205395

FINAL

REMEDIAL ACTION REPORT
LANDFILL CAP SYSTEM

VOLUME I of II – TEXT, FIGURES, TABLES, AND DRAWINGS

METAMORA LANDFILL SITE
LAPEER COUNTY, MICHIGAN

FINAL

REMEDIAL ACTION REPORT
LANDFILL CAP SYSTEM

VOLUME I of II – TEXT, FIGURES, TABLES, AND DRAWINGS

METAMORA LANDFILL SITE
LAPEER COUNTY, MICHIGAN

AUGUST 2002
REF. NO. 3298 (131)

Prepared by:
Conestoga-Rovers & Associates

14496 Sheldon Road
Suite #200
Plymouth, MI 48170

Office: 734·453·5123
Fax: 734·453·5201

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
1.1	GENERAL	1
1.2	SITE BACKGROUND	1
1.3	REPORT ORGANIZATION	2
2.0	OPERABLE UNIT BACKGROUND	3
3.0	PROJECT ORGANIZATION	5
3.1	AGENCY OVERSIGHT	5
3.2	TECHNICAL COORDINATION	5
3.3	CONSTRUCTION MANAGEMENT	5
3.4	CONTRACTOR/SUBCONTRACTORS	5
4.0	CONSTRUCTION ACTIVITIES	6
4.1	SHEET PILE WALL INSTALLATION	6
4.2	LANDFILL CAP CONSTRUCTION	7
4.2.1	ON-SITE GRADING FILL LAYER	8
4.2.2	BEDDING SOIL LAYER	8
4.2.3	GEOSYNTHETIC CLAY LINER	8
4.2.4	FLEXIBLE MEMBRANE LINER	9
4.2.5	SAND DRAINAGE LAYER	10
4.2.6	COMMON FILL LAYER	11
4.2.7	TOPSOIL LAYER	11
4.2.8	VEGETATIVE COVER	12
4.3	LANDFILL AND PERIMETER GAS VENTS	12
4.4	LANDFILL AND PERIMETER GAS PROBES	12
4.5	CHANGES TO ORIGINAL SCOPE OF WORK	13
5.0	CHRONOLOGY OF EVENTS	16
6.0	PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL	17
6.1	REVISED FINAL (100%) DESIGN REPORT	17
6.2	HEALTH AND SAFETY PLAN	17
6.3	CONSTRUCTION QUALITY ASSURANCE PLAN	17
6.4	SURFACE WATER MANAGEMENT PLAN	18
6.5	OPERATION AND MAINTENANCE PLAN	18
6.6	EROSION AND SEDIMENT CONTROL PLAN	18
6.7	SEEDING AND EROSION CONTROL PLAN	19
7.0	HEALTH AND SAFETY	20
7.1	GENERAL	20
7.2	HEALTH AND SAFETY PLAN IMPLEMENTATION	21

TABLE OF CONTENTS (CONT'D)

Page

7.3 AIR MONITORING 21
7.3.1 EXCLUSION ZONE AIR MONITORING 21
7.3.2 SITE PROPERTY LINE AIR MONITORING 22
7.3.3 METEOROLOGICAL MONITORING 22

8.0 INSPECTION AND CERTIFICATION 23
8.1 SUBSTANTIAL COMPLETION INSPECTION 23
8.2 FINAL INSPECTION 23
8.3 INSTITUTIONAL CONTROLS 23
8.4 CERTIFICATION 23

9.0 OPERATION AND MAINTENANCE ACTIVITIES 25

10.0 SUMMARY OF PROJECT COSTS 26

11.0 OBSERVATIONS AND LESSONS LEARNED 27

12.0 CONTACT INFORMATION 28

LIST OF FIGURES
(Following Report)

FIGURE 1.1 SITE LOCATION

FIGURE 1.2 SITE PLAN

FIGURE 3.1 PROJECT ORGANIZATION CHART

LIST OF TABLES
(Following Report)

TABLE 5.1 CHRONOLOGY OF MAJOR EVENTS

LIST OF APPENDICES

APPENDIX A ON-SITE GRADING FILL LAYER CONFORMANCE TEST RESULTS

APPENDIX B BEDDING SOIL LAYER CONFORMANCE TEST RESULTS

APPENDIX C GCL CONFORMANCE TEST RESULTS

APPENDIX D INTERFACE SHEAR TEST RESULTS

APPENDIX E GCL MANUFACTURER CERTIFICATIONS

APPENDIX F GCL MANUFACTURER WARRANTY

APPENDIX G FML CONFORMANCE TEST RESULTS

APPENDIX H FML MANUFACTURER CERTIFICATIONS

LIST OF APPENDICES (CONT'D)

APPENDIX I	FML MANUFACTURER WARRANTY
APPENDIX J	FML QA/QC TEST RESULTS
APPENDIX K	SAND DRAINAGE CONFORMANCE TEST RESULTS
APPENDIX L	COMMON FILL CONFORMANCE TEST RESULTS
APPENDIX M	TOPSOIL CONFORMANCE TEST RESULTS
APPENDIX N	LANDFILL GAS VENT AND PROBE RECORD DOCUMENTS
APPENDIX O	AIR MONITORING RESULTS
APPENDIX P	SHEET PILE WALL DOCUMENTATION

LIST OF AS RECORDED DRAWINGS

DRAWING 1	EXISTING CONDITIONS AS OF DECEMBER 2000
DRAWING 2	GENERAL SITE PLAN OF COMPLETED WORKS
DRAWING 3	SUBGRADE CONTOURS
DRAWING 4	FML AS-BUILT
DRAWING 5	CAP SECTIONS
DRAWING 6	CAP DETAILS
DRAWING 7	ACCESS ROAD AND DRAINAGE DITCH DETAILS
DRAWING 8	LANDFILL GAS VENT, PROBE, AND FENCING DETAILS
DRAWING 9	SHEET PILE DETAILS

Remedial Action Report
Landfill Cap System

Record of Preparation, Review, and Approval

Metamora Landfill Site
Lapeer County, Michigan

This Report has been prepared in general accordance with U.S. EPA OSWER Directive 9320.2-09A-P.

RA Report Prepared By:	Conestoga-Rovers & Associates, Inc.	*Signature* James Reid *Name and Title* JAMES REID PROJECT MANAGER *Date* 8/29/02
Approved By:	U.S. EPA Region 5	*Signature* *Name and Title* JAMES N. MAYKA, P.E. CHIEF, REMEDIAL RESPONSE BRANCH *Date* 10/2/02

1.0 INTRODUCTION

1.1 GENERAL

Conestoga-Rovers and Associates, Inc. (CRA), on behalf of the Metamora Landfill Settling Potentially Responsible Party (PRP) Group (MLSPG), has prepared this Remedial Action (RA) Report - Landfill Cap System (Report) for the Metamora Landfill Site (Site) located in Lapeer County, Michigan. This Report was prepared in general accordance with the United States Environmental Protection Agency (U.S. EPA) guidance document entitled "Close Out Procedures for National Priorities List Site, Office of Solid Waste and Emergency Response (OSWER) Directive 9320.2-09A-P", (U.S. EPA; January 2000).

1.2 SITE BACKGROUND

The Site is situated on a 160-acre parcel of land located approximately 3/4 miles east of the Village of Metamora in Lapeer County, Michigan. The landfill encompasses an area of approximately 25 acres within the 160-acre Site. The Site is situated on a local topographic high which is comprised of extensive sand and gravel deposits. Figure 1.1 presents the Site location. Figure 1.2 presents the Site plan as it existed prior to the landfill cap construction activities.

