11	ASTM D-1593	40.51	
100 % MOD LB/IN WIDTH	MD	42.33	40.47	45.63	44.25	ASTM D-882A	36 MIN
	CD	40.65	37.63	41.85	40.36		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	109.6	113.6	122.2	112.3	ASTM D-882A	92 MIN
	CD	106.6	110.3	1105.6	108.6		92 MIN
ELONGATION RATE %	MD	447.7	478.6	446.6	450.6	ASTM D-882A	350 MIN
	CD	502.7	554.5	552.3	511.1		350 MIN
SHRINKAGE %	MD	-2.74	-2.44	-2.21	-2.85	ASTM D-1204	-5.0 MAX
COLD CRACK	%c	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C
TEAR STRENGTH LB	MD	18.12	18.25	18.78	18.31	ASTM D-1004	10.0 MIN
	CD	17.33	17.05	17.12	17.21		10.0 MIN
VOLATILE LOSS %	-0.36	-0.41	-0.47	-0.44	ASTM D1203-A	-0.5 MAX	
WATER EXTRACTION %	-0.13	-0.18	-0.20	-0.17	ASTM D-1063-A	-0.35 MAX	
HYDROSTATIC RESISTANCE LB/SQ IN.	PASS	PASS	PASS	PASS	ASTM D-751A	82 MIN	
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	ASTM D-1063A	1. BREAKING FACTOR 2. ELONGATION AT BREAK 3. WEIGHT LOSS AT 1000 P.S.I. FOR 1000	
	CD	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OPINION	PASS						
SUPERVISOR				TESTER		Linda	
DATE: 08-01-97							

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CUSTOMER NAME	ROCHEUX CA-02		PRODUCT CODE	PPTX		PRODUCT NUMBER	FR74190-1 IN 7B27
	ENVIR		TESTING RH/TEMP.	52% 23C			
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERED TO	STANDARDS
ROLL #	140		145	150	155		
SPEC. GRAVITY	1.24		1.24	1.24	1.24		
THICKNESS	40.88		42.58	40.48	40.53	ASTM D-1593	40±5%
100 % MOD LB/IN WIDTH	MD	44.63	44.42	44.11	42.02	ASTM D-882A	36 MIN
	CD	44.25	42.83	41.22	38.07		36 MIN
TENSILE - STRENGTH LB/IN WIDTH	MD	105.5	111.9	114.9	119.0	ASTM D-882A	92 MIN
	CD	103.3	105.5	106.66	113.3		92 MIN
ELONGATION RATE %	MD	394.6	446.6	480.6	475.6	ASTM D-882A	350 MIN
	CD	446.6	457.6	496.6	505.5		350 MIN
SHRINKAGE %	MD	-2.45	-2.63	-2.77	-2.52	ASTM D-1204	-5.0 MAX
COLD CRACK	°C	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C
TEAR STRENGTH LB	MD	18.25	18.78	18.45	18.21	ASTM D-1004	10.0 MIN
	CD	17.60	17.72	17.25	17.36		10.0 MIN
VOLATILE LOSS %	-0.43		-0.44	-0.39	-0.33	ASTM D1203-A	-0.5 MAX
WATER EXTRACTION %	-0.11		-0.16	-0.19	-0.20	ASTM D-3083-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/30 IN.	PASS		PASS	PASS	PASS	ASTM D-751A	82 MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D 3083A	RELATIVE A DEFORMATION A MAX
	CD	PASS	PASS	PASS	PASS		RELATIVE A DEFORMATION A MAX
TECHNICAL DEPARTMENT OPINION	PASS						
DATE TESTED	4-26-97			TESTER		10000	
DATE 05.01.97							

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1 <i>6017827</i>
	ENVIR	TESTING RH/TEMP	52A 23C				
SPEC	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERRED TO	STANDARDS
ROLL #	160		165	170	175		
SPEC. GRAVITY	1.24		1.24	1.24	1.24		
THICKNESS	41.00		40.77	40.00	40.12	ASTM D- 1593	40±5%
100 % MOD LB/IN WIDTH	MD	42.02	46.52	46.52	41.63	ASTM D- 882A	36 MIN
	CD	39.45	45.52	41.22	38.96		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	125.5	118.6	115.5	105.0	ASTM D- 882A	92 MIN
	CD	114.5	103.1	101.2	100.0		92 MIN
ELONGATION RATE %	MD	510.3	439.6	477.5	480.6	ASTM D- 882A	350 MIN
	CD	519.6	486.6	490.6	505.6		350 MIN
SHRINKAGE %	MD	-2.63	-2.58	-2.45	-2.31	ASTM D 1204	-5.0 MAX
COLD CRACK	°C	PASS	PASS	PASS	PASS	ASTM D- 1792	-29°C
TEAR STRENGTH LB	MD	17.85	17.12	18.05	17.96	ASTM D- 1004	10.0 MIN
	CD	17.12	16.96	16.79	16.39		10.0 MIN
VOLATILE LOSS %	-0.44		-0.40	-0.38	0.40	ASTM D1203-A	0.5 MAX
WATER EXTRACTION %	-0.17		-0.11	-0.18	-0.16	ASTM D- 3993-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	ASTM D- 751A	62 MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D- 1041A	1.0% MAX. FACTOR INFORMATION AT PALM 1.0% MAX. FACTOR ELONGATION
	CD	PASS	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS						
SUPERVISOR	<i>4-6-1</i>			TESTER		Date	
DATE 05 01 91							

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02		PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1 617B27
	ENVIR		TESTING RH/TEMP.	52% 23C				
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERED TO	STANDARDS	
ROLL #	180		185	190	195			
SPEC. GRAVITY	1.24		1.24	1.24	1.24			
THICKNESS	41.49		40.62	40.64	40.35	ASTM D-1593	40±5%	
100 % MOD LB/IN WIDTH	MD	42.44	38.99	39.55	38.07	ASTM D-882A	36 MIN	
	CD	39.71	36.69	36.41	36.52		36 MIN	
TENSILE STRENGTH LB/IN WIDTH	MD	120.2	121.5	120.4	121.0	ASTM D-882A	92 MIN	
	CD	111.3	113.8	114.6	113.5		92 MIN	
ELONGATION RATE %	MD	496.6	566.3	557.2	556.6	ASTM D-882A	350 MIN	
	CD	505.5	585.5	581.6	592.3		350 MIN	
SHRINKAGE %	MD	-2.63	-2.74	-2.47	-2.88	ASTM D-1204	-5.0 MAX	
COLD CRACK	°c	PASS	PASS	PASS	PASS	ASTM D-1790	-29°C	
TEAR STRENGTH LB	MD	18.12	18.96	18.61	18.08	ASTM D-1004	10.0 MIN	
	CD	18.00	17.45	17.25	17.33		10.0 MIN	
VOLATILE LOSS %	-0.41		-0.38	-0.36	-0.44	ASTM D1203-A	-0.5 MAX	
WATER EXTRACTION %	-0.16		-0.18	-0.12	-0.16	ASTM D-3083-A	-0.35 MAX	
HYDROSTATIC RESISTANCE LB SQ. IN.	PASS		PASS	PASS	PASS	ASTM D-751A	82 MIN	
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D-3083A	1. IMPROVED FAT 2. FLEXURE & BREAK 3. IMPROVED FAT 4. IMPROVED FAT	
	CD	PASS	PASS	PASS	PASS			
TECHNICAL DEVELOPMENT OPINION	PASS							
DATE	APR 1 01 97			TESTER		Dennis		

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NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02		PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1	
	ENVIR.		TESTING RH*TEMP:	52% 23C				W17B2.7	
SPEC.	THICKNESS (MM) 1.026			WIDTH (IN) 92"			TEST METHOD REFERED TO	STANDARDS	
ROLL #	200			205	210	215			
SPEC. GRAVITY	1.24			1.24	1.24	1.24			
THICKNESS	40.29			40.18	40.34	39.82	ASTM D-1593	40±5%	
100 % MOD LB/IN WIDTH	MD	38.63		40.17	37.00	39.46	ASTM D-882A	36	MIN
	CD	36.50		37.54	36.52	36.55		36	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	108.5		121.2	115.5	114.5	ASTM D-882A	92	MIN
	CD	105.3		111.6	113.3	113.0		92	MIN
ELONGATION RATE %	MD	464.0		478.7	525.5	503.3	ASTM D-882A	350	MIN
	CD	555.1		577.6	570.6	546.6		350	MIN
SHRINKAGE %	MD	-2.85		-2.14	-2.33	-2.47	ASTM D-1204	-5.0	MAX
COLD CRACK	°C	PASS		PASS	PASS	PASS	ASTM D-1790	-29°C	
TEAR STRENGTH LB	MD	18.22		18.08	18.31	18.11	ASTM D-1004	10.0	MIN
	CD	17.96		18.00	17.58	17.99		10.0	MIN
VOLATILE LOSS %	-0.44			-0.40	-0.38	-0.42	ASTM D1203-A	-0.5	MAX
WATER EXTRACTION %	-0.21			-0.21	0.18	-0.19	ASTM D-3083-A	-0.35	MAX
HYDROSTATIC RESISTANCE LB/CO. IN.	PASS			PASS	PASS	PASS	ASTM D-751A	82	MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS		PASS	PASS	PASS	ASTM D-3083A	SUB-SAMPLES FOR TESTING IN A FIELD 1.0% MAX. CHANGE IN STRENGTH	
	CD	PASS		PASS	PASS	PASS			
PHYSICAL DEVELOPMENT STANDARD	PASS								
TESTER					TESTER		TESTER		
DATE	01 97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHECA CA-02	PRODUCT CODE	PTTX			PRODUCT NUMBER	FR74190-1	
	ENVIR	TESTING RH/TEMP.	52% 23C				<i>W17B27</i>	
SPEC	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERED TO	STANDARDS	
ROLL #	220		225	230	235			
SPEC GRAVITY	1.24		1.24	1.24	1.24			
THICKNESS	40.26		40.60	40.40	40.70	ASTM D- 1593	40±5%	
100 % MOD LB/IN WIDTH	MD	42.05	45.60	40.13	40.54	ASTM D- 882A	36	MIN
	CD	41.12	41.13	38.10	36.99		36	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	116.6	121.2	115.5	108.6	ASTM D- 882A	92	MIN
	CD	114.5	119.6	101.6	106.6		92	MIN
ELONGATION RATE %	MD	469.6	505.5	511.2	480.7	ASTM D- 882A	350	MIN
	CD	526.6	570.3	541.6	535.1		350	MIN
SHRINKAGE %	MD	-2.67	-2.77	-2.58	-2.39	ASTM D- 1204	-5.0	MAX
COLD CRACK	%	PASS	PASS	PASS	PASS	ASTM D- 1790	-29°C	
TEAR STRENGTH LB	MD	17.85	17.36	17.45	17.78	ASTM D- 1004	10.0	MIN
	CD	17.25	17.12	17.05	17.32		10.0	MIN
VOLATILE LOSS %	-0.17		-0.45	-0.44	-0.40	ASTM D1203-A	-0.5	MAX
WATER EXTRACTION %	-0.13		-0.16	-0.11	-0.15	ASTM D- 3083 A	-0.15	MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	ASTM D- 751A	82	MIN
SOIL BURIAL % CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D- 3083A	1. BALANCE FACTOR 2. ELONGATION AT BREAK 3. MODULUS AT 100% ELONGATION	
	CD	PASS	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OPINION	PASS							
SUPERVISOR	<i>[Signature]</i>				TESTER	Leydia		
DATE 05-01-97								

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-C2	PRODUCT CODE	PPTX			PRODUCT NUMBER	FR74190-1
	ENVIR	TESTING RH/TEMP.	52% 23C				607627
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"			TEST METHOD REFERED TO	STANDARDS
ROLL #	240		245	250	260		
SPEC. GRAVITY	1.24		1.24	1.24	1.24		
THICKNESS	41.25		40.50	40.60	41.35	ASTM D- 1553	40.51
100 % MOD LB/IN WIDTH	MD	42.34	45.90	40.70	41.10	ASTM D- 882A	35 MIN
	CD	40.94	38.88	35.43	40.96		35 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	113.9	116.0	113.3	116.6	ASTM D- 882A	92 MIN
	CD	113.3	115.0	107.5	115.3		92 MIN
ELONGATION RATE %	MD	537.5	474.5	477.2	500.2	ASTM D- 882A	350 MIN
	CD	545.5	422.6	526.6	527.6		350 MIN
SHRINKAGE %	MD	-2.25	-2.33	-2.11	-2.17	ASTM D- 1553	-5.0 MAX
TEAR CRACK	MD	PASS	PASS	PASS	PASS	ASTM D- 1792	-20% C
TEAR STRENGTH LB	MD	17.94	17.12	17.23	17.36	ASTM D- 1553	10.0 MIN
	CD	17.05	17.11	17.11	17.11		10.0 MIN
WATER ABSORP. %	0.11		0.11	0.11	0.11	ASTM D- 1553 A	0.15 MAX
WATER EXTRACTION %	0.11		0.11	0.11	0.11	ASTM D- 1553 A	0.15 MAX
HYDROSTATIC RESISTANCE LB/INCH	PASS		PASS	PASS	PASS	ASTM D- 708A	50 MIN
SOIL BURIAL & HARDENING IN ORIGINAL FORM	MD	PASS	PASS	PASS	PASS	ASTM D- 1553A	PASS
	CD	PASS	PASS	PASS	PASS		
TESTED BY		E.A.					
TESTED BY		E.A.					
TESTED BY		E.A.					