The landfill began operations in 1966 as a privately owned, unregulated open dump. In 1969, the landfill was upgraded to meet existing standards, and licensed to receive general refuse. The landfill accepted both industrial and municipal waste until it closed in 1980.

A number of environmental investigations have been completed at the Site. The Site was added to the National Priorities List (NPL) on October 15, 1984. The U.S. EPA subsequently issued a Phased Feasibility Study in August 1986 and a Record of Decision (ROD) in September 1986 calling for the excavation and off-Site incineration of buried drummed wastes and interstitial soils from Drum Areas 1 and 4. Incineration of buried drums and soils located in the two drum disposal areas was termed the Operable Unit Number 1 (OU1) RA.

In 1988, the Michigan Department of Natural Resources[1] (MDNR) contracted with Chemical Waste Management, Inc. (CWM) to conduct the drum excavation, handling,

[1] The Michigan Department of Environmental Quality is referred to as the Michigan Department of Natural Resources if the communication was conducted prior to October 1995.

transport and off-Site incineration of all excavated waste materials as part of the OU1 RA. CWM began excavation in 1989. As of December 1990, a total of approximately 25,000 drums had been excavated. A total of approximately 15,000 drums were disposed of at an off-Site incineration facility and approximately 10,000 remained on Site on the drum storage pad. Drum excavation and disposal activities were discontinued by the MDNR in December 1990.

A ROD for Operable Unit Number 2 (OU2) was subsequently signed which is the subject of this Report and described in Section 2.0.

1.3 REPORT ORGANIZATION

The Report provided herein summarizes the activities pertaining to the Landfill Cap System RA. The Report is organized as follows:

i) Section 1.0 - presents the introduction;

ii) Section 2.0 - presents the OU background;

iii) Section 3.0 - presents the project organization;

iv) Section 4.0 - presents the major construction activities;

v) Section 5.0 - presents a chronology of the major events;

vi) Section 6.0 - provides an assessment of the performance standards and a construction quality control program;

vii) Section 7.0 - presents a summary of the Health and Safety Implementation;

viii) Section 8.0 - provides details of the substantial completion Site inspection;

ix) Section 9.0 - describes Operation and Maintenance (O&M) activities for the RA;

x) Section 10.0 - summarizes the estimated and actual project costs;

xi) Section 11.0 - provides observations and lessons learned; and

xii) Section 12.0 - presents contact information.

2.0 OPERABLE UNIT BACKGROUND

During the summer of 1990, a Remedial Investigation/Feasibility Study (RI/FS) for the associated landfill and groundwater, OU2, was finalized by the U.S. EPA. The OU2 remedy included provisions for a landfill cap and a groundwater extraction/treatment system. The OU2 culminated in a ROD in September 1990 for the OU2 remedial actions.

Subsequent negotiations between the U.S. EPA and the PRPs resulted in the development of the Consent Decree (CD) and Scope of Work (SOW), which addressed all remaining Site-wide remedial actions proposed for the Site. The SOW was modified by an August 1996 ROD amendment for OU1 and a September 2001 ROD amendment for OU2. The 1996 ROD amendment allowed for the relocation of Drum Area 1 (DA1) soils under the landfill cap instead of off-Site incineration. The 2001 ROD amendment allowed for a natural attenuation groundwater treatment remedy instead of groundwater pump and treat system. The CD and SOW outlined the conceptual approach to design and implementation of individual remedy components of the Site-wide remedy. The remedy components dealing with the groundwater are being addressed separately.

As part of the CD and SOW, the MLSPG in 1994 completed the drum excavation work and incineration of all excavated containerized waste and soil containing mobile non-aqueous phase liquids (MNAPLs) and polychlorinated biphenyls (PCBs) greater than 500 mg/kg. The completion of the work culminated in the Source Removal and Disposal Program Phase II Report submitted to and approved by the U.S. EPA in April 1995.

The Final (100%) Design Report for the Landfill Cap System and addendum, which presented the design of the landfill cap system, was submitted to, and approved by, the U.S. EPA in 1998. In anticipation of the landfill cap construction, implementation of the U.S. EPA-approved Site Preparation Activities (SPA) Work Plan (October 1996) commenced in July 1998. The SPA Work Plan outlined excavating and relocating Soil Staging Area (SSA) and DA1 soils and constructing the south grading layer of the landfill cap. However, access to the Site was suspended by the John R Sand & Gravel Company (John R) between December 1998 and April 1999. Through further negotiations with the U.S. EPA and John R, access was gained and the SPA re-commenced in November 1999 and was completed in March 2000. The Completion of Construction-Site Preparation Activities Report was submitted to the U.S. EPA in August 2000. Approximately 40,660 cubic yards of SSA and DA1 soils were relocated and covered with approximately 182,000 cubic yards of imported fill material.

In June 2000, the Conceptual Site Model (CSM) Report was submitted to the U.S. EPA to support a petition to amend the remedial actions specified in the 1990 ROD. The CSM Report supported the placement of a permeable cap over most of the landfill in order to promote the naturally occurring attenuation of constituents of concern in the groundwater (a low permeable cap was still recommended to be placed over the relocated SSA and DA1 soils), and the use of monitored attenuation instead of a groundwater extraction system.

However, the Michigan Department of Environmental Quality (MDEQ) denied the MLSPG's request for modification of the cap to the permeable option. As an alternate, the MDEQ (in consultation with the U.S. EPA) allowed the MLSPG to evaluate other landfill cap designs.

Following negotiations with the Agencies, an alternate landfill cap design was agreed upon. As a result, a Revised Final (100%) Design Report for the Landfill Cap System was prepared and submitted to the U.S. EPA in January 2001 and an Amendment submitted in April 2001. The Revised Final (100%) Design Report and Amendment for the Landfill Cap System was approved by the U.S. EPA in March 2001 and May 2001, respectively.

The primary objective of the Landfill Cap System was to address the RA components related to the Site-wide remedy including:

- installation, monitoring, and long-term maintenance of a Landfill Cap System meeting scope of work requirements and technical performance requirements of Michigan Act 451, Part 111;
- installation, monitoring, and long-term maintenance of a passive gas venting system; and
- implementation of associated institutional controls, including installation, monitoring, and long-term maintenance of a 6-foot high chain link security fence around the perimeter of the landfill area of the Site, topped with three strands of barbed wire, and implementation of access/deed restrictions.

3.0 PROJECT ORGANIZATION

The purpose of this section is to present the project team that completed the RA. Figure 3.1 presents the project organization chart.

3.1 AGENCY OVERSIGHT

The U.S Army Corps of Engineers (U.S. ACE) was contracted by the U.S. EPA to provide oversight of construction activities and to act as the U.S. EPA's on-Site representative. The U.S. ACE monitored Site-related cap construction activities, reviewed data as it was generated, attended regular progress meetings, and provided written and photographic documentation of all activities to the U.S EPA. In addition, a MDEQ representative frequented the Site to inspect and oversee the project.

3.2 TECHNICAL COORDINATION

Engineering Management, Inc. (EMI) was retained by the MLSPG to act as technical coordinator. EMI's responsibilities included coordinating communications between the MLSPG, U.S. EPA, MDEQ, and the community and providing oversight of the construction manager.

3.3 CONSTRUCTION MANAGEMENT

CRA was retained by the MLSPG to design the landfill cap system and manage the construction activities conducted at the Site. CRA's responsibilities included full-time management and inspection of the construction contractor activities to ensure that the U.S. EPA-approved project specifications for the Landfill Cap System were properly implemented, and review of conditions during construction to ensure the remedy would perform as designed.

3.4 CONTRACTOR/SUBCONTRACTORS

The MLSPG retained CRA Services, the Construction Division of Conestoga-Rovers & Associates, Inc. (CRA Services) as the construction contractor. In addition, CRA Services retained various subcontractors to perform specialized tasks.

4.0 CONSTRUCTION ACTIVITIES

The Landfill Cap System construction field activities were conducted during the period of April 12, 2001 to September 20, 2001. Minor erosion repair work was conducted in October 2001 and May 2002. Final demobilization activities were completed on October 19, 2001. The Landfill Cap System was constructed in general accordance with the U.S. EPA-approved Revised Final (100%) Design Report. The As Recorded drawings are presented as Drawing No. 1 through Drawing No. 9.

The construction activities performed at the Site included the following:

- equipment, facilities, and personnel mobilization;
- soil erosion and sediment control measures implementation;
- sheet pile wall installation;
- landfill and perimeter gas vent and probe installation;
- multi-layer landfill cap construction;
- Site access road and perimeter drainage ditch construction;
- fence installation and repair;
- Site restoration including seeding; and
- demobilization.

The major construction activities are further discussed in the following Sections.

4.1 SHEET PILE WALL INSTALLATION

A 464 linear-foot sheet pile wall was designed and installed along a portion of the northeast Site boundary to support the toe of the landfill cap and to allow the landfill cap to be constructed without encroaching on the Folkman property to the north. The sheet pile wall consisted of 253 individual interlocking sheet piles constructed of SZ-15, Grade 50 rolled steel meeting or exceeding the requirements of American Society for Testing and Materials (ASTM) A572.

Prior to the sheet pile wall installation, CRA completed a geotechnical investigation to evaluate soil conditions along the sheet pile wall alignment in order to verify design assumptions and recommended a minimum embedment depth of 14.7 feet for sheet piles retaining up to a 4-foot high landfill cap. The sheet piles were installed to

approximately 15 feet below ground surface using a vibratory mechanism which applied a constant pressure of 3,600 pounds per square inch. Sixteen individual sheet piles at discontinuous locations encountered refusal and were unable to be installed to the required minimum depth; however, CRA performed an engineering evaluation, which determined that the as constructed sheet pile wall would function as required.

In addition, CRA Engineering, Inc. reviewed the sheet pile wall design and the as-constructed sheet pile wall evaluation performed by CRA. CRA Engineering, Inc. concurred that the as-constructed wall is considered to meet the design embedment depth requirement to retain and allow construction of the landfill cap.

The geotechnical investigation memorandum and the sheet pile wall certification are presented in Appendix P.

4.2 LANDFILL CAP CONSTRUCTION

A 22.6 acre landfill cap system, meeting or exceeding the requirements of the Michigan Administrative Rule R.299.9619 (as regulated by Act 451, Part 111) and Resource Conservation and Recovery Act (RCRA) Subtitle C (landfill closure under Title 40 of the Code of Federal Regulations [CFR] Section 264.310), was constructed at the Site.

The landfill cap consists of the following components listed in order from bottom to top:

- on-Site grading fill layer (varying depths);
- 12-inch bedding soil layer;
- geosynthetic clay liner (GCL);
- 40-mil flexible membrane liner (FML);
- 12-inch sand drainage layer;
- 6-inch common fill layer;
- 6-inch topsoil layer; and
- vegetative cover.

A brief description of each component is provided in the subsections below.

4.2.1 ON-SITE GRADING FILL LAYER

Prior to on-Site soil rough grading and balancing activities, areas were cleared and grubbed where necessary. The trees and brush were chipped and/or removed from the Site. Chipped materials were incorporated into the on-Site grading fill layer.

Approximately 62,500 cubic yards of grading fill material was necessary to achieve the required sub-base contours. The grading fill layer consisted of on-Site soils excavated from the storm water retention pond and excess soil generated from other Site activities. The grading fill layer was placed and compacted in layers a maximum of 12 inches in depth. The grading fill layer was compacted to a minimum of 90% standard maximum dry density. Soils excavated from the stormwater retention pond were mixed with other on-Site soils and placed on the relatively flat areas of the landfill.

The results of the grading fill layer conformance testing are presented in Appendix A.

4.2.2 BEDDING SOIL LAYER

A 12-inch thick bedding soil layer was placed in order to provide a smooth, compact surface on which to install the GCL. The bedding soil layer consisted primarily of imported material from B&A Aggregates, Inc. (B&A) (approximately 34,300 cubic yards), with the exception of the area on the eastern portion of the landfill with final design elevations greater than 1140 feet above mean sea level (AMSL). The bedding soil layer in this area consisted of 6 inches of on-Site material overlain with 6 inches of imported material from B&A which was placed and compacted separately. The bedding soil layer for remaining portions of the landfill was placed and compacted in a single 12 inch lift. The bedding soil layer was compacted to a minimum of 95% standard maximum dry density.

All bedding soil layer material met the approved specifications. The results of the bedding soil layer conformance testing are presented in Appendix B.

4.2.3 GEOSYNTHETIC CLAY LINER

Approximately 109,300 square yards of GCL, based on horizontal projection, was installed at the Site. The GCL consisted of a layer of low permeability sodium-montmorillonite sandwiched between two non-woven geotextiles.

Prior to installation of the GCL, the bedding soil layer was inspected and all unsuitable materials such as organic materials, debris, roots, sticks, and angular rocks larger than one inch in diameter were removed. In addition, all cracks and voids in the bedding soil layer were filled.

The GCL panels were overlapped a minimum of 6 inches to form a shingle effect and the seams were sealed with bentonite. Any soil or debris was removed from the seams to ensure sufficient sealing. All GCL installed was covered by FML that same day to prevent premature hydration of the GCL.

On slopes equal to or greater than 20 percent (5H:1V), the long dimension of all panels was oriented parallel to the direction of the slope (up/down slope) and the upper end (if on the slope or within 25 feet of the crest) was secured in an anchor trench a minimum of 9 inches in depth.

All GCL testing results met approved specifications. The GCL conformance testing is presented in Appendix C. The interface shear testing results are presented in Appendix D. The manufacturer's certificates are included in Appendix E. The manufacturer's warranty is included in Appendix F.

4.2.4 FLEXIBLE MEMBRANE LINER

Approximately 109,300 square yards, based on horizontal projection, of 40-mil FML were installed at the Site. Two types of FML were used for the landfill cap. On slopes less than 9 percent (11.2H:1V), a smooth FML was used. On slopes of 9 percent or steeper (11.2H:1V), a textured FML on both sides was utilized to provide additional frictional resistance between the GCL and FML, and between the FML and sand drainage layer.

The FML panels were overlapped a minimum of 4 inches and seamed together by dual hot wedge welding techniques so that the flow of water over top of the FML would not be hindered (i.e., shingled). In addition, if cross-slope seams were utilized, the seams were installed greater than 5 feet from the toe of the slope at an angle of approximately 45 degrees.

Prior to field seaming, test seams were conducted to verify that the seaming conditions were adequate. Any soil or debris was removed from the field seams to ensure sufficient sealing. Non-destructive seam testing was conducted over the entire seam

length by pressure testing. Destructive seam testing, both peel and shear, was conducted at a frequency of a minimum of 1 sample per 1,000 linear feet of field seam.

Seams and non-seam areas of the FML were inspected for defects, holes, and blisters. Upon identification, all defects, holes, and blisters were repaired and subsequently vacuum tested for air leaks.

All FML testing results met approved specifications. The FML conformance testing is presented in Appendix G. The interface shear testing results are presented in Appendix D. The manufacturer's certificates are included in Appendix H. The FML manufacturer's warranty is presented in Appendix I. The FML quality assurance/quality control testing is presented in Appendix J.