1) General Studies (from examination
1991)

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX	PRODUCT NUMBER	FR74190-1 1017B27
	ENVIR	TESTING RH/TEMP.	52% 23C		
SPEC.	THICKNESS (MM) 1.026		WIDTH (IN) 92"	TEST METHOD REFERRED TO	STANDARDS
ROLL #	270		275		
SPEC. GRAVITY	1.24		1.24		
THICKNESS	40.63		40.25	ASTM D-1593	40±5%
100 % MOD LB/IN WIDTH	MD	43.12	41.36	ASTM D-882A	36 MIN
	CD	40.45	39.96		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	105.6	99.96	ASTM D-882A	92 MIN
	CD	100.1	98.45		92 MIN
ELONGATION RATE %	MD	511.2	500.3	ASTM D-882A	350 MIN
	CD	525.5	512.3		350 MIN
SHRINKAGE %	MD	-2.77	-2.63	ASTM D-1204	-5.0 MAX
COLD CRACK	°C	PASS	PASS	ASTM D-1790	-29°C
TEAR STRENGTH LB	MD	17.53	17.33	ASTM D-1004	10.0 MIN
	CD	17.13	17.11		10.0 MIN
VOLATILE LOSS %	-0.45		-0.39	ASTM D1203-A	-0.5 MAX
WATER EXTRACTION %	-0.13		-0.18	ASTM D-3083 A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	ASTM D 751A	82 MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	ASTM D-3083A	DRAINAGE RATE DETERMINED AT 100°F 1.000000 AT 1000 10.000000
	CD	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS				
SUPPLIER	[Signature]		DATE:	REVISION:	
DATE: 05-21-97					

CERTIFICATE OF ANALYSIS

4. Time

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX		PRODUCT NUMBER	FR79087-2 W17C64M
	ENVIR	TESTING RH/TEMP.	52% 23C			
SPEC.	THICKNESS (MM) 1.018		WIDTH (IN) 92"		TEST METHOD REFERED TO	STANDARDS
ROLL #	280		290	300		
SPEC. GRAVITY	1.25		1.25	1.25		
THICKNESS	40.22		40.01	40.01	ASTM D- 1593	40±5%
100 % MOD LB/IN WIDTH	MD	47.52	50.85	47.25	ASTM D- 882A	36 MIN
	CD	42.12	40.63	43.66		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	105.5	100.3	118.6	ASTM D- 882A	92 MIN
	CD	93.96	97.45	101.26		92 MIN
ELONGATION RATE %	MD	488.6	490.6	500.0	ASTM D- 882A	350 MIN
	CD	512.3	500.0	525.1		350 MIN
SHRINKAGE %	MD	-2.00	-2.05	-2.08	ASTM D- 1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	ASTM D- 1791	-29°C
TEAR STRENGTH LB	MD	19.00	18.86	17.63	ASTM D- 1001	10.0 MIN
	CD	17.00	17.31	17.45		10.0 MIN
VOLATILE LOSS %	-0.44		-0.45	-0.36	ASTM D1211-A	-0.5 MAX
WATER EXTRACTION %	-0.15		-0.11	-0.11	ASTM D- 1031-A	-0.15 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	ASTM D- 751	82 MIN
SOIL BURIAL & CHANGE MAX IN ORIGINAL VALUE	MD	PASS	PASS	PASS	ASTM D- 3011	1. BREAKING FACTOR 2. ELONGATION AT BREAK 3. MAX. ELONGATION 4. ELONGATION
	%	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS					
SUPERVISOR	<i>Steve</i>			TESTER		
DATE OF TEST						

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX		PRODUCT NUMBER	FR79087-2 W17C64	
	ENVIR	TESTING RH/TEMP.	52% 23C				
SPEC.	THICKNESS (MM) 1.018		WIDTH (IN) 92"		TEST METHOD REFERED TO	STANDARDS	
ROLL #	1		10	20			
SPEC. GRAVITY	1.25		1.25	1.25			
THICKNESS	40.23		40.55	40.85	ASTM D- 1593	40±5%	
100 % MOD LB/IN WIDTH	MD	50.25	49.63	51.12	ASTM D- 882A	36	MIN
	CD	48.55	52.12	47.85		36	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	122.2	111.5	118.6	ASTM D- 882A	92	MIN
	CD	98.52	105.5	100.3		92	MIN
ELONGATION RATE %	MD	518.5	489.6	496.6	ASTM D- 882A	350	MIN
	CD	522.2	508.6	508.6		350	MIN
SHRINKAGE %	MD	-2.12	-2.08	-2.66	ASTM D- 1204	-5.0	MAX
COLD CRACK	%	PASS	PASS	PASS	ASTM D- 1790	-29°C	
TEAR STRENGTH LB	MD	18.101	17.93	18.78	ASTM D- 1604	10.0	MIN
	CD	17.22	17.66	17.12		10.0	MIN
VOLATILE LOSS %	-0.39		-0.34	-0.47	ASTM D1204-A	-0.5	MAX
WATER EXTRACTION %	-0.10		-0.34	-0.30	ASTM D- 3053-A	-0.35	MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	ASTM D- 7084	82	MIN
SOIL BURIAL & CHANGE MAX IN ORIGINAL VALUE	MD	PASS	PASS	PASS	ASTM D- 1130	1. BREAKING FACTOR 2. ELONGATION AT BREAK 3. MODULUS AT 100% ELONGATION	
	CD	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OPINION	PASS						
SUPERVISOR			TESTER	Legel			
DATE: 09-19-97							

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR79087-2	
	ENVIR	TESTING PH/TEMP.	52% 23C					w7c6kE	
SPEC.	THICKNESS (MM) 1.013		WIDTH (IN) 92"				TEST METHOD REFERED TO	STANDARDS	
ROLL #	111		140	150	160	170			
SPEC. GRAVITY	1.25		1.25	1.25	1.25	1.25			
THICKNESS	40.00		38.63	39.99	38.45	40.13	ASTM D-1593	40±5%	
100 % MOD LB/IN WIDTH	MD	50.00	53.16	52.52	50.00	49.36	ASTM D-882A	35	MIN
	CD	49.52	45.55	47.46	49.06	49.13		35	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	120.2	115.5	103.6	120.3	101.3	ASTM D-882A	92	MIN
	CD	116.6	108.5	101.1	99.63	100.1		92	MIN
ELONGATION RATE %	MD	486.5	485.5	466.6	480.6	469.3	ASTM D-882A	350	MIN
	CD	500.3	499.6	510.3	505.5	510.1		350	MIN
SHRINKAGE %	MD	-2.02	-2.10	-2.11	-2.02	-1.99	ASTM D-1204	-5.0	MAX
COLD CRACK	PASS		PASS	PASS	PASS	PASS	ASTM D-1790	-29 C	
TEAR STRENGTH LB	MD	19.10	18.36	17.99	17.45	18.31	ASTM D-1004	10.0	MIN
	CD	17.47	17.33	17.33	17.25	17.11		10.0	MIN
VOLATILE LOSS %	1.19		1.14	1.11	1.07	1.11	ASTM D1303-A	10.5	MAX
WATER EXTRACTION %	1.18		1.12	1.15	1.20	1.13	ASTM D-1083-A	1.35	MAX
HYDROSTATIC RESISTANCE LB/SQ.IN.	PASS		PASS	PASS	PASS	PASS	ASTM D-781A	92	MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D-1081A	1.0% MAX	
	CD	PASS	PASS	PASS	PASS	PASS		1.0% MAX	
TECHNICAL DEPARTMENT OPINION	PASS								
DATE	Steve				PLANT		LABOR		

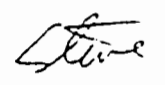
NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR79087-2 <i>W17C6CH</i>	
	ENVIR	TESTING RH/TEMP.	524 23C						
SPEC.	THICKNESS (MM) 1.018		WIDTH (IN) 92"				TEST METHOD REFERRED TO	STANDARDS	
ROLL #	180		190	200	210	220			
SPEC. GRAVITY	1.25		1.25	1.25	1.25	1.25			
THICKNESS	40.25		40.03	39.85	39.45	40.22	ASTM D- 1593	40±5%	
100 % MOD LB/IN WIDTH	MD	46.63	48.55	48.63	50.00	51.35	ASTM D- 882A	16	MIN
	CD	44.66	42.52	45.52	48.66	45.52		16	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	105.5	112.5	108.6	106.6	112.2	ASTM D- 882A	92	MIN
	CD	98.63	98.12	100.3	105.5	100.6		92	MIN
ELONGATION RATE %	MD	474.5	485.5	500.0	502.5	478.9	ASTM D- 882A	350	MIN
	CD	514.3	512.3	508.3	522.3	499.6		350	MIN
SHRINKAGE %	MD	-2.12	-2.00	-2.10	-2.17	-2.00	ASTM D- 1204	-5.0	MAX
COLD CRACK	MD	PASS	PASS	PASS	PASS	PASS	ASTM D- 1790	-29°C	
TEAR STRENGTH LB	MD	18.63	17.63	18.45	18.66	17.00	ASTM D- 1004	10.0	MIN
	CD	17.12	17.00	17.08	17.10	16.90		10.0	MIN
VOLATILE LOSS %	-0.41		-0.43	-0.40	-0.46	-0.41	ASTM D1203-A	-0.5	MAX
WATER EXTRACTION %	-0.21		-0.16	-0.18	-0.14	-0.15	ASTM D- 3083-A	-0.15	MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	PASS	ASTM D- 751A	80	MIN
SOIL BURIAL & CHANGE MAX IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D- 1031A	1.5% MAX IN 1 YEAR 1.0% MAX IN 2 YEARS 0.5% MAX IN 3 YEARS	
	CD	PASS	PASS	PASS	PASS	PASS			
TECHNICAL DEPARTMENT OPINION	PASS								
SUPERVISOR	<i>L. Tye</i>				TESTER		L. Tye		
DATE: 12-13-87									

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX		PRODUCT NUMBER	FR79087-2 W17C64M
	ENVIR	TESTING RH/TEMP.	52% 23C			
SPEC.	THICKNESS (MM) 1.018		WIDTH (IN) 92"		TEST METHOD REFERRED TO	STANDARDS
ROLL #	280		290	300		
SPEC. GRAVITY	1.25		1.25	1.25		
THICKNESS	40.22		40.01	40.01	ASTM D-1593	40±5%
100 % MOD LB/IN WIDTH	MD	47.52	50.85	47.25	ASTM D-882A	36 MIN
	CD	42.12	40.63	43.66		36 MIN
TENSILE STRENGTH LB/IN WIDTH	MD	105.5	100.3	118.6	ASTM D-882A	92 MIN
	CD	99.96	97.45	101.26		92 MIN
ELONGATION RATE %	MD	488.6	490.6	500.0	ASTM D-882A	350 MIN
	CD	512.3	500.0	525.1		350 MIN
SHRINKAGE %	MD	-2.00	-2.05	-2.08	ASTM D-1204	-5.0 MAX
COLD CRACK	%	PASS	PASS	PASS	ASTM D-1781	-29°C
TEAR STRENGTH LB	MD	19.00	18.83	17.63	ASTM D-1004	10.0 MIN
	CD	17.20	17.31	17.45		10.0 MIN
VOLATILE LOSS %	-0.44		-0.45	-0.38	ASTM D1004-A	-0.5 MAX
WATER EXTRACTION %	-0.15		-0.13	-0.11	ASTM D-3083-A	-0.35 MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	ASTM D-7510	82 MIN
SOIL BURIAL & CHANGE MAX IN ORIGINAL VALUE	MD	PASS	PASS	PASS	ASTM D-3083-A	1. BREAKING FACTOR 2. ELONGATION AT BREAK 3. MAXIMUM ELONGATION
	CD	PASS	PASS	PASS		
TECHNICAL DEPARTMENT OPINION	PASS					
SUPERVISOR				TESTER		
DATE: 11-20-97						

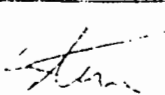
NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX		PRODUCT NUMBER	FR79087-2	
	ENVIR	TESTING RH/TEMP.	50% 23C			017C64	
SPEC.	THICKNESS (MM) 1.018		WIDTH (IN) 92"		TEST METHOD REFERED TO	STANDARDS	
ROLL #	310		320	330			
SPEC. GRAVITY	1.25		1.25	1.25			
THICKNESS	40.12		40.00	40.11	ASTM D- 1593	40.5%	
100 % MOD LB/IN WIDTH	MD	48.63	47.45	48.05	ASTM D- 882A	36	MIN
	CD	40.45	40.77	42.16		36	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	101.2	110.3	115.6	ASTM D- 882A	92	MIN
	CD	99.00	98.85	101.0		92	MIN
ELONGATION RATE %	MD	485.5	485.5	477.6	ASTM D- 882A	350	MIN
	CD	511.0	502.0	511.1		350	MIN
SHRINKAGE %	MD	-2.11	-2.00	-2.22	ASTM D- 1204	-5.0	MAX
COLD CRACK	MD	PASS	PASS	PASS	ASTM D- 1791	-29°C	
TEAR STRENGTH LB	MD	18.89	18.78	18.45	ASTM D- 1004	10.0	MIN
	CD	17.44	17.31	17.63		10.0	MIN
VOLATILE LOSS %	-0.11		-0.10	-0.44	ASTM D- 3101-A	-0.5	MAX
WATER EXTRACTION %	-0.11		-0.10	-0.17	ASTM D- 3101-A	-1.25	MAX
HYDROSTATIC RESISTANCE LB/ST. IN.	PASS		PASS	PASS	ASTM D- 708A	12	MIN
SOIL BURIAL & CHARACT. MAX IN. CUMULATIVE LOSS	PASS		PASS	PASS	ASTM D- 3101-A	PASS	
TECHNICAL DEPARTMENT OPINION	PASS						
APPROVED				TESTER	DATE		
DATE							