4.2.5 SAND DRAINAGE LAYER

A 12-inch thick sand drainage layer with a minimum hydraulic conductivity of $3x10^{-2}$ cm/s was placed in order to provide a free-draining medium above the GCL and FML. Approximately 37,800 cubic yards of sand drainage layer materials were imported from B&A, Starr Aggregate, Newark Sand and Gravel, and Napi sources. The sand drainage layer was placed and compacted in a single 12 inch lift. The sand drainage layer was compacted to a minimum of 90% standard maximum dry density.

In order to reduce the likelihood of cap instability by saturation of the sand drainage layer, lateral drains (cap drains) were installed across the natural flow paths to reduce the drainage flow path length. The lateral cap drains consisted of 6-inch perforated, corrugated high-density polyethylene (HDPE), which was wrapped with a geotextile filter sock. In addition, in order to ensure that flow was fully intercepted, an FML barrier was installed on the downslope side to direct flow to the drain trench.

A lateral drain (toe drain) was installed along the perimeter of landfill cap, except where the access road traversed the landfill cap in which a cap drain with an FML barrier was utilized. The toe drains consisted of 4-inch perforated, corrugated HDPE drain tile which was placed within a 12-inch high by 24-inch wide aggregate drain trench, outletting approximately every 500 feet. At the intersections of the cap drains and toe drains, both the cap drain and downgradient toe drain were outletted to the drainage ditch.

All sand drainage layer material met approved specifications. The results of the sand drainage layer conformance testing are presented in Appendix K.

4.2.6 COMMON FILL LAYER

A 6-inch layer of common fill was placed over the drainage layer in order to prevent clogging of the drainage layer due to vegetation root penetration and to provide frost protection for the GCL and FML. Approximately 19,500 cubic yards of common fill layer materials were imported from B&A. The common fill layer was placed and compacted in a single 6-inch lift. The common fill layer was compacted to a minimum of 90% standard maximum dry density.

An engineering analysis of the gradation results for the common fill layer negated the need for a geotextile filter cloth material between the common fill and sand drainage layers to prevent fines from potentially clogging the sand drainage layer.

All common fill layer material met approved specifications, with the exception of one hydraulic conductivity conformance test result. However, CRA determined that the equivalent vertical hydraulic conductivity of the common fill and topsoil layers together as a unit was acceptable. The results of the common fill layer conformance testing are presented in Appendix L.

4.2.7 TOPSOIL LAYER

A 6-inch topsoil layer was placed in a loose lift over the common fill layer to support vegetative growth. Approximately 33,000 cubic yards of topsoil were imported to the Site from United Soils Incorporated to be used on the cap and for restoration of disturbed areas outside of the cap. The topsoil was graded sufficiently to produce a smooth surface, and traffic was minimized to prevent over-compaction of the soil.

All topsoil layer material met approved specifications with the exception of the topsoil pH. The topsoil pH was generally slightly higher than that required by the project specifications; however, it was determined that this would not significantly affect the establishment of vegetative growth. It should be noted that 19 out of 34 topsoil samples collected, CRA Services used a more conservative Michigan accredited method for determining pH and organic content rather than the ASTM method outlined in the Construction Quality Assurance Plan (CQAP). However, the method was approved by CRA and did not alter the overall effectiveness of the Landfill Cap System components. The results of the topsoil conformance testing are presented in Appendix M.

4.2.8 VEGETATIVE COVER

The vegetative cover was applied on the landfill cap utilizing the approved Brillion® method. The vegetative cover consisted of hard, shallow rooted grasses consisting of 50 percent creeping red fescue, 15 percent perennial rye grass, 15 percent Kentucky blue grass, 15 percent empire trefoil, and 5 percent white clover. The seed mixture was applied at a rate of 200 pounds per acre and fertilized. On slopes 25 percent (4H:1V) or greater, erosion control blankets were placed to form a continuous mat.

The area surrounding the stormwater retention pond was seeded in June 2001 and growth was established prior to the Substantial Completion Site inspection. The landfill cap and remaining areas were seeded in September 2001 and growth was established prior to the final Site inspection.

4.3 LANDFILL AND PERIMETER GAS VENTS

A landfill and perimeter passive gas venting system was installed to ensure potential gas that builds up beneath the cap is released, protecting the integrity of the landfill cap system and ensuring perimeter gas migration is effectively controlled and mitigated. The landfill gas vents (LGV-1 through LGV-21) penetrate the entire thickness of the cap and were installed at a spacing of approximately one per acre. The perimeter gas vents (PGV-1 through PGV-13) were installed just beyond the north portion of the landfill area at a spacing of approximately 100 feet. PGV-13 through PGV-24 were installed through the east edge of the landfill approximately every 100 feet with a FML boot and skirt assembly.

The landfill and perimeter gas vent record documents are presented in Appendix N.

4.4 LANDFILL AND PERIMETER GAS PROBES

The landfill gas probes (LGP-1 through LGP-4) and a perimeter gas probe (PGP-7) were installed to monitor gas pressure and gas migration in the landfill and perimeter vent systems, respectively. In addition, perimeter gas probe PGP-1 was abandoned in accordance with Michigan Act 368 requirements since it interferred with the access road.

The landfill and perimeter gas probe record documents are presented in Appendix N.

4.5 CHANGES TO ORIGINAL SCOPE OF WORK

Throughout the project, situations were encountered in the field that required changes to the original SOW. These changes did not alter the overall effectiveness of the Landfill Cap System design components. These situations included:

1. The existing conditions survey completed by CRA Services indicated that actual Site elevations were on average approximately 9 inches below design elevations, which were based on an aerial survey. Therefore, design elevations were lowered 6 inches on the basis of test pits excavated on May 3, 2001 by CRA Services. The test pits were installed to determine how much the landfill cap could be lowered without excavating or grading extensive amounts of landfill refuse. Additional on-Site grading fill was required to compensate for the average 3-inch discrepancy between actual and design elevations.
2. Additional on-Site grading fill material was generated by increasing the depth of the stormwater retention pond and excavating excess soils in the southwestern corner of the stormwater retention pond while maintaining 25% maximum and 4% minimum slopes.
3. The east drainage ditch elevations were slightly modified in order to decrease the volume of refuse required to be relocated.
4. The anchor trench depths were reduced to a minimum of 9 inches in order to minimize encountering refuse.
5. The ½-inch, Schedule 40 polyvinyl chloride (PVC) piping specified for the gas probes was replaced with ½-inch Schedule 80 PVC.
6. As requested by the MDEQ, the GCL/FML was extended to the limit of refuse or the property boundary, whichever was encountered first. As a result, the GCL/FML was extended beneath the east drainage ditch to the east property boundary, and beneath a portion of the southwest access road. In addition, the perimeter gas vents (PGV-13 through PGV-24) that penetrated the GCL/FML were installed with a FML boot and skirt assembly.
7. The method for testing the FML coupons in shear and peel specified in the projects specifications was replaced with ASTM D4437.
8. Non-solvent based double-sided tape PolySeal TP2SCL was used to secure the drainage flaps on the FML rather than thermal welding.
9. A 'V' swale lined with 8-inch riprap was installed in the southeast corner of the Stormwater Retention Pond where significant erosion was identified.
10. Additional excavation of the Stormwater Retention Pond increased the lengths of the erosion control measures required. Therefore, the gabion mattress located in

the southwest corner of the Stormwater Retention Pond was replaced with a culvert in order to extend the remaining Stormwater Retention Pond gabion mattresses.

11. It was determined that sod would not effectively grow if placed over 6 inches of topsoil underlain with GCL/FML along the slope east of the east drainage ditch. Therefore, the sod was replaced with 6-inch riprap in order to more effectively prevent erosion.