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX				PRODUCT NUMBER	FR85063-1 <i>W18B20</i>	
	ENVIR	TESTING RH/TEMP.	52% 23C						
SPEC.	THICKNESS (MM) 1.018		WIDTH (IN) 92"				TEST METHOD REFERED TO	STANDARDS	
ROLL #	1		5	10	15	20			
SPEC. GRAVITY	1.25		1.25	1.25	1.25	1.25			
THICKNESS	39.63		39.45	39.63	39.45	39.12	ASTM D-1593	40±5%	
100 % MOD LB/IN WIDTH	MD	55.15	53.38	53.05	53.60	54.12	ASTM D-882A	41	MIN
	CD	52.54	52.52	46.52	51.12	50.55		41	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	126.5	120.0	121.2	129.6	130.0	ASTM D-882A	97	MIN
	CD	119.9	118.5	98.93	123.0	99.63		97	MIN
ELONGATION RATE %	MD	472.5	454.5	419.5	471.5	480.0	ASTM D-882A	400	MIN
	CD	523.3	505.5	458.5	503.5	511.3		400	MIN
SHRINKAGE %	MD	-1.89	-1.58	-1.63	-2.08	-1.08	ASTM D-1204	-3.0	MAX
COLD CRACK	Ec	PASS	PASS	PASS	PASS	PASS	ASTM D-1790	-29 C	
TEAR STRENGTH LB	MD	19.96	19.45	18.63	18.45	18.44	ASTM D-1004	10.5	MIN
	CD	17.45	18.33	17.85	17.33	17.45		10.5	MIN
VOLATILE LOSS %	-0.47		-0.50	-0.44	-0.48	-0.46	ASTM D-1103-A	-0.50	MAX
WATER EXTRACTION %	0.12		-0.13	-0.10	-0.15	-0.19	ASTM D-1103-A	-0.20	MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	PASS	ASTM D-706A	120	MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	PASS	ASTM D-1002A	1. BREAKING FACTOR	
	CD	PASS	PASS	PASS	PASS	PASS		2. ELONGATION AT BREAK	
TECHNICAL DEPARTMENT OPINION	PASS FGI STD								
APPROVED FOR					TESTER	10/16/10			
DATE: 01-28-98									

NAN YA PLASTICS CORPORATION, AMERICA

CERTIFICATE OF ANALYSIS

CUSTOMER NAME	ROCHEUX CA-02	PRODUCT CODE	PPTX			PRODUCT NUMBER	JR85064-1	
	ENVIR	TESTING RH/TEMP.	52% 23C				W/8B21	
SPEC.	THICKNESS (MM) 1.018		WIDTH (IN) 92"			TEST METHOD REFERRED TO	STANDARDS	
ROLL #	1		5	10	15			
SPEC. GRAVITY	1.25		1.25	1.25	1.25			
THICKNESS	40.70		40.70	39.23	38.22	ASTM D- 2593	40±5%	
100 ± MOD LB/IN WIDTH	MD	56.11	59.21	58.63	47.57	ASTM D- 882A	41	MIN
	CD	51.01	56.46	54.63	43.23		41	MIN
TENSILE STRENGTH LB/IN WIDTH	MD	130.3	132.3	131.2	115.5	ASTM D- 882A	97	MIN
	CD	118.5	123.5	121.2	108.0		97	MIN
ELONGATION RATE %	MD	445.5	430.3	446.5	449.6	ASTM D- 882A	400	MIN
	CD	455.5	435.5	456.5	475.6		400	MIN
SHRINKAGE %	MD	-1.99	-1.96	-2.03	-2.12	ASTM D- 1204	-3.0	MAX
COLD CRACK	MD	PASS	PASS	PASS	PASS	ASTM D- 1790	-29°C	
TEAR STRENGTH LB	MD	20.00	19.65	19.25	20.05	ASTM D- 1004	10.5	MIN
	CD	16.36	18.12	18.00	18.96		10.5	MIN
VOLATILE LOSS %	-0.43		-0.50	-0.41	-0.47	ASTM D1203-A	-0.50	MAX
WATER EXTRACTION %	-0.10		-0.15	-0.13	-0.17	ASTM D- 3083-A	-0.20	MAX
HYDROSTATIC RESISTANCE LB/SQ. IN.	PASS		PASS	PASS	PASS	ASTM D- 751A	120	MIN
SOIL BURIAL & CHANGE MAX. IN ORIGINAL VALUE	MD	PASS	PASS	PASS	PASS	ASTM D- 3082A	1. DRAKING FACTOR 5%	
	CD	PASS	PASS	PASS	PASS		2. ELONGATION AT BREAK 20%	
							3. MODULUS AT 100% ELONGATION 20%	
TECHNICAL DEPARTMENT OPINION	PASS PGI STD							
SUPERVISOR					TESTER	Lg-41a		

APPENDIX 3

GEOMEMBRANE FABRICATION REPORT

THE FOLLOWING ROLL-NUMBERS REPRESENT
THE MATERIAL FABRICATED INTO BLANKETS FOR
CLARKSTOWN LANDFILL, NY
JOB #1818

MATERIAL: 40 MIL SMOOTH

LOT NUMBERS: W17B27

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
101	20	102	20
	21		21
	23		23

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
103	20	104	20
	21		21
	23		23

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
105	13	106	13
	22		22
	96		96

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
107	13	108	13
	22		22
	96		96

ATTACHED ARE THE MANUFACTURE'S ACTUAL CERTIFICATION TEST RESULTS FOR THE
ABOVE LISTED ROLL NUMBERS. THIS IS TO SATISFY MATERIAL SPECIFICATION
REQUIREMENTS.

THE FOLLOWING ROLL-NUMBERS REPRESENT
THE MATERIAL FABRICATED INTO BLANKETS FOR
CLARKSTOWN LANDFILL, NY
JOB #1818

MATERIAL: 40 MIL SMOOTH

LOT NUMBERS: W17B27

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
109	5	110	5
	6		6
	70		70
	217		217

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
111	5	112	5
	6		6
	70		70
	217		217

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
113	5	114	5
	6		6
	70		70
	217		217

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
115	275	116	275
	276		276

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
117	12	118	12
	24		24
	34		34
	35		35
	70		70

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:
119	32	120	32
	33		33
	34		34
	38		38
	39		39

BLANKET NUMBER:	ROLL NUMBER:	BLANKET NUMBER:	ROLL NUMBER:

CLARKSTOWN LANDFILL

40 MIL SMOOTH

ENVIRONMENTAL LINERS INC.

Material Thickness Measurement Log

Date: 6/03/97

ROLL/BATCH NUMBER	ROLL START			ROLL END		
	SIDE	CENTER	SIDE	SIDE	CENTER	SIDE
W17B27# 276	40	41	41	41	41	40
W17B27# 275	41	41	40	40	40	41
W17B27# 6	41	40	39	41	41	40
W17B27# 5	40	41	40	39	41	41
W17B27# 217	40	40	40	40	40	40
W17B27# 70	40	40	41	41	41	40
W17B27# 12	40	41	41	40	40	40
W17B27# 25	41	40	40	40	40	41
W17B27# 24	41	41	40	40	41	40
W17B27# 35	40	40	41	41	41	40
W17B27# 36	40	41	41	40	39	41
W17B27# 37	41	41	40	41	40	41
W17B27# 43	39	40	41	41	40	39
W17B27# 42	40	39	40	41	41	40
W17B27# 41	41	41	40	39	41	40
W17B27# 40	41	40	41	40	39	41
W17B27# 105	40	40	41	40	40	41
W17B27# 17	40	41	41	41	40	40
W17B27# 16	40	41	40	41	41	40
W17B27# 182	41	40	41	39	41	41
W17B27# 11	39	40	40	40	41	40
W17B27# 98	40	40	39	40	40	39
W17B27# 28	40	41	40	40	39	40
W17B27# 29	41	40	41	41	40	40
W17B27# 44	40	41	40	41	40	41

SIGNATURE: Chara Kinney



ENVIRONMENTAL LINERS, INC.

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IN COLORADO (970) 565-9540 / 565-4221 / FAX (970) 565-8844

eliners@tone.net
www.tone.net/eliners

BONDED SEAM STRENGTH TEST RESULTS (ASTM D3083)

PROJECT NO.: 1818

DATE: 5/14/97

PROJECT NAME: CLARKSTOWN LANDFILL

TIME: 8:00

GEOMEMBRANE TYPE: 40 MIL PVC SMOOTH

SEAM TYPE: DIELECTRIC FUSION - FACTORY

SEAM ID 1ST		SEAM PEEL ADHESION	
SAMPLE NO.	SEAM NO.	LOAD (psi)	BREAK TYPE
101 A LONGITUDINAL	1		FTB
AVERAGE			

SEAM ID 1ST		BONDED SEAM STRENGTH (SHEAR)	
SAMPLE NO.	SEAM NO.	LOAD (psi)	BREAK TYPE
101 A	1	77.1	FTB-SE
	2	76.9	FTB-SE
	3	76.6	FTB-SE
	4	77.3	FTB-SE
	5	77.0	FTB-SE
AVERAGE		76.9	

Terry McNamee 
Terry McNamee, Production Manager



ENVIRONMENTAL LINERS, INC.

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www.elone.net/eliners

BONDED SEAM STRENGTH TEST RESULTS (ASTM D3083)

PROJECT NO.: 1818

DATE: 5/14/97

PROJECT NAME: CLARKSTOWN LANDFILL

TIME: 8:30

GEOMEMBRANE TYPE: 40 MIL PVC SMOOTH

SEAM TYPE: DIELECTRIC FUSION - FACTORY

SEAM ID 3RD		SEAM PEEL ADHESION	
SAMPLE NO.	SEAM NO.	LOAD (ppi)	BREAK TYPE
101 B LONGITUDINAL	1		FTB
AVERAGE			

SEAM ID 3RD		BONDED SEAM STRENGTH (SHEAR)	
SAMPLE NO.	SEAM NO.	LOAD (ppi)	BREAK TYPE
101 B	1	77.5	FTB-SE
	2	77.0	FTB-SE
	3	77.0	FTB-SE
	4	76.7	FTB-SE
	5	77.3	FTB-SE
AVERAGE		77.1	

Terry McNamee OK
Terry McNamee, Production Manager

APPENDIX 4

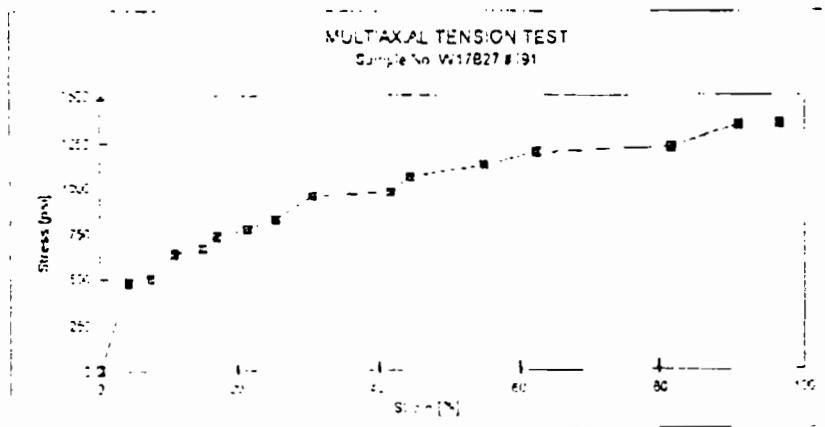
RESULTS OF MULTI-AXIAL TENSILE TESTS ON THE GEOMEMBRANE

MULTIAXIAL TENSION TEST
ASTM D-5617

CLIENT: Ogden Remediation Services
PROJECT: Clarkstown Landfill
MATERIAL: 40 mil Smooth PVC
SAMPLE ID: W17B27 #191, BULK #1751-178

JOB No.: 96S2111
DATE: 1-22-98
TESTED BY: KU
CHECKED BY: MS

Pressure [psi]	Displacement [in]	Stress [psi]	Strain [%]
0.00	0.00	0.00	0.00
1.50	3.01	476.72	4.14
2.00	4.02	458.01	7.32
3.00	4.95	638.27	10.98
3.50	5.85	668.43	15.16
4.00	6.28	731.58	17.28
4.50	7.06	772.22	21.68
5.00	7.74	823.27	25.79
6.00	8.53	951.84	31.06
6.40	10.11	974.13	42.09
7.00	10.46	1059.65	44.90
7.50	11.75	1125.23	55.09
8.00	12.32	1200.00	62.54
8.20	15.50	1230.00	81.44
9.00	16.75	1350.00	90.72
9.00	17.50	1350.00	96.40

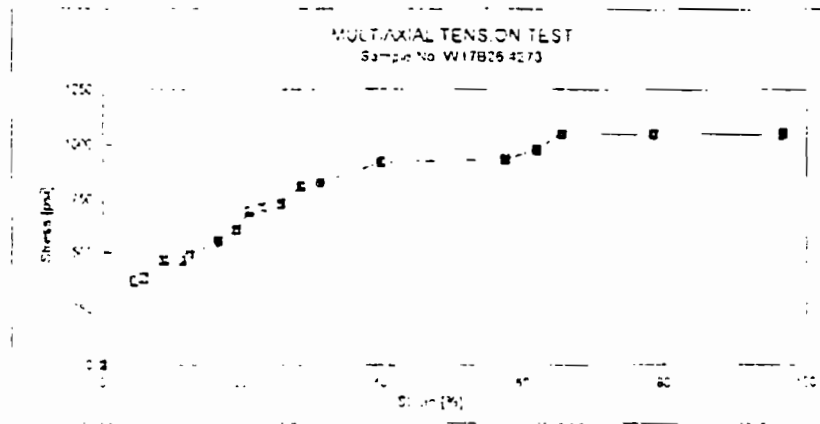


MULTIAXIAL TENSION TEST
ASTM D-5617

CLIENT: Ogden Remediation Services
PROJECT: Clarkstown Landfill
MATERIAL: 40 mil Embossed PVC
SAMPLE ID: W17B26 #273 BLK #267&268

JOB No.: 99S2111
DATE: 1-22-99
TESTED BY: KU
CHECKED BY: MS

Pressure [psi]	Displacement [in]	Stress [psi]	Strain [%]
0.00	0.00	0.00	0.00
1.20	3.11	370.59	4.42
1.40	3.50	381.50	5.90
2.00	4.39	454.00	8.70
2.20	5.03	462.80	11.33
2.40	5.27	438.92	12.40
3.00	6.12	555.93	16.53
3.40	6.52	602.91	19.19
4.00	6.97	650.75	21.16
4.20	7.29	709.88	23.03
4.40	7.73	724.86	25.70
5.00	8.18	805.75	26.56
5.20	8.62	823.07	31.46
6.00	9.93	917.56	40.00
6.20	12.08	930.00	57.47
6.50	12.72	975.00	61.66
7.00	13.25	1050.00	65.45
7.00	15.08	1050.00	78.38
7.00	17.52	1050.00	96.56