12. It was determined that riprap would reduce future O&M costs; therefore, all Typical Grass Lined 'V' Swale ditches were replaced with Typical 6-inch Riprap Lined 'V' Swale ditches. However, the CRA Services determined that Typical 8-inch Riprap lined 'V' Swale ditches were more cost effective. Therefore, all ditches are either Typical 8-inch Riprap Lined 'V' Swale or Typical Gabion Mat Lined 'V' Swale.

13. To inhibit water flowing onto the Site from John R's infiltration pond, an earthen berm was constructed and the perimeter Site access road and fence were realigned in the southwestern corner of the Site.

14. To direct surface runoff into the north and east perimeter ditches, an earthen berm was constructed with topsoil in the northeast corner of the Site.

15. To prevent erosion along the northern slope of the north perimeter access road, erosion control blankets were installed.

16. The northern perimeter fence alignment was relocated approximately 40 feet south in order to preserve existing trees.

17. The southern perimeter fence alignment near MW-20 was not modified.

18. On the eastern portion of the landfill with final elevations greater than 1,140 feet AMSL, on-Site fill material was used as the bottom 6 inches of the bedding soil layer.

19. The perimeter toe drain drainage pipes were extended to the perimeter ditches instead of utilizing riprap aprons.

20. At the intersection of the cap drains and toe drains, both the cap drain and downgradient toe drain were outletted to the perimeter ditch.

21. A cap drain was installed in lieu of a toe drain where the access road traversed the landfill cap.

22. Hydroseeding was substituted with the Brillion® method of seeding.

23. Only CRA Services hydraulic conductivity tests were conducted for the common fill layer.

Changes that affected the final lines and grades of the landfill cap (Changes #1, 2, 3, and 10) were presented in a letter dated June 18, 2001 to U.S. EPA.

5.0 CHRONOLOGY OF EVENTS

A chronology of the major events from the issuance of the ROD for OU2 in September 1990 to the Landfill Cap System final Site inspection on July 16, 2002 is provided in Table 5.1.

6.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

The purpose of this section is to identify the documents containing performance standards and quality control requirements for the landfill cap construction.

6.1 REVISED FINAL (100%) DESIGN REPORT

As part of Task 3 of the SOW for the remedial design at the Site, Revised Final (100%) Design Report was developed by CRA in January 2001 and approved by the U.S. EPA to implement the Landfill Cap System construction. The Revised Final (100%) Design Report was based on the U.S. EPA-approved Final (100%) Design Report and Addendum thereto submitted in January 1998 and March 1998, respectively. The Revised Final (100%) Design Report included final construction plans and specifications. In addition, the Revised Final (100%) Design Report included the following plans which formed the basis for the items discussed in Sections 6.2 to 6.5:

- Health and Safety Plan;
- Construction Quality Assurance Plan;
- Surface Water Management Plan; and
- Operation and Maintenance Plan.

6.2 HEALTH AND SAFETY PLAN

Site-Specific Health and Safety Plans (HASPs) were prepared by CRA and CRA Services in accordance with the standards set forth in Title 29, CFR, Parts 1910 and 1926. Details of the HASPs are presented in Section 7.0.

6.3 CONSTRUCTION QUALITY ASSURANCE PLAN

A Site-specific CQAP was prepared by CRA to ensure that the landfill cap system was constructed to meet design criteria, plans, and specifications. The CQAP defined responsibility and authority, personnel qualifications, inspection activities, sampling requirements, and documentation. The construction activities, including Construction Quality Control (CQC) and Construction Quality Assurance (CQA) testing, were performed and the test results were within acceptable criteria, unless otherwise noted in Section 4.0.

6.4 SURFACE WATER MANAGEMENT PLAN

A Site-specific Surface Water Management (SWM) Plan was prepared by CRA to mitigate the potential impacts from changes to the surface water flow patterns caused by the Landfill Cap System. The SWM Plan addressed relevant design issues including flood risk, groundwater recharge, erosion potential, and operational and physical concerns.

6.5 OPERATION AND MAINTENANCE PLAN

A Site-specific O&M Plan was prepared by CRA to address both the implementation and long-term maintenance of the Landfill Cap System. The O&M Plan included descriptions of the normal operation and maintenance to be followed, the frequency of routine operation and maintenance tasks, a description of potential problems and their possible remedies, a description of routine monitoring procedures, and a schedule of routine monitoring activities. In addition, the O&M Plan included corrective actions to be implemented in the event problems with system operation or in the event of the failure of the system to perform as designed. Details of the O&M Plan are presented in Section 9.0.

6.6 EROSION AND SEDIMENT CONTROL PLAN

A Soil Erosion and Sediment Control Plan (ESCP) was prepared by CRA Services prior to beginning construction to address sediment and erosion control during construction activities. The plan was prepared in accordance with Michigan Act 451 – Part 91 and Title 40 of CFR Part 122.26(b)(14)(x). The plan included guidelines for the installation of silt fences around the landfill cap perimeter and in areas downstream of grading activities, the installation of check dams, sediment traps, and diversion swales to prevent the migration of excess sediments from source areas, and the construction and use of sediment ponds for the containment of sediments. The plan also included control measures for storm water management as well as soil particulate control. The ESCP was successfully implemented and no major erosion was observed during the Substantial Completion Site inspection.

6.7 SEEDING AND EROSION CONTROL PLAN

A Seeding and Erosion Control Plan (ESCP) was prepared by CRA Services prior to placing topsoil. The plan included the seed mixture and fertilizer for the Site, application rates, time of year to plant such mixtures, methods to prepare areas for seeding, and methods to provide erosion control until the vegetation was established. As observed during the final Site inspection, vegetation was established as expected.

7.0 HEALTH AND SAFETY

The purpose of this section is to provide an overview of the HASPs implemented for the landfill cap system construction.

7.1 GENERAL

The HASPs were developed to ensure that all Site activities were performed safely, and in accordance with the applicable regulatory requirements, and that all Site personnel, the general public, and the environment were protected from potential exposure to Site-related impacted material. The HASPs included information on and requirements for the following:

- Site characterization and potentially hazardous compounds;
- medical surveillance and training;
- work zones;
- levels of personal protective equipment;
- respiratory protection program;
- personal hygiene;
- air monitoring and action levels;
- communications;
- emergency and first aid equipment;
- equipment and personnel decontamination procedures;
- vapor and particulate control;
- contamination migration control; and
- material safety data sheets.

All construction activities were performed in accordance with the HASPs. No lost time incidents occurred during the performance of the work.

Emergency procedures and protocols for the Site were presented in the report entitled "Off-Site Response, Standard Operating Procedures for Metamora Landfill Site, Lapeer County, Michigan" (CRA; December 1993).

7.2 HEALTH AND SAFETY PLAN IMPLEMENTATION

CRA Services provided a full-time on-Site Health and Safety Officer (HSO) during the duration of construction activities. The HSO was responsible for the daily implementation and enforcement of the health and safety program. The HSO conducted health and safety meetings each morning covering topics applicable to the work being performed that day. The HSO also maintained and submitted to the construction manager daily safety logs including information on the following:

- weather conditions;
- work activities;
- health and safety equipment in use;
- personal protective equipment being worn;
- physical condition of workers; and
- accidents or health and safety violations.

Telephone numbers and contacts were posted near the Site telephones in accordance with the HASP. A chain of command was established to determine who would direct and coordinate activities and personnel in the event of an on-Site emergency.