APPENDIX 5

RESULTS OF SHEAR STRENGTH TESTS ON SOIL AND INTERFACES

TO: Roy F. Weston of New York, Inc. (RFW)

Clarkstown Field Office

166 Route 303

West Nyack, NY 10994

(914) 353-5221/5491 (fax)

Date: 01/09/98

ORSC Project No. 60010 0000 0050 8000

Attention: John Woodley

Re: Remediation of Clarkstown Sanitary LF & LF Capping

Town of Clarkstown, Rockland County, New York

Ogden Remediation Services Co., Inc. (ORSC)

Submittal Item # 62.189

Subcontractor/Supplier:

We Are Sending You (by hand):

- ☒ Attached
 ☐ Prints
 ☐ Under separate cover via _____ the following items:
 ☐ Shop drawings
 ☐ Change order
 ☐ Plans
 ☐ Samples
 ☐ Specifications
 ☐ Copy of letter
 ☐ Reviewed & Approved
 ☒ ASTM D5321 Test Results

COPIES	DATE	NO. of Pgs	DESCRIPTION
5	1/6/98	18	40 Mil PVC Direct Shear Testing w/ WMX and Van Orden S & G cover soil
			Applicable Spec. Section: 06010B, 1.02.3, A

These are transmitted as checked below:

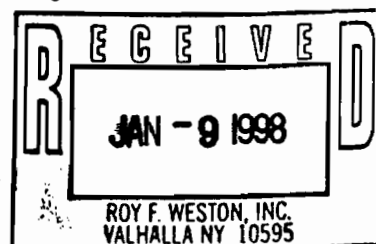
- ☒ For approval
 ☐ Approved as submitted
 ☐ Resubmit ____ copies for approval
 ☐ For your use
 ☐ Approved as noted
 ☐ Submit ____ copies for distribution
 ☐ As requested
 ☐ Returned for corrections
 ☐ Return ____ corrected prints
 ☐ For review and comment
 ☐
☐ For Bids Due on
 ☐ For Record Purposes
 ☐ Prints Returned After Loan to Us

Remarks: Test performed in accordance with project specifications 06010B-1.02.3 on sample taken from approximately halfway point of the production.

Copies To: DS/TJ/JW, RFW w/attachment
FF.NY144 w/att.; CF.PM, ORSC w/att.; CL

Signed: *[Signature]*
Michael Diana Quality Control

Ogden Remediation Services Co., Inc. (ORSC)
166 Route 303
W. Nyack, NY 10994
(914) 358-2720 (EST)
(914) 358-2790 (fax)





J&L TESTING COMPANY, INC.

GEO TECHNICAL AND GEOSYNTHETICS MATERIALS TESTING AND RESEARCH

January 6, 1998
95S2111

OGDEN Remediation Services Co., Inc.
166 Route 303
West Nyack, NY 10994

Attn: Michael J. Diana

**RE: CLARKSTOWN MUNICIPAL SANITARY LANDFILL REVEDEATION
FINAL COVER MATERIAL INTERFACE SHEAR TESTS**

Dear Mr. Diana:

J&L Testing Company, Inc. (JLT) is pleased to submit this report of interface shear testing performed on materials for the above referenced project. The following materials provided to JLT by OGDEN were used in the testing program:

1. 40 mil smooth PVC (Lot No. w17B27. Blanket #175-176).
2. 40 mil embosed PVC (Lot No. W17B26. Blanket Nos. 267,268).
3. Geocomposite drainage material ("DC4205 with TG600 fabric").
4. Geonet drainage material;
5. AMOCO style 4506 (6oz) Geotextile; and
6. Soils - SF-SB-01 (Cover Soil) and SF-WMX-180. (Structural Fill)

A total of seven (7) interfaces were tested. Each test was performed with the entire cross section components in the test configuration as described below. In each case, the cover soil (SF-SB-01) was compacted to 90% of its Standard Proctor Maximum density (133.1 pcf) at optimum moisture content (7.8%) and the structural fill soil (WMX-180) was compacted to 95% of its Standard Proctor Maximum density (122.9 pcf) at optimum moisture content (11.6%).

① ^{COVER} Soil vs. Geocomposite: The testing of this interface was performed using the following setup: **38.3 36.3 residual**

Lower Box: Geocomposite over Embosed PVC over AMOCO geotextile over compacted structural fill soil, with the geosynthetics anchored to the lower half of the box.

Upper Box: Compacted cover soil (CS-10)

MD
PM
TP
CL

- 2) ^{COVER} Soil vs. AMOCO 4506 Geotextile: The testing of this interface was performed using the following setup: *36-2*

Lower Box: AMOCO geotextile over Geonet over smooth PVC over geotextile over structural fill soil, with the geosynthetics anchored to the box.

Upper Box: Cover soil (SF-SB-01) (CS-10)

- 3) Geocomposite vs. Embosed PVC: The testing of this interface was performed using the following setup: *23.9 23.1° residual*

Lower Box: Embosed PVC over AMOCO geotextile over compacted structural fill soil, with the geosynthetics anchored to the lower half of the box.

Upper Box: Geocomposite anchored to the upper box and overlain by the Compacted cover soil.

- 4) Geonet vs. smooth PVC: The testing of this interface was performed using the following setup: *13.4 12.1 residual*

Lower Box: Smooth PVC over AMOCO geotextile over compacted structural fill soil, with the PVC and the geotextile anchored to the lower half of the box.

Upper Box: Geonet overlain by AMOCO geotextile anchored to the upper box and overlain by the cover soil.

- 5) Smooth PVC vs. AMOCO ⁴⁵⁰⁶ Geotextile: The testing of this interface was performed using the following setup: *22.3 21.4° residual*

Lower Box: AMOCO geotextile over compacted structural fill soil, with the geotextile anchored to the lower half of the box.

Upper Box: Smooth PVC overlain by geonet overlain with AMOCO geotextile anchored together to the upper box and overlain by the Cover soil.

- 6) Embosed PVC vs. AMOCO 4506 Geotextile: The testing of this interface was performed using the following setup: *26.7 26.4° residual*

Lower Box: AMOCO geotextile over compacted structural fill soil, with the geotextile anchored to the lower half of the box

Upper Box: Embossed PVC overlain with geocomposite anchored anchored together to the upper box and overlain by the Cover soil.

(7) Geonet vs. AMOCO Geotextile: The testing of this interface was performed using the following setup: 18.8 15.4° residual

Lower Box: Geonet over smooth PVC over geotextile over structural fill soil, with the geosynthetics anchored to the box.

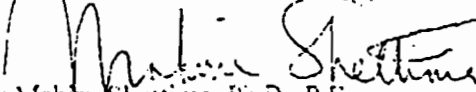
Upper Box: AMOCO geotextile anchored to the box and overlain by Compacted cover soil.

Three (3) setups, one under each of the required normal loads (144, 288 or 720 psf) were constructed and tested. After each load was applied using dead weights, the box was flooded with water and allowed to sit for a period of one hour prior to shearing. The interfaces were then shear using a displacement rate of either 0.04 in/min or 0.2 in/min, as noted in the report. Shear force vs. deformation readings were continuously monitored until a minimum of two (2) inches of displacement was achieved. The results of the tests are attached.

Should you have any questions, comments or require additional information, please call.
Thank you.

Sincerely,

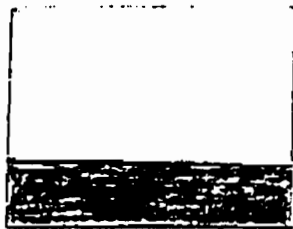
J&L TESTING COMPANY, INC.


Mahru Shehima, P.E.D., P.E.
Director

Enclosures
MJD:dg
1/6/98/6/98/98

INTERFACE FRICTION TEST - SET UP/TEST CRITERIA

ASTM D-5521

Test No. _____ Client: CIGDEN REMEDIATION Job No. _____ Date: _____

Cover

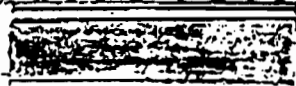
Top Interface:

SOIL

 $\gamma_d = 119.8 \text{ Pcf}$ $w = 9.8\%$

VS

38.3



Bottom Interface:

GEOCOMPOSITE

Cover

EMBOSED PVC

GEOTEXTILE (AMOCO 4506)

SOIL

 $\gamma_d = 116.76 \text{ Pcf}$ $w = 11.6$

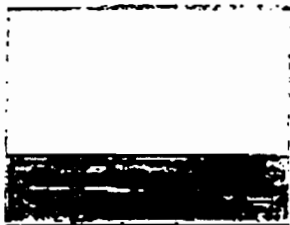
FIXED BASE

Normal Loads: 144 psf 288 psf 720 psf _____ psf

Saturated Yes X No _____ Rate of Displacement: 0.04 in/min

Comments or other instructions: _____

Test No. _____ Client: _____ Job No. _____ Date: _____



Cover

COVER

 $\gamma_d = 119.8 \text{ Pcf}$

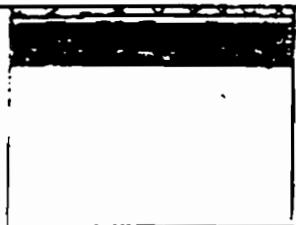
Top Interface:

SOIL

 $w = 7.8\%$

VS

36.2



Bottom Interface:

GEOTEXTILE (AMOCO 4506)

Cover

GEONET

SMOOTH PVC

SOIL

FIXED BASE

Normal Loads: 144 psf 288 psf 720 psf _____ psf

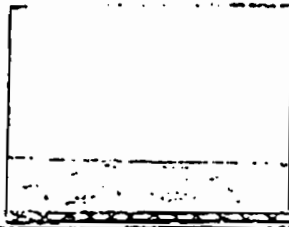
Saturated Yes X No _____ Rate of Displacement: 0.04 in/min

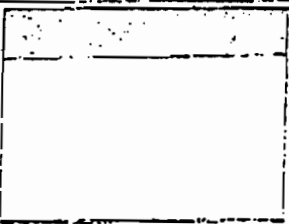
Comments or other instructions: _____

Tested By _____ Date: _____ Checked By _____ Date: _____

INTERFACE FRICTION TEST - SET UP/TEST CRITERIA

ASTM D-5521

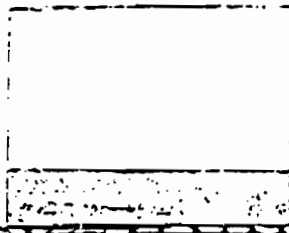
 Test No. _____ Client: OGDEN REMEDIATION Job No. 96S 2111- Date: _____

 Client: SOIL
GEOCOMPOSITE

 Top Interface: EMBOSSED PVC
VS 26.7

 Bottom Interface: GEOTEXTILE (AMOCO 4506)

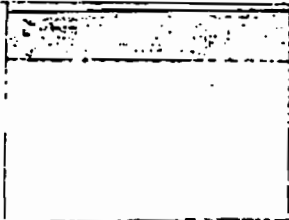
 Client: SOIL

FIXED BASE

 Normal Loads: 144 psi 288 psi 720 psi _____ psi
 Saturated Yes X No _____ Rate of Displacement: 0.2 in/min
 Comments or other instructions: _____

 Test No. _____ Client: OGDEN REMEDIATION Job No. _____ Date: _____

 Client: SOIL

 Top Interface: GEOCOMPOSITE
VS 23.9

 Bottom Interface: EMBOSSED PVC

 Client: GEOTEXTILE (AMOCO 4506)
SOIL

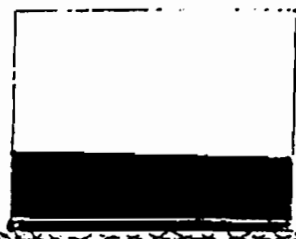
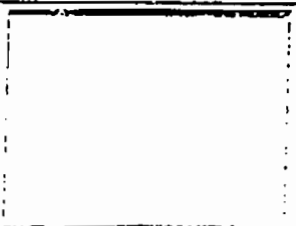
FIXED BASE

 Normal Loads: 144 psi 288 psi 720 psi _____ psi
 Saturated Yes X No _____ Rate of Displacement: 0.2 in/min
 Comments or other instructions: _____

Tested By _____ Date: _____ Checked By _____ Date: _____

INTERFACE FRICTION TEST - SET UP/TEST CRITERIA

ASTM D-5321

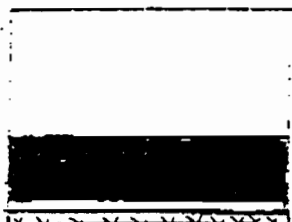
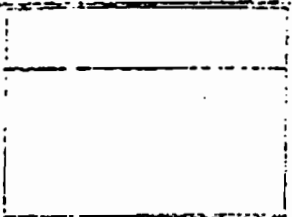
Test No. _____ Client: CG DEN RENEVIATION Job No. 96S2111 - Date: _____Soil: SOILGEOTEXTILE (AMOCO)Top Interface: GEONETVS 13.4° 12.1° residualBottom Interface: SMOOTH PVCSoil: GEOTEXTILE (AMOCO 4506)SOIL

FIXED BASE

Normal Loads: 144 psf 288 psf 720 psf _____ psfSaturated Yes X No _____ Rate of Displacement: 0.2 in/min