7.3 AIR MONITORING

Air monitoring was conducted at the Site to ensure the protection of Site personnel, the surrounding community, and the environment. The air monitoring activities were conducted in accordance with the Site-specific HASP. The results of daily air monitoring activities were summarized in weekly reports which were transmitted to the U.S. EPA, MDEQ, Technical Advisory Committee (TAG) representative, EMI, and CRA Services. The Air Monitoring Reports are presented in Appendix O.

Exclusion Zone (EZ) air monitoring and Site property line air monitoring were conducted during the construction activities. These air monitoring activities are described in the following paragraphs.

7.3.1 EXCLUSION ZONE AIR MONITORING

Real-time air monitoring within the EZ was conducted every three hours during intrusive activities (i.e. gas vent/probe installation). Ambient air in the vicinity of the

intrusive activity was monitored for total volatile organic compounds (VOCs) using a photionization detector (PID) at breathing zone height and the lower explosive limit (LEL) of combustible gases to verify proper personal protective equipment. All air monitoring equipment was calibrated according to the manufacturer's specifications.

During the construction activities, measured EZ air monitoring action levels were not exceeded. Air monitoring results are presented in Appendix O.

7.3.2 SITE PROPERTY LINE AIR MONITORING

Real-time air monitoring at the Site property was conducted daily during construction activities (every three hours during intrusive activities). Ambient air at twelve equidistant locations around the Site was monitored for PM_{10} (particulate matter less than 10 microns in diameter). All air monitoring equipment was calibrated according to the manufacturer's specifications.

During construction activities, a PM_{10} measurement of 156 $\mu g/m^3$ was detected on June 8, 2001. Work was temporarily suspended and corrective action measures were implemented, which included applying water as a dust suppressant via a water truck. At no other time were Site property line air monitoring action levels exceeded. Air monitoring results are presented in Appendix O.

7.3.3 METEOROLOGICAL MONITORING

Meteorological monitoring was performed by CRA during the construction activities utilizing a meteorological station which was installed in an appropriate area of the support zone (CRA's on-Site field trailer). The following data were monitored and recorded twice daily in a logbook:

- wind speed;
- wind direction;
- temperature; and
- general weather conditions.

Meteorological air monitoring results are presented in Appendix O.

8.0 INSPECTION AND CERTIFICATION

8.1 SUBSTANTIAL COMPLETION INSPECTION

The U.S. EPA, MDEQ, EMI, CRA, and CRA Services conducted a Substantial Completion Site inspection on September 24, 2001. No significant operational problems affecting the performance of the remedial action were noted and it was determined that substantial completion of the Landfill Cap System construction, as defined in the Revised Final (100%) Design Report, had been achieved.

8.2 FINAL INSPECTION

The U.S. EPA, MDEQ, EMI, and CRA conducted a final Site inspection on July 16, 2002. The U.S. EPA, in conjunction with the MDEQ, concluded that the Landfill Cap System was complete and that no defective work remained to be corrected.

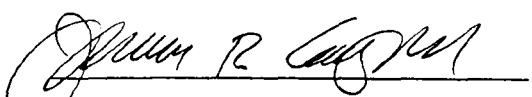
8.3 INSTITUTIONAL CONTROLS

Institutional controls will be implemented to ensure the integrity of the RA and to minimize the potential for, or eliminate, trespass onto the Site. Institutional controls for implementation on the Parrish and County Transfer Station (Faulkender) properties are included in the Revised Final (100%) Design Report. The Parrish property institutional controls were executed on May 10, 2002. The County Transfer Station property institutional controls were executed on June 30, 1997. The institutional controls are filed with the Lapeer County Register of Deeds.

8.4 CERTIFICATION

I, James R. Campbell, certify under penalty of law that based on personal knowledge and appropriate inquiries of all other persons involved in preparation of this Remedial Action Report for the Landfill Cap System, the information submitted is true, accurate, and complete to the best of my knowledge and belief.

ENGINEERING MANAGEMENT, INC.

Signature: 

Date: 8/22/02

I, James A. Reid, certify under penalty of law that based on personal knowledge and appropriate inquiries of all other persons involved in preparation of this Remedial Action Report for the Landfill Cap System, the information submitted is true, accurate, and complete to the best of my knowledge and belief.

CONESTOGA-ROVERS & ASSOCIATES, INC.

Signature: James Reid

Date: 8/29/02

9.0 OPERATION AND MAINTENANCE ACTIVITIES

Year 1 O&M activities were initiated in November 2001 to address both the implementation and long-term maintenance of the Landfill Cap System. The O&M activities will be conducted in accordance with the O&M Plan included in the U.S. EPA-approved Revised Final (100%) Design Report.

Year 1 O&M activities consist of conducting monthly Site inspections. The Site inspections will verify the conditions of the following:

- vegetative soil cover;
- access roads;
- perimeter fence;
- perimeter signs;
- drainage pipe clean outs;
- drainage ditches;
- culverts;
- drainage pipe and toe drain screens;
- sheet pile wall;
- gas vents and probes; and
- stormwater retention pond.

In addition, the landfill and perimeter gas probes will be monitored for pressure build-up and combustible gases.

The Site conditions and any changes that occurred since the previous inspection will be reported to the U.S. EPA and MDEQ in a monthly memorandum. In addition, an annual report will be prepared and submitted to the U.S. EPA and MDEQ. The annual report will include all inspections and a summary of the results of the monitoring program.

10.0 SUMMARY OF PROJECT COSTS

The actual RA costs to date compared to the ROD costs are as follows:

Item	ROD Estimate (1990)	Adjusted ROD Estimate (2001)[1,2]	Actual (2001)[1]
RA Capital Costs	$5,395,596	$7,468,767	$7,579,000

Notes:

1 = Does not include O&M costs or U.S. EPA oversight costs

2 = ROD was adjusted from 1990 cost to 2001 costs using 3% annual inflation

11.0 OBSERVATIONS AND LESSONS LEARNED

A summary of observations and lessons learned from the Landfill Cap System construction activities is provided below:

1. It is critical to establish Site survey control prior to beginning construction activities. In addition, topographic maps generated by an aerial survey may not accurately represent actual field conditions.
2. Comprehensive stormwater management and erosion and sediment controls must be implemented during landfill cap construction activities and should not allow large areas of highly erodible soils to be exposed at one time.
3. Construction schedules should allow for additional time and personnel to prepare submittals in order to meet project specifications or allow evaluation of substitute items.

12.0 CONTACT INFORMATION

The project manager for the U.S. EPA was:

Mr. Thomas Williams
U.S. EPA, Region V
Superfund Division (SR-6J)
Remedial Response Branch 1, Section 1
77 West Jackson Blvd.
Chicago, Illinois 60604
Phone: (312) 886-6157

The project manager for the MDEQ was:

Mr. Mark Henry
MDEQ- Environmental Response Division
300 South Washington
Lansing, Michigan 48909
Phone: (517) 335-3390

The U.S. EPA used the following contractor for construction oversight:

Mr. Rich Sallans
United States Army Corps of Engineers
477 Michigan Ave.
Detroit, Michigan 48226
Phone: (313) 226-4550

The project manager for EMI was:

Dr. Jim Campbell
Engineering Management, Inc.
1500 Ardmore Blvd., Suite 502
Pittsburgh, Pennsylvania 15221
Phone: (412) 244-0917

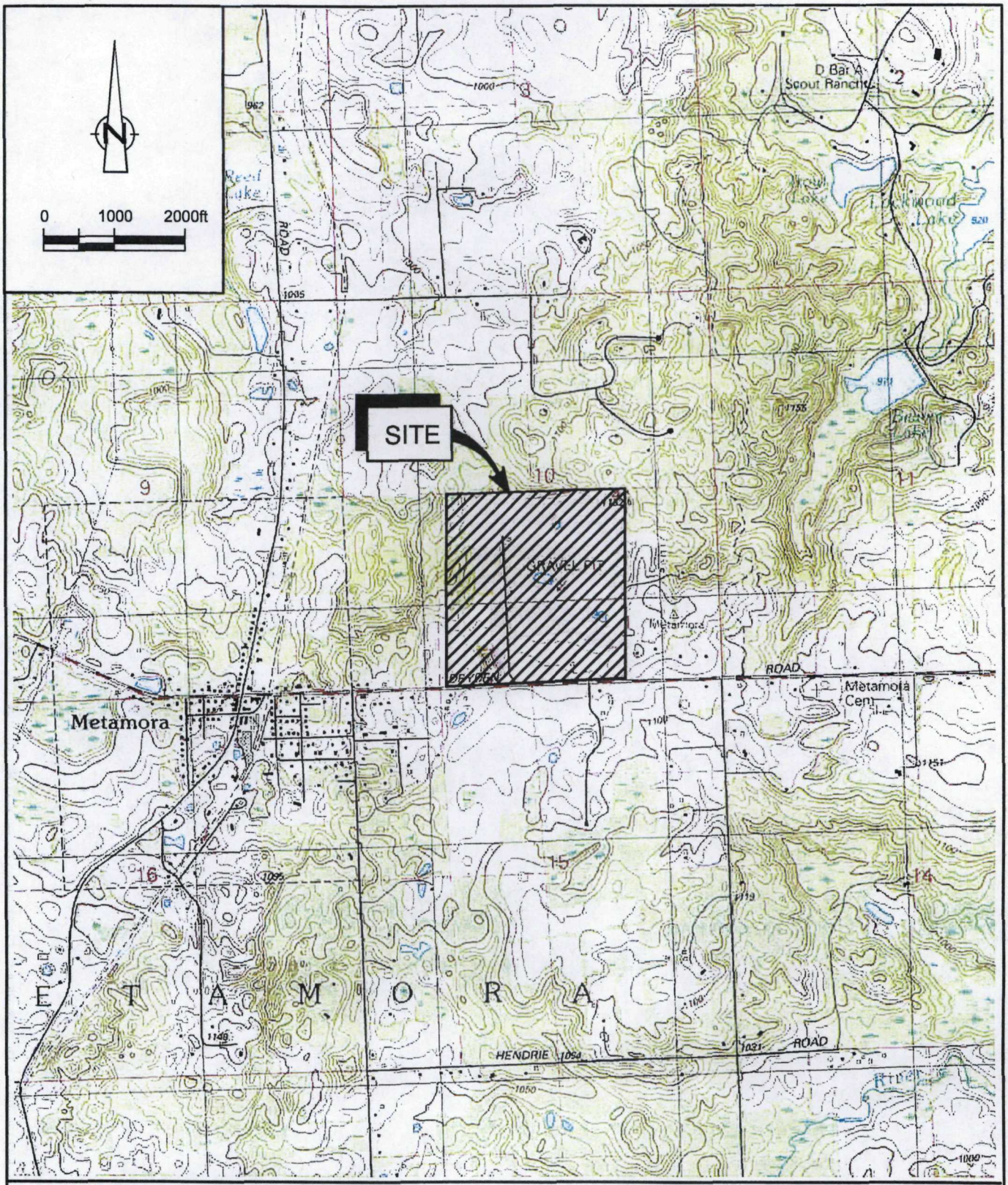
The project manager for CRA was:

Mr. James A. Reid
Conestoga-Rovers & Associates, Inc.
14496 Sheldon Road, Suite 200
Plymouth, Michigan 48170
Phone: (734) 453-5123

The project manager for CRA Services was:

Mr. John Etling
CRA Services, the Construction Division of Conestoga-Rovers & Associates, Inc.
621 E. North Street
Kalamazoo, Michigan 49007
Phone: (616) 344-1230