Comments or other instructions: _____

Test No. _____ Client: _____ Job No. _____ Date: _____

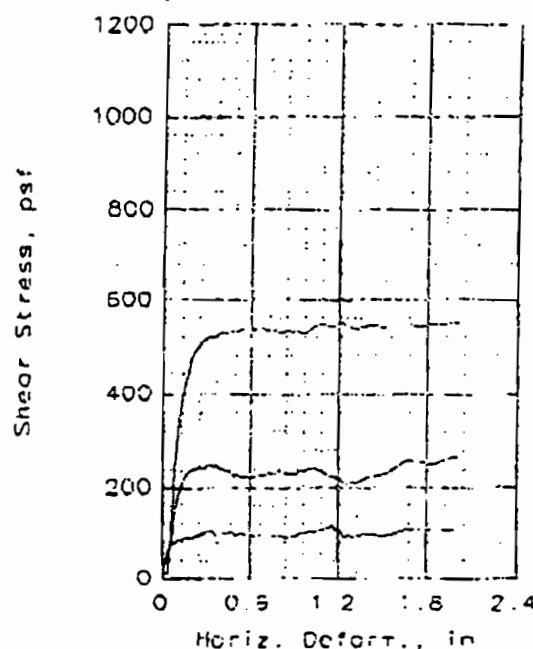
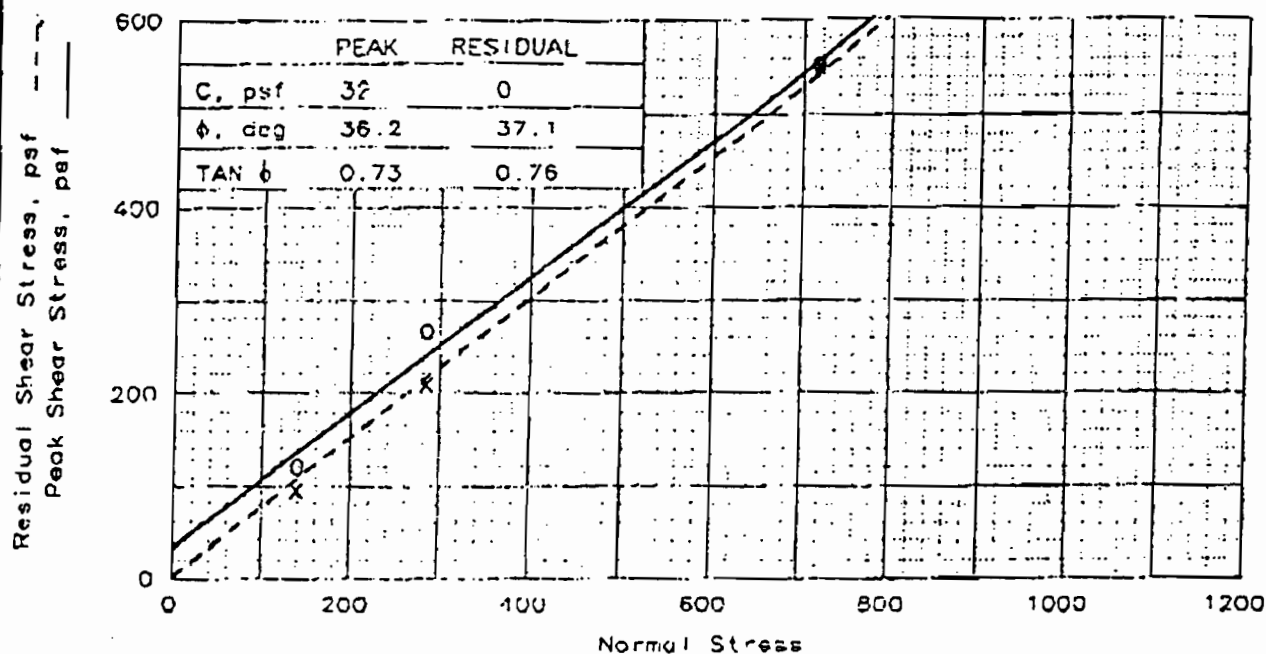
Soil: SOIL ON GEOTEXTILEGEONETTop Interface: SMOOTH PVCVS 22.3Bottom Interface: GEOTEXTILE (AMOCO 4506)Soil: SOIL

FIXED BASE

Normal Loads: 144 psf 288 psf 720 psf _____ psfSaturated Yes X No _____ Rate of Displacement: 0.2 in/min

Comments or other instructions: _____

Tested By _____ Date: _____ Checked By _____ Date: _____



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	7.8	7.8	7.8
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %	54.3	54.3	54.3
	VOID RATIO	0.381	0.381	0.381
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
A ⁺ TEST	WATER CONTENT, %	14.4	14.4	14.3
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %	99.9	99.9	99.6
	VOID RATIO	0.381	0.381	0.381
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, psf		144	288	720
MAXIMUM SHEAR, psf		119	266	552
RESIDUAL SHEAR, psf		94	209	550
Strain rate, in/min		0.040	0.040	0.040

SAMPLE DATA

SAMPLE TYPE: WET INTERFACE
 DESCRIPTION: ^{COVER} SOIL vs. GEOTEXTIL
 /GEONET/SM. PVC/GEOTEX./SOIL
 LL = PL = P =
 SPECIFIC GRAVITY = 2.65
 REMARKS: SETUP HYDRATED UNDER
 TEST LOAD FOR ONE HOUR PRIOR
 TO SHEARING. INTERFACE WAS
 TESTED UNDER WATER
 FIG. NO. OGN-1

CLIENT: OGDEN REMEDIATION SERVICES

PROJECT: CLARKSTOWN LANDFILL

INTERFACE SHEAR TESTS PER ASTM D-5321

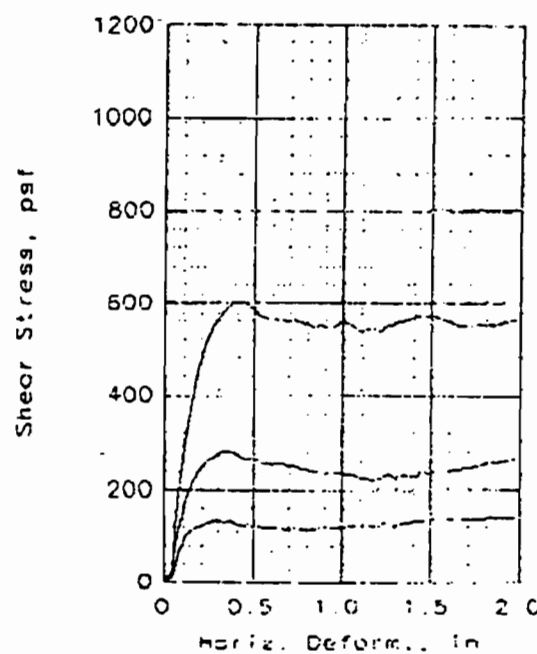
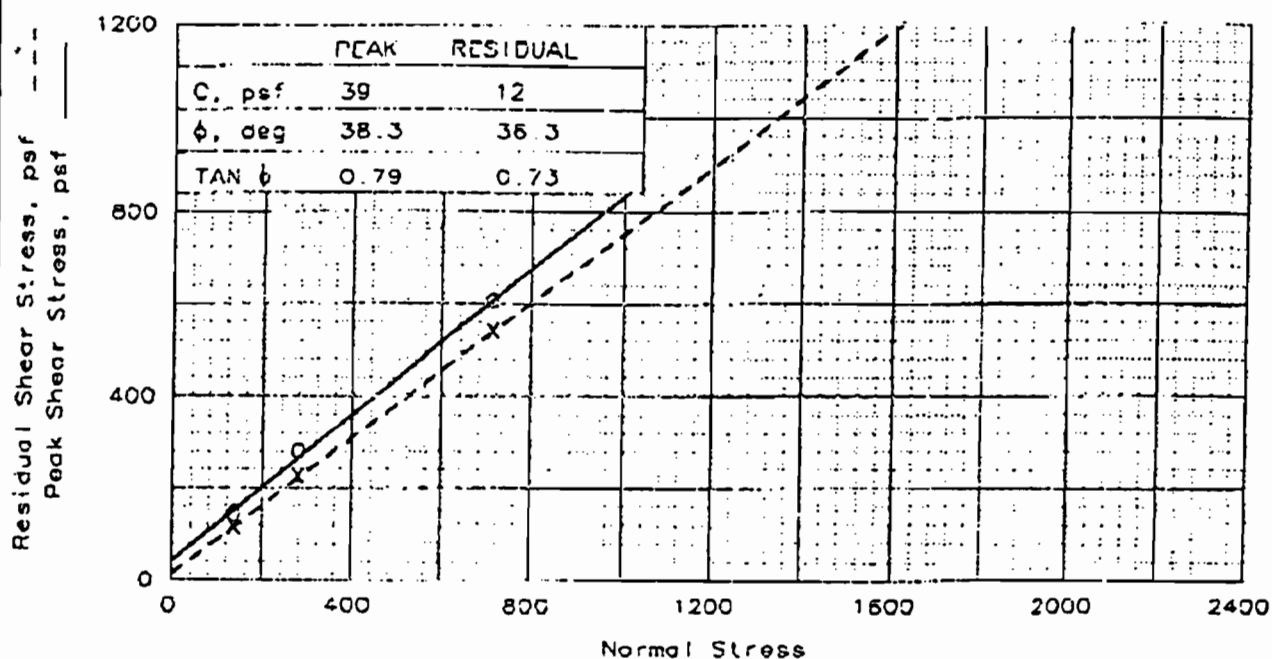
SAMPLE LOCATION: VAN ORDEN SAND & GRAVEL
 QUARRY (COVER SOIL SF-S9-01)

PROJ. NO.: 97S2111

DATE: 12/23/97

DIRECT SHEAR TEST REPORT

J & L TESTING CO., INC.



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	7.8	7.8	7.8
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %	54.3	54.3	54.3
	VOID RATIO	0.381	0.381	0.381
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	14.4	14.3	14.3
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %	99.5	99.6	99.6
	VOID RATIO	0.381	0.381	0.381
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, psf		144	288	720
MAXIMUM SHEAR, psf		143	279	604
RESIDUAL SHEAR, psf		115	225	540
Strain rate, in/min		0.040	0.040	0.040

SAMPLE DATA

SAMPLE TYPE: WET INTERFACE
 DESCRIPTION: ^{COVER} SOIL vs. GEOTEXTILE/EMB. PVC/GEOTEXTILE/SOIL
 LL= PL= PI=
 SPECIFIC GRAVITY= 2.55
 REMARKS: SETUP HYDRATED UNDER
 TEST LOAD FOR ONE HOUR PRIOR
 TO SHEARING. INTERFACE WAS
 TESTED UNDER WATER
 FIG. NO. OGN-2

CLIENT: OGDEN REMEDIATION SERVICES

PROJECT: CLARKSTOWN LANDFILL

INTERFACE SHEAR TESTS - ASTM D 5321

SAMPLE LOCATION: CLARKSTOWN LANDFILL

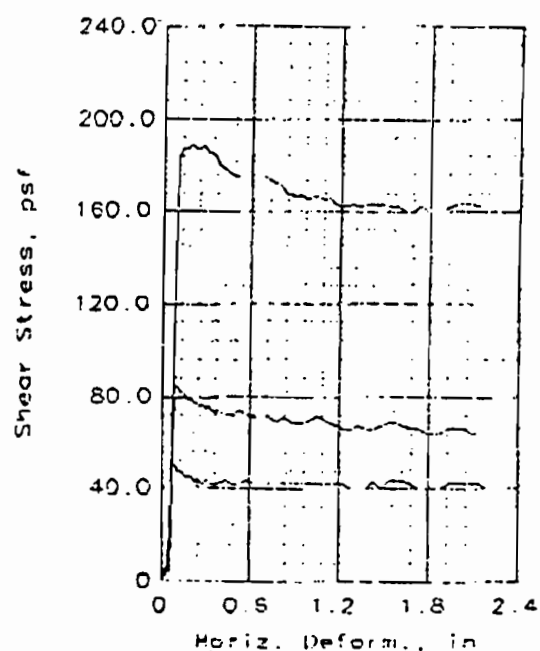
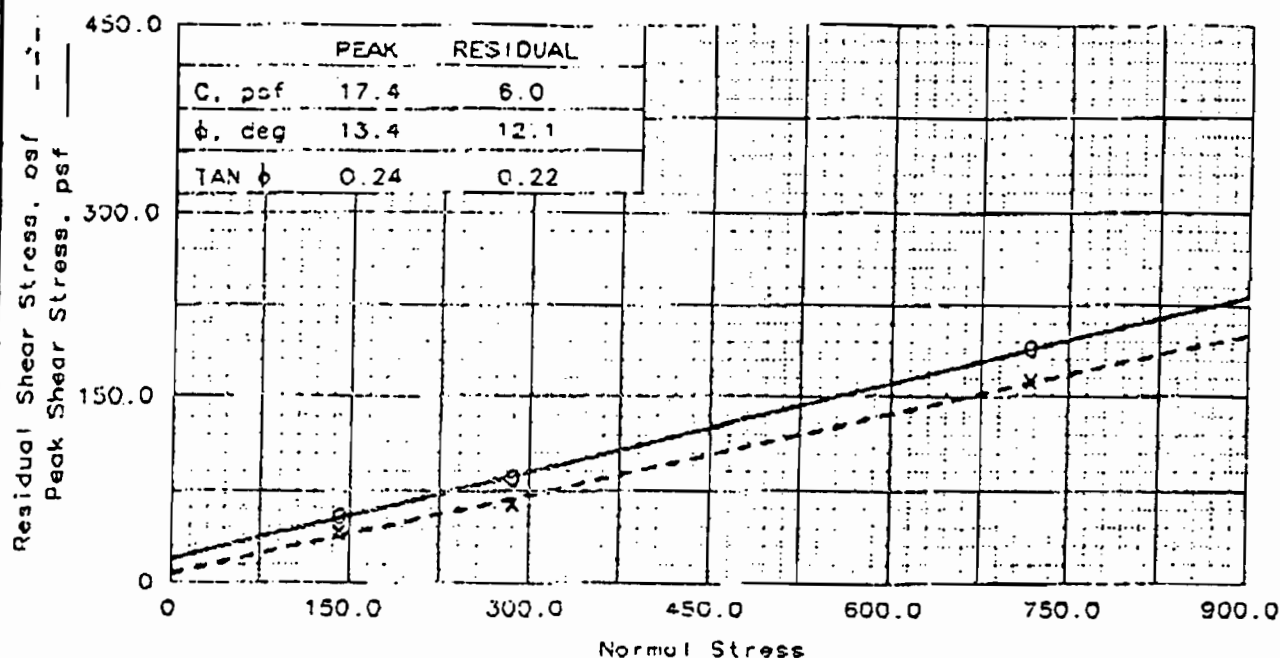
VAN ORDEN SAND & GRAVEL CLARY

PROJ. NO.: 97S2111

DATE: 12/23/97

DIRECT SHEAR TEST REPORT

J & L TESTING CO., INC.



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	7.8	7.8	7.8
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %	54.3	54.3	54.3
	VOID RATIO	0.381	0.381	0.381
	SIDE LENGTH, in	12.00	12.00	12.00
AT TEST	HEIGHT, in	1.00	1.00	1.00
	WATER CONTENT, %	14.4	14.3	14.3
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %	99.8	99.6	99.6
	VOID RATIO	0.381	0.381	0.381
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
	NORMAL STRESS, psf	144.0	288.0	720.0
MAXIMUM SHEAR, psf		53.0	84.0	189.0
RESIDUAL SHEAR, psf		40.0	64.0	162.0
Strain rate, in/min		0.200	0.200	0.200

SAMPLE DATA

SAMPLE TYPE: WEI INTERFACE
DESCRIPTION: SOIL/GEOTEXT/GEUNT
vs. SM PVC/GEOTEX/SOIL

LL= PL= PI=

SPECIFIC GRAVITY= 2.65

REMARKS: SETUP HYDRATED UNDER
TEST LOAD FOR ONE HOUR PRIOR
TO SHEARING. INTERFACE WAS
TESTED UNDER WATER

FIG. NO. OGN-3

CLIENT: OGDEN REMEDIATION SERVICES

PROJECT: CLARKSTOWN LANDFILL

INTERFACE SHEAR TESTS - ASTM D 5321

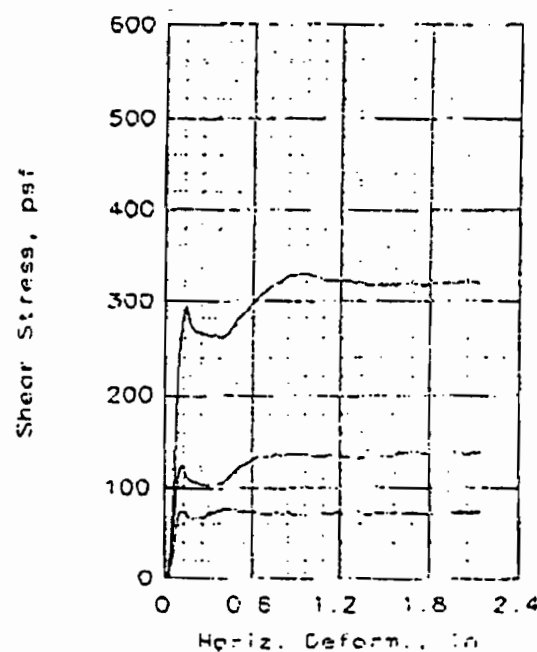
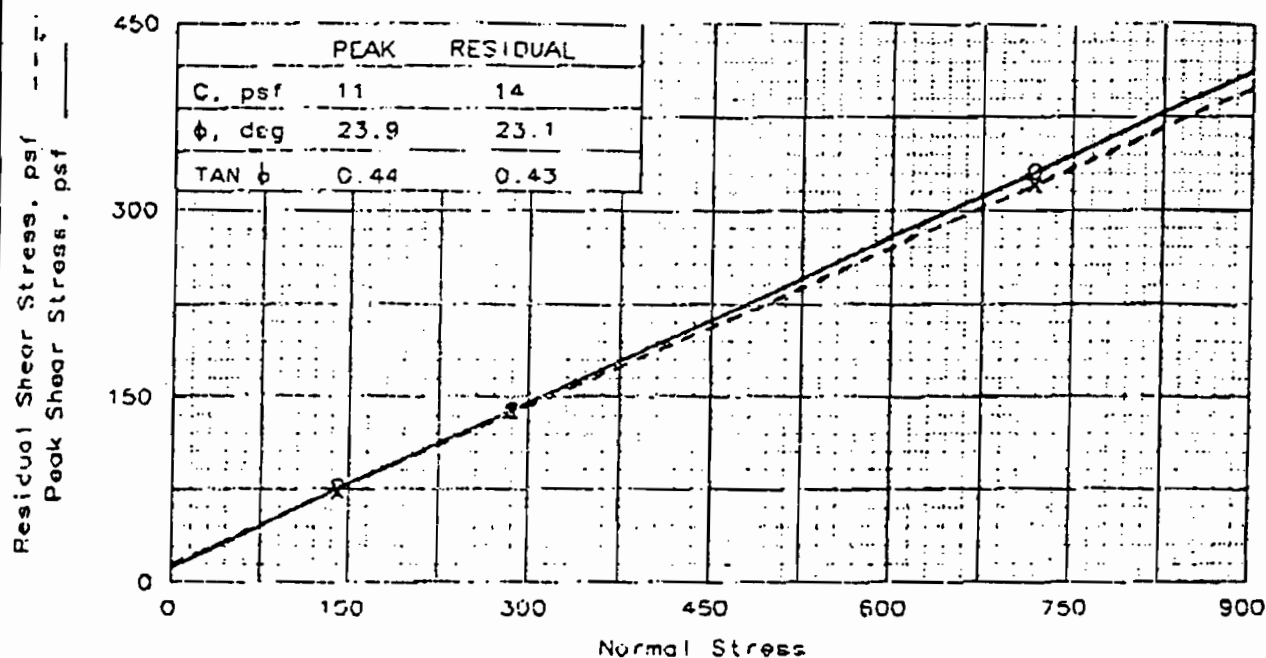
SAMPLE LOCATION: CLARKSTOWN LANDFILL

PROJ. NO.: 9752111

DATE: 12/29/97

DIRECT SHEAR TEST REPORT

J & L TESTING CO., INC.



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	7.6	7.8	7.8
	DRY DENSITY, pcf	119.6	119.8	119.8
	SATURATION, %			
	VOID RATIO			
	SIDE LENGTH, in	12.00	12.00	12.00
AT TEST	HEIGHT, in	1.00	1.00	1.00
	WATER CONTENT, %	14.4	14.3	14.3
	DRY DENSITY, pcf	119.2	119.8	119.8
	SATURATION, %			
	VOID RATIO			
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, psf		144	288	720
MAXIMUM SHEAR, psf		75	138	331
RESIDUAL SHEAR, psf		74	138	320
Strain rate, in/min		0.200	0.200	0.200

SAMPLE DATA
SAMPLE TYPE: WET INTERFACE
DESCRIPTION: SOIL/GEOTEXTILE
vs. EMB. PVC/GEOTEXTILE/SOIL
LL= PL= PI=
SPECIFIC GRAVITY=
REMARKS: SETUP HYDRATED UNDER
TEST LOAD FOR ONE HOUR PRIOR
TO SHEARING. INTERFACE WAS
TESTED UNDER WATER
FIG. NO. OGN-4

CLIENT: OGDEN REMEDIATION SERVICES

PROJECT: CLARKSTOWN LANDFILL

INTERFACE SHEAR TESTS - ASTM D 5321

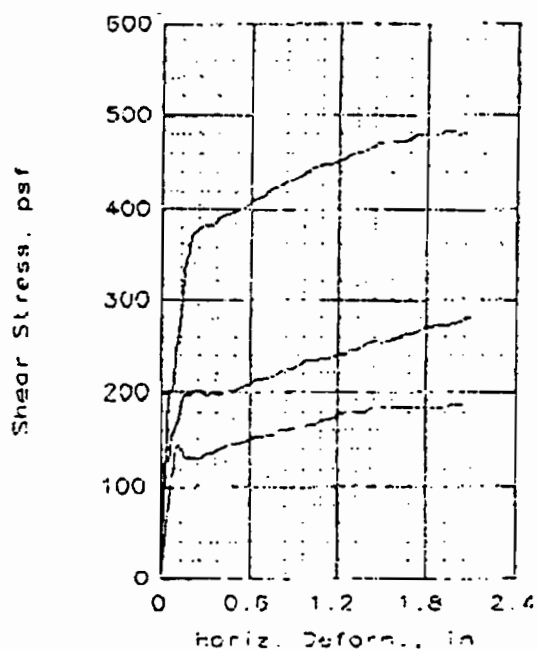
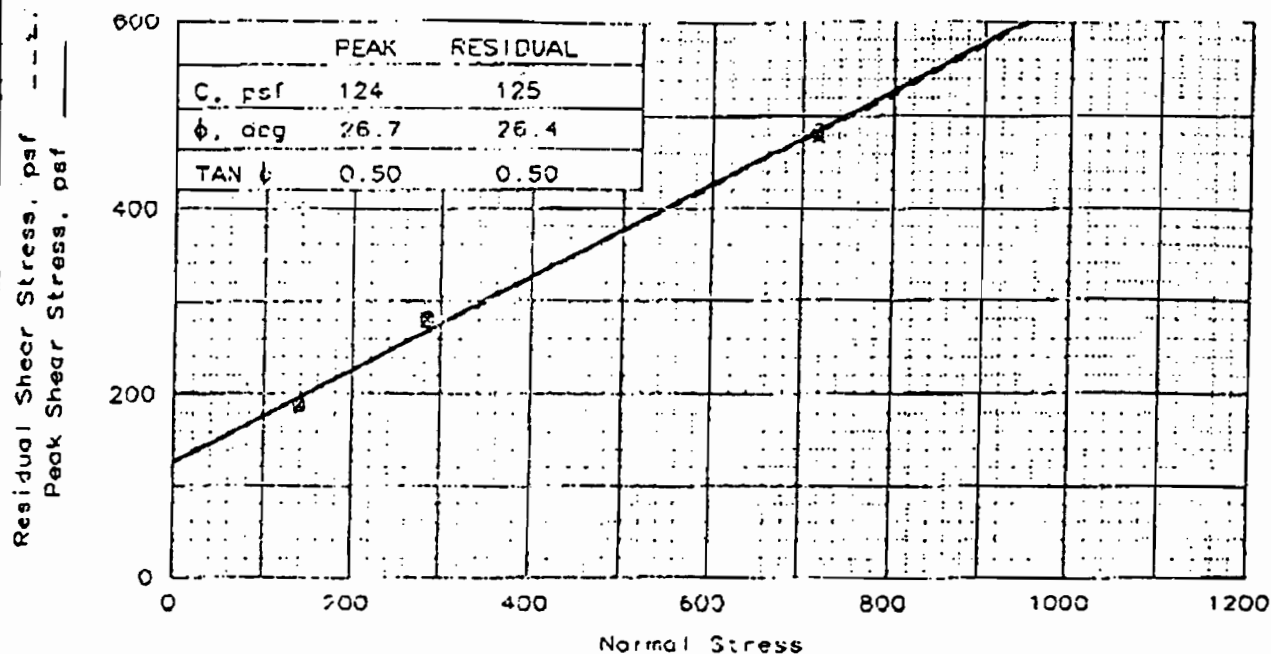
SAMPLE LOCATION: CLARKSTOWN LANDFILL

PROJ. NO.: 9752111

DATE: 12/29/97

DIRECT SHEAR TEST REPORT

J & L TESTING CO., INC.



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	7.8	7.8	7.8
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %			
	VOID RATIO			
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	14.4	14.3	14.3
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %			
	VOID RATIO			
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, psf		144	288	720
MAXIMUM SHEAR, psf		188	280	483
RESIDUAL SHEAR, psf		188	280	480
Strain rate, in/min		0.200	0.200	0.200

SAMPLE DATA

SAMPLE TYPE: WET INTERFACE
 DESCRIPTION: SOIL/GEOTEXTILE/
 EMB PVC vs. GEOTEXTILE/SOIL
 LL- PL- PI-

SPECIFIC GRAVITY=

REMARKS: SETUP HYDRATED UNDER
 TEST LOAD FOR ONE HOUR PRIOR
 TO SHEARING. INTERFACE WAS
 TESTED UNDER WATER

FIG. NO. OGN-5

CLIENT: OGDEN REMEDIATION SERVICES

PROJECT: CLARKSTOWN LANDFILL

INTERFACE SHEAR TESTS - ASTM D 5321

SAMPLE LOCATION: CLARKSTOWN LANDFILL

VAN OGDEN SAND & GRAVEL QUARRY

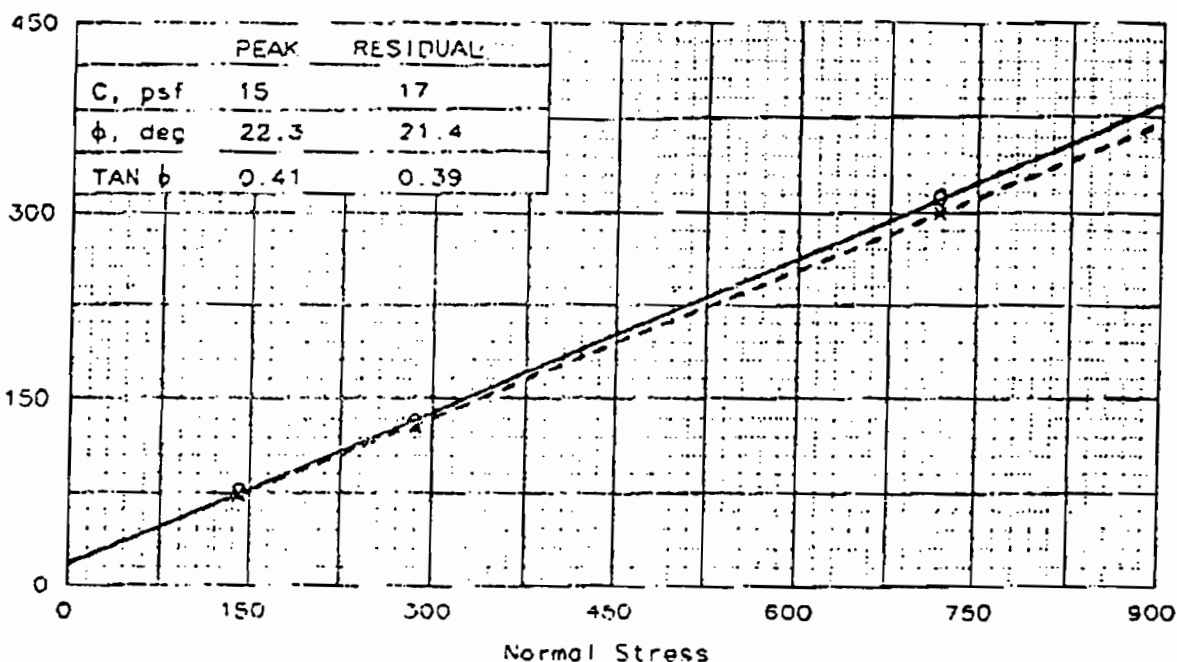
PROJ. NO.: 9752111

DATE: 1/2/98

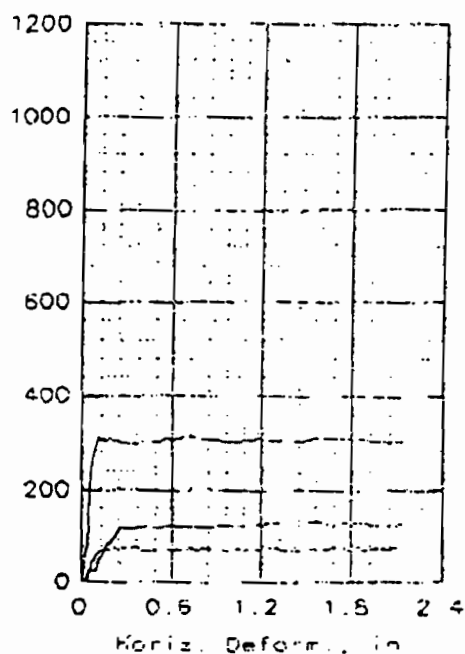
DIRECT SHEAR TEST REPORT

J & L TESTING CO., INC.

Residual Shear Stress, psf
Peak Shear Stress, psf



Shear Stress, psf



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	7.8	7.8	7.8
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %			
	VOID RATIO			
	SIDE LENGTH, in	12.00	12.00	12.00
AT TEST	HEIGHT, in	1.00	1.00	1.00
	WATER CONTENT, %	14.4	14.3	14.3
	DRY DENSITY, pcf	119.8	119.8	119.8
	SATURATION, %			
	VOID RATIO			
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
	NORMAL STRESS, psf	44	288	720
MAXIMUM SHEAR, psf		75	131	311
RESIDUAL SHEAR, psf		74	128	299
Strain rate, in/min		0.200	0.200	0.200

SAMPLE DATA

SAMPLE TYPE: WET INTERFACE

DESCRIPTION: SOIL/GEOTEXT/GEONT

SM PVC vs. GEOTEXTILE/SOIL

LL= PL= PI=

SPECIFIC GRAVITY=

REMARKS: SETUP HYDRATED UNDER
TEST LOAD FOR ONE HOUR PRIOR
TO SHEARING. INTERFACE WAS
TESTED UNDER WATER

FIG. NO. OGN-6

CLIENT: OGDEN REMEDIATION SERVICES

PROJECT: CLARKSTOWN LANDFILL

INTERFACE SHEAR TESTS - ASTM D 5321

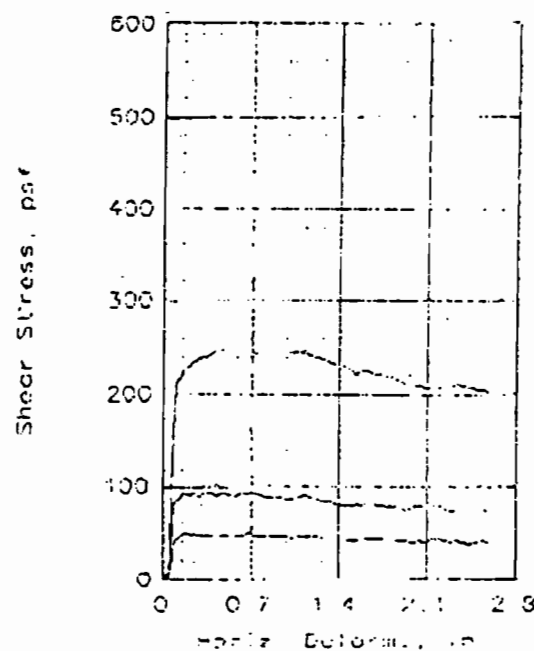
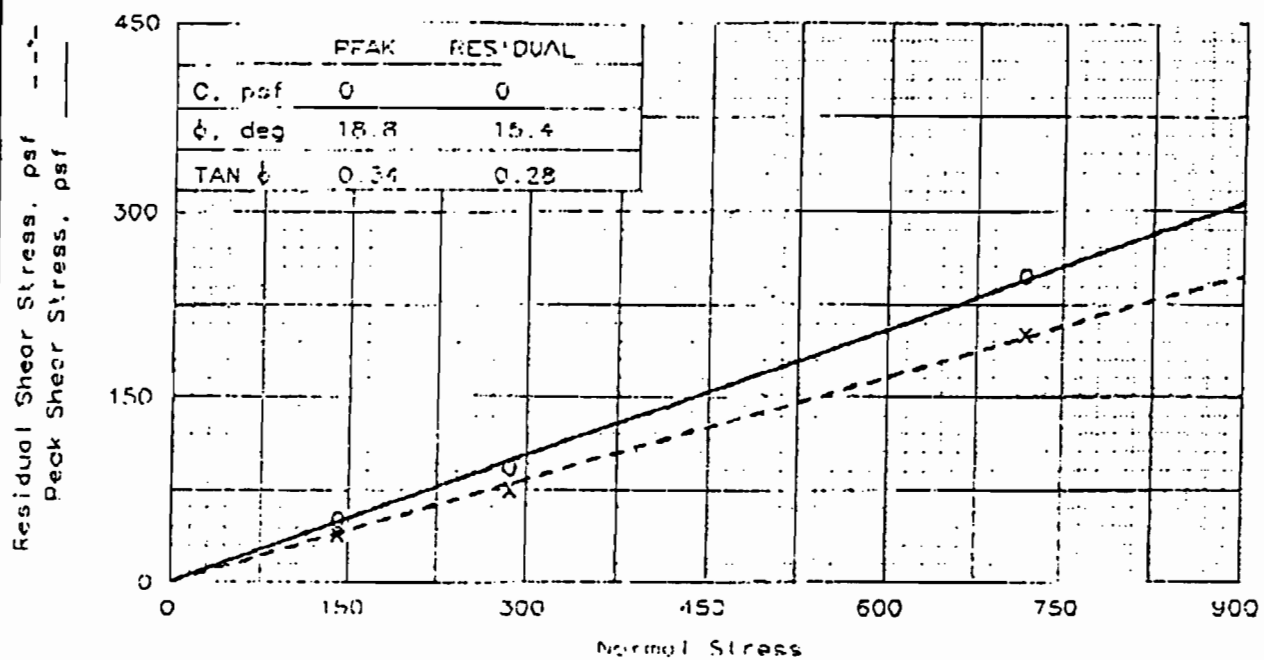
SAMPLE LOCATION: CLARKSTOWN LANDFILL

PROJ. NO.: 97S2111

DATE: 1/2/98

DIRECT SHEAR TEST REPORT

J & L TESTING CO., INC.



SAMPLE NO		1	2	3
INITIAL	WATER CONTENT, %	0.0	0.0	0.0
	DRY DENSITY, pcf	0.0	0.0	0.0
	SATURATION, %			
	VOID RATIO			
AT TEST	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
	WATER CONTENT, %	0.0	0.0	0.0
	DRY DENSITY, pcf	0.0	0.0	0.0
	SATURATION, %			
	VOID RATIO			
	SIDE LENGTH, in	12.00	12.00	12.00
	HEIGHT, in	1.00	1.00	1.00
NORMAL STRESS, psf		144	288	720
MAXIMUM SHEAR, psf		50	92	247
RESIDUAL SHEAR, psf		38	75	200
Strain rate, in/min		0.200	0.200	0.200

SAMPLE DATA

SAMPLE TYPE: WET INTERFACE
 DESCRIPTION: SOIL/GEOTEXTILE VS
 GEONET/SM PVC/GEOTEXTILE/SOIL
 LL= PL= FI=

SPECIFIC GRAVITY=

REMARKS: SETUP HYDRATED UNDER
 TEST LOAD FOR ONE HOUR PRIOR
 TO SHEARING. INTERFACE WAS
 TESTED UNDER WATER

FIG. NO. UGN-7

CLIENT: OODEN REMEDIATION SERVICES

PROJECT: CLARKSTOWN LANDFILL

INTERFACE SHEAR TESTS - ASTM D 5321

SAMPLE LOCATION: CLARKSTOWN LANDFILL

PROJ. NO.: 97S2111

DATE: 1/6/98

DIRECT SHEAR TEST REPORT

J & L TESTING CO., INC.



FAIRWAY TESTING

CONSTRUCTION MATERIALS: TESTING · INSPECTION · RESEARCH

P.O. BOX 578 · STONY POINT, NY 10980 · TELEPHONE (914) 942-2088 · FAX (914) 942-0995

SOILS TEST REPORT

November 13, 1997

client Ogden Remediation Services

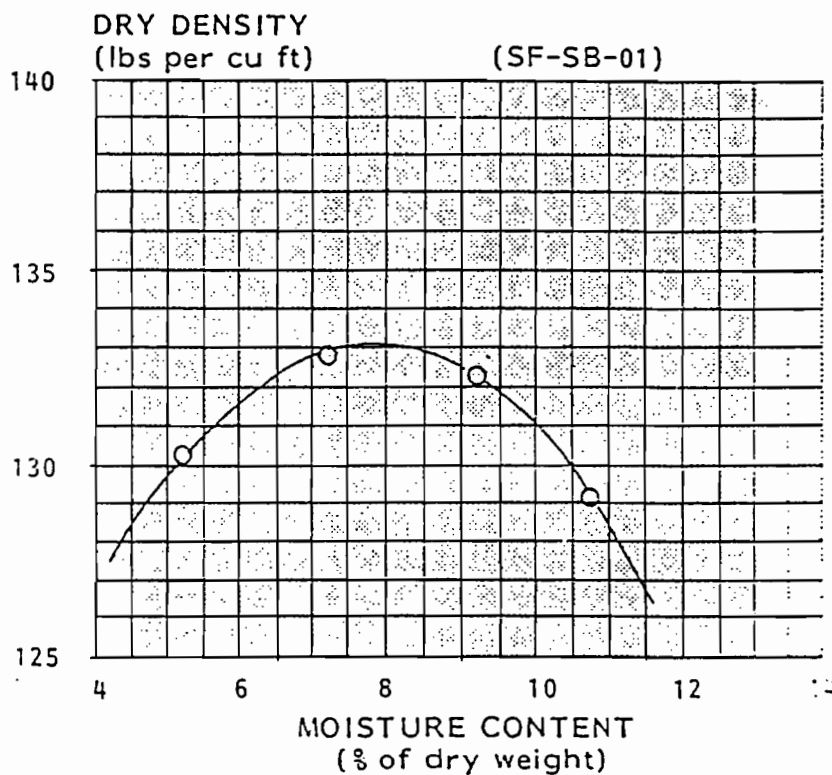
project Clarkstown Landfill

subject Moisture-Density Curve Analysis

Compaction Method ASTM D698

Maximum Dry Density 133.1 pcf
Optimum Moisture Content 7.8%

On this date, a representative from this firm visited the jobsite and picked-up a sample labeled SF-SB-01. Test results are shown below.



FAIRWAY TESTING CO., INC.

P. J. Aguirre
P. J. Aguirre, P.E.

Soil Sample Test Request Record[illegible]



FAIRWAY TESTING

CONSTRUCTION MATERIALS: TESTING · INSPECTION · RESEARCH

P.O. BOX 578 · STONY POINT, NY 10980 · TELEPHONE (914) 942-2088 · FAX (914) 942-0995

SOILS TEST REPORT

December 19, 1997

client Ogden Remediation Services

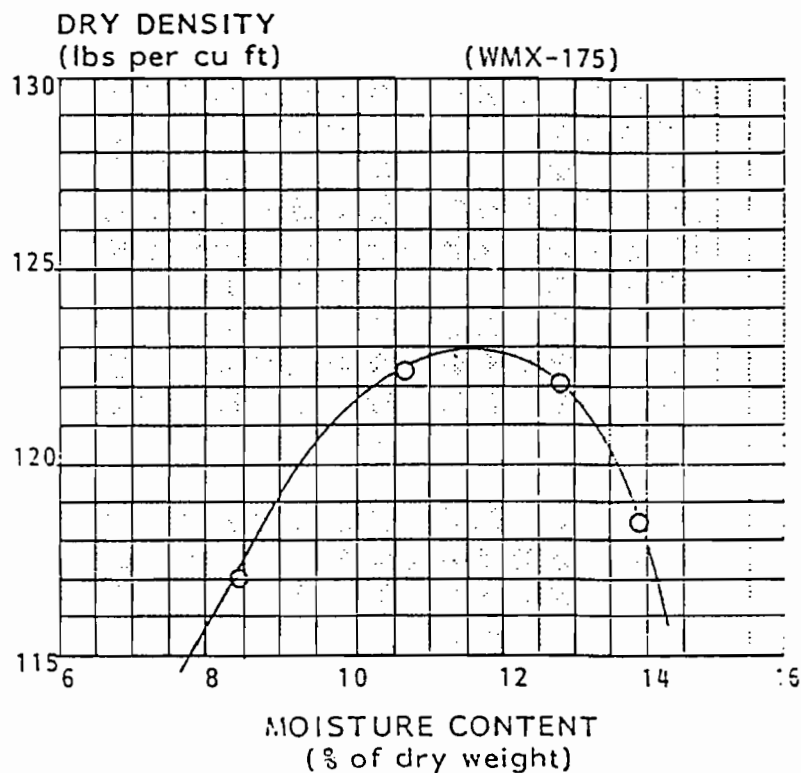
project Clarkstown Landfill

Compaction Method ASTM D698

subject Moisture-Density Curve Analysis

Maximum Dry Density 122.9 pcf
Optimum Moisture Content 11.6%

On Decembet 18, 1997, a represenatative from this firm visited the jobsite and took sample WMX-175. Test results are shown below.



FAIRWAY TESTING CO., INC.

P. J. Aguanno, P. E.

[illegible]

Doc. 473

White Copy - Lit
Yellow Copy - File
Pink Copy - Attach to Daily Report

5000

Project Name/Client: <u>Charlottean LE 44 F Capping</u>	Project No.: <u>600160002</u>	Date Sent: <u>12/19/97</u>
Project Location: <u>Charlottean landfill/west of Jack</u>	Purchase Order No.: _____	Shipped Via: _____
Sampled By: <u>A. Rembo</u>	Lab Contact: _____	Date Received: <u>12/19/97</u>
(Signature)		

Sample No.	Description	ANALYSES REQUIRED								
		Standard Proctor ASTM D1557	Modified Proctor ASTM D1557	AASHTO T99	Sieve Analysis ASTM D422	Hydro- meter ASTM D1160	Moisture Content ASTM D2216	Classifi- cation ASTM D2497	Remolded Proctor ASTM D2216	Falling Head Perm. ASTM D2216
SF-100X 180										ASTM
										5321
										X

Comments/Special Instructions: <u>Sampled from on site stock pile</u>



Roy F. Weston, Inc.
1400 Weston Way
P.O. Box 2653
West Chester, PA 19380
610-701-3000 • Fax 610-701-3186
www.rfweston.com

6.8

January 14, 2000

Robert C. Knizek, P.E.
New York State Department of
Environmental Conservation (NYSDEC)
Bureau of Construction Services, Room 267
Division of Environmental Remediation
50 Wolf Road
Albany, NY 12233-7010

**RE: Clarkstown Landfill Remediation
NYSDEC Site No. 3-44-001
Further Explanation of Field Constructed Geomembrane Seams**

Dear Mr. Knizek:

This letter is written in response to your request for Roy F. Weston, Inc. (WESTON®) to provide its opinion regarding the integrity of the PVC geomembrane seams constructed as part of the cover system at the Clarkstown Landfill.

I have reviewed the following documents in preparation of this letter:

1. The original design calculations prepared by WESTON's design department in West Chester, Pennsylvania.
2. The geomembrane specification (Section 06010B - Polyvinyl Chloride (PVC) Geomembrane).
3. The destructive seam testing summary report prepared by TRI/Environmental, Inc. (TRI).
4. The review and analyses of the seams performed by GeoSyntec Consultants, Inc. (GeoSyntec).

In keeping with conventional design practice, WESTON designed the landfill cover system so as to preclude the development of tension in any of the geosynthetic components. As such, by providing a design in which tension was not developed, the tensile strength of the geomembrane, the other geosynthetic components, and their associated seams becomes a less critical component





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of the overall design. By eliminating the potential for tension to develop in the cover system via design considerations, the engineering basis for tensile property requirements of the geosynthetic components is essentially eliminated.

Consequently, the mechanical properties of the cover system components are dictated by either regulations or by typical industry values. As the NYSDEC regulations (i.e., 6 NYCRR Part 360), governing landfill covers require a minimum geomembrane thickness of 40 mils (60 mils for geomembranes comprised of high density polyethylene), the mechanical properties of the candidate geomembrane were, by default, based on the manufacturers' values. In regard to the strength of the geomembrane seams, the tensile property requirements (i.e., shear and peel strengths) were based on the National Sanitation Foundation (NSF) International Standard (NSF 54) for Flexible Membrane Liners for 40-mil PVC material. This standard requires that factory seams obtain a minimum shear and peel strength for a 40-mil PVC geomembrane of 74 lb/in and 10 lb/in, respectively. In general, the industry requires that field constructed seams have a shear and peel strength equal to that of factory constructed seams.

As you are aware, and as discussed in the TRI summary report, 30 of 136 archived destructive seam samples tested by NTH Consultants, Ltd. resulted in shear strength values below the specified value of 74 lb/in with a minimum average value of 65 lb/in. As a result of a number of seam shear strength test values not meeting or exceeding the specified value, WESTON contracted GeoSyntec to review the integrity of the geomembrane seams. GeoSyntec conducted a rigorous evaluation of the acceptability of the seams using the average shear strength value of 65 lb/in reported by TRI. For the configured landfill two conditions, localized subsidence and slope stability, that could cause tension in the seams were analyzed to determine the potential for a shear type failure of the sub-standard seams. Upon completion of its evaluation, GeoSyntec concluded that a seam shear strength value of 65 lb/in would "meet the intent of the design".

WESTON concurs with the GeoSyntec findings and believes that the cover system performance will not be negatively impacted as a result of seam shear strength values less than the specified value of 74 lb/in. Based on a review of the original design calculations, the results of the seam shear strength tests performed on archived destructive seam test samples, and the analyses performed by GeoSyntec, WESTON believes that the integrity of the PVC geomembrane seams constructed during the installation of the cover system at the Clarkstown Landfill will not have an adverse or negative impact on the long-term performance of the cover system.

I have attached a copy of my professional WESTON profile for your reference.



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If you have any additional questions regarding this issue, please contact me at (610) 701-5293, or Paul O'Connor at (212) 502-7856.

Very truly yours,

ROY F. WESTON, INC.

Andrew Harpur, P.E.
Geotechnical Project Engineer

Attachment

cc: J. Helemset - NYSDEC
P. O'Connor - WESTON
N. Nowak - WESTON
T. Leonard - WESTON
R. Desantis - WESTON
D. Bauer - WESTON

W. ANDREW HARPUR, P.E.

Qualifications Summary

- Five years of professional experience.
- Performed geotechnical evaluation and design for landfill closure projects and chemical and industrial sites.
- Select geosynthetic components for landfill closure projects based on design calculations and performance requirements.
- Prepared technical specifications for landfill closures and capping of industrial sites.
- Developed design-drawing details incorporating soil and geosynthetic components for various projects.
- Provided construction oversight for landfill closures, pipeline installation, and building foundation construction.

Registration

Registered Professional Engineer in the Commonwealth of Pennsylvania

Fields of Competence

Geotechnical evaluation and design including foundation design, slope stability analyses, consolidation and settlement analyses. Geosynthetic design and selection-based performance requirements. Preparation of technical specifications relating to soil and geosynthetic components of construction. Oversight of construction projects.

Credentials

M.S., Civil Engineering—Drexel University (1994)
B.S., Civil Engineering—Drexel University (1992)
Certified—Troxler Nuclear Density Gauge (1996)
Certified Erosion and Sediment Control, State of Maryland (1996)
8-Hour Hazardous Waste Refresher Course, OSHA 29 CFR 1910.120(e)(8), WESTON (1999)
International Geosynthetics Society
North American Geosynthetics Society
American Society of Civil Engineers

Employment History

1999-Present WESTON
1998 URS Greiner Woodward Clyde
1998 Dames & Moore
1995-1998 WESTON
1994-1995 Part-Time Employment
1992-1994 Drexel University, Geosynthetic Research Institute (Graduate Student)
1991-1992 Drexel University (Undergraduate Student)
1989-1991 Crossing Construction Company

Key Projects

Landfill Design, Pensacola, FL, Confidential Client, Design Engineer. Reviewed geosynthetic and geotechnical submittals for

Key Projects (Continued)

approval during construction phase of project. Performed slope stability analyses during design phase and revised as construction conditions dictated.

Industrial Site Cap and Containment System, Middlesex, NJ, Rhone-Poulenc, Design Engineer. Evaluated various capping material alternatives and groundwater cut-off wall technologies for active industrial site. Prepared preliminary cost analyses and evaluated technical merit for each option. Developed concept-level plans for drainage ditch remediation and stabilization. Generated capping alternatives for peripheral properties that met capping requirements while considering cost and aesthetic requirements of property owners. Developed and updated design and preliminary construction schedule as project progressed.

Landfill Closure, Delaware City, DE, Star Enterprises, Design Engineer. Prepared construction level technical specifications and construction drawing details for landfill closure. Analyzed settlement potential of highly compressible dredge spoil materials and the impact of material consolidation on final landfill grades. Evaluated stability of sideslopes and geosynthetic material properties.

Landfill Closure, North Landfill, Wilmington, DE, Confidential Client, Design Engineer. Reviewed historical landfill records to gain an understanding of past operational procedures. Developed 30% design-level drawings and associated calculations, including preliminary construction schedule and costs analyses. Conducted preliminary evaluation on the use of alternate materials, i.e., residual waste materials for use as a landfill cover material.

Landfill Closure, Dorney Road Landfill, Allentown, PA, Cooperating Respondents, Field Engineer. Provided quality assurance oversight for construction of landfill cap. Reviewed contractor submittals, inspected incoming materials. Responded to contractor requests for information.

Tank Farm Containment Dike Evaluation, Various Locations, Exxon, Design Engineer. Evaluated field and laboratory data and performed calculations to determine the permeability of tank farm containment dikes.

Pipeline Installation and Pump Station Construction, Lehigh County Authority, Lower Macungie Township, PA, Field Engineer. Provided quality assurance oversight for pipeline excavation, pipe installation, and backfilling on state and township roadways and on private property. Monitored construction of pump station including foundation preparation, erection of formwork, placement of concrete, and application of waterproofing materials.

Landfill Closure, Philadelphia International Airport, Department of Aviation, Field Engineer/Design Engineer. Evaluated geotechnical laboratory data, performed design-level slope stability and settlement analyses for the proposed construction of the Enterprise Avenue Landfill cap. Revised analyses during construction to reflect changes in construction sequencing and schedule. Provided quality assurance oversight for the placement and installation of earthen and geosynthetic materials during the construction of cap materials.

Key Projects (Continued)

Road Upgrade and Landfill Closure, Aberdeen Proving Ground, MD, Field Engineer.

Provided quality control oversight of road upgrade including aggregate placement and compaction, and asphalt and concrete placement. Directed the installation of bin block walls and geogrid. Tracked material quantities and laboratory test results.

Landfill Closure, West Nyack, NY, Town of Clarkstown, Design Engineer. Assisted in the preparation and review of technical specifications. Performed slope stability analyses. Evaluated settlement potential of perimeter/stormwater berms. Evaluated integrity of gravel access road.

Landfill Closures, Various Locations, Multiple Clients, Design Engineer. Involved in various phases of municipal solid waste landfill closure design including settlement evaluation, veneer stability of the lining system, slope stability, drainage layer performance (HELP model), and depth of frost penetration analyses. Clients included U.S. Army Corps of Engineers (USACE), West Point, NY and Zeneca Inc., Dighton, MA.

Housing Redevelopment Project, Philadelphia, PA, Philadelphia Housing Development Corporation and the Strawberry Mansion Housing Coalition, Design Engineer. Analyzed the settlement of condominium deep foundations over unstable fill. Developed initial time and cost estimates for the installation of foundations.

Slope Stability Analyses, Wilmington, DE, Delaware Solid Waste Authority, Design Engineer. Conducted slope stability analyses of a berm constructed atop dredge spoils using computer software. Consideration was given to strength gain of the underlying soils and the sequencing of waste placement.

Health and Safety Plan Development (HASP), Pensacola, FL, Confidential Client, Design Engineer. Developed a HASP for subsurface investigation at a contaminated site. The plan took into consideration the contaminant, the possible exposure routes, and the activities to be performed.

Vertical Expansion of Landfill, Honey Brook, PA, Chester County Solid Waste Authority, Design Engineer. Evaluated the performance of the geosynthetic components of the lining system under increased loads imposed by a vertical expansion of the existing landfill. Also performed slope stability analyses on the proposed reconfigured side slopes.

Existing Cap Evaluation, Broadway, NJ, New Jersey Department of Environmental Protection, Design Engineer. Evaluated the adequacy of an existing landfill cover system that was found to have thin areas of cover material. Performed calculation to determine if any remedial action was required to ensure the integrity of the capping system.

Foundation Design, Mobil Soil Incinerator, Michigan, USACE, Design Engineer. Analyzed proposed foundations to determine if equipment manufacturer's settlement criteria were met. Deform computer program was utilized to determine total and differential settlement of the various foundation slabs.

Instrument Monitoring, Wilmington, DE, Delaware Solid Waste Authority, Design Engineer. Monitoring of slope inclinometers and groundwater wells and manipulation of the

Key Projects (Continued)

recorded data. Monitored slope inclinometers installed in a berm constructed atop hydraulic fill. Responsibilities included field recording of movement via electronic measuring devices and reduction of data to report format. Also included monitoring of groundwater wells and visual inspection of the berm slopes.

Testing of Geosynthetic Clay Liners, Philadelphia, PA, Drexel University, Geosynthetic Research Institute, Research Assistant. Performed various tests on geosynthetics, in particular, direct shear and intimate contact tests on geosynthetic clay liners. Set up all testing equipment and designed testing program. Provided continuous monitoring of instruments and recorded appropriate data. Interpreted data and evaluated performance of the various test specimens.

Publications and Presentations

Koerner, R.M., R. Wilson-Fahmy, and W.A. Harpur. 1995. "Long Term Pullout of Polymeric Geogrids." *Journal of Geotechnical Engineering, American Society of Civil Engineers*, Vol. 121, No. 10, p. 723-728.

Harpur, W.A., R.F. Wilson-Fahmy, and R.M. Koerner. 1994. "Evaluation of the Contact Between Geosynthetic Clay Liners and Geomembranes in Terms of Transmissivity." Proceedings GRI-7 Conference on Geosynthetic Liner Systems, IFAL, St. Paul, MN, p. 138-149.

Harpur, W.A. 1994. "Mid-Plane Hydrated Shear Strength of Selected Geosynthetic Clay Liners." Master of Science Thesis, Drexel University, Philadelphia, PA.

Harpur, W.A., R.F. Wilson-Fahmy, and R.M. Koerner. 1993. "Evaluation of the Contact Between Geosynthetic Clay Liners and Geomembranes in Terms of Transmissivity." Proceedings of the 7th Annual Geosynthetic Research Institute Conference, Philadelphia, PA.