FIGURES



SOURCE: USGS QUADRANGLE MAP;
METAMORA, MICHIGAN

CRA

figure 1.1

SITE LOCATION
REMEDIAL ACTION
METAMORA LANDFILL SITE
Lapeer County, Michigan

03298-89(131)GN-DE001 DEC 05/2001

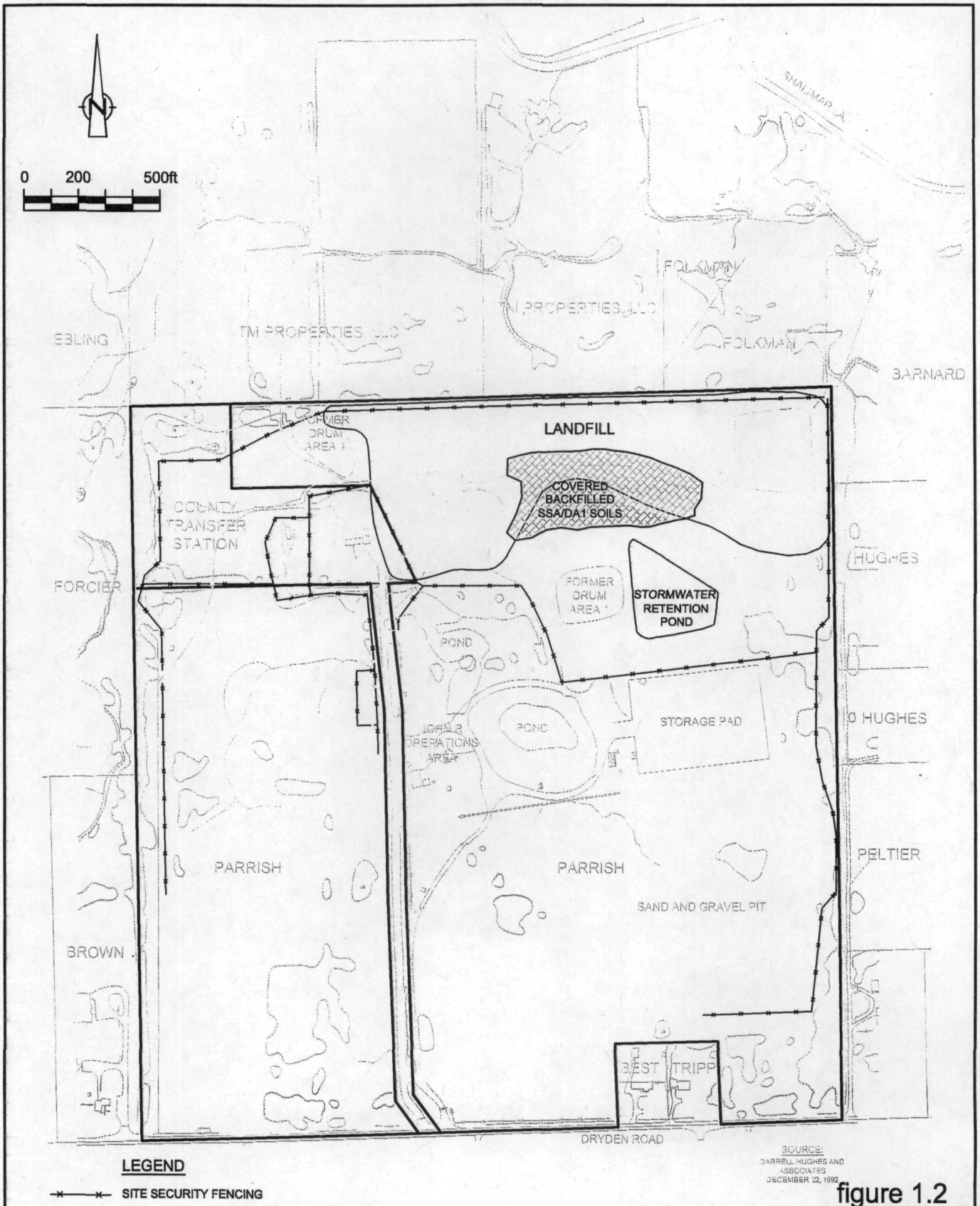


figure 1.2

SITE PLAN
PRE-REMEDIAL ACTION
METAMORA LANDFILL SITE
Lapeer County, Michigan

CRA

03298-89(131)GN-DE002 DEC 05/2001

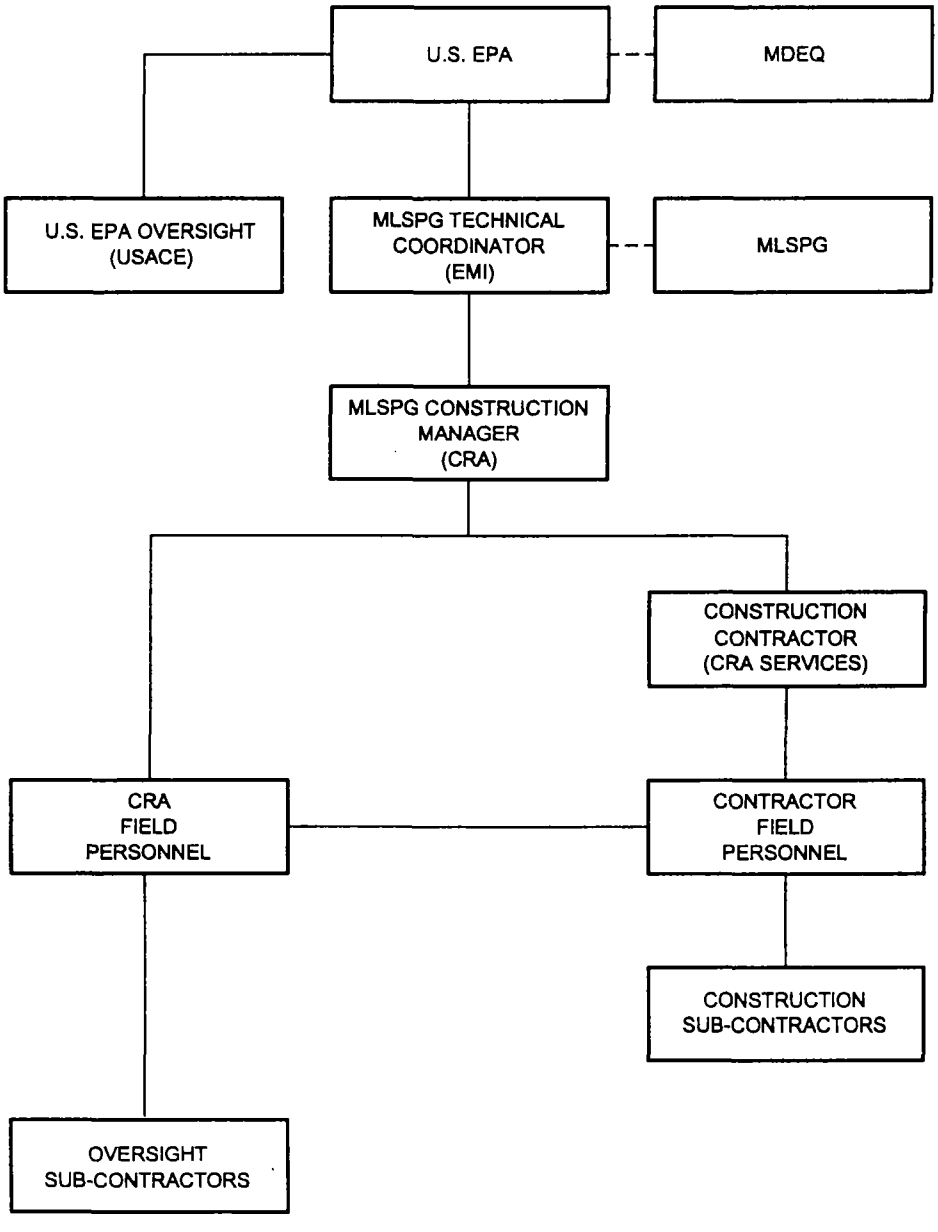


figure 3.1

PROJECT ORGANIZATION CHART
REMEDIAL ACTION
METAMORA LANDFILL SITE
Lapeer County, Michigan

CRA

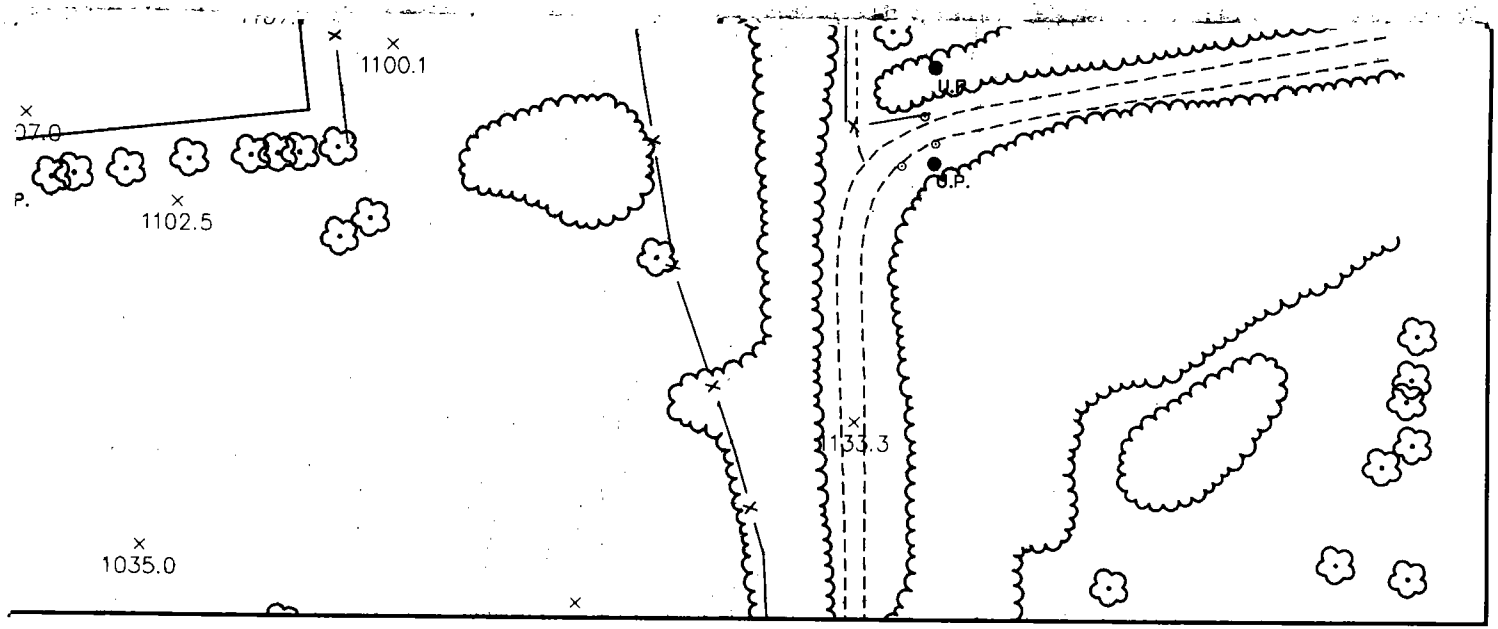
03298-89(131)GN-DE003 JUL 25/2002

TABLES

TABLE 5.1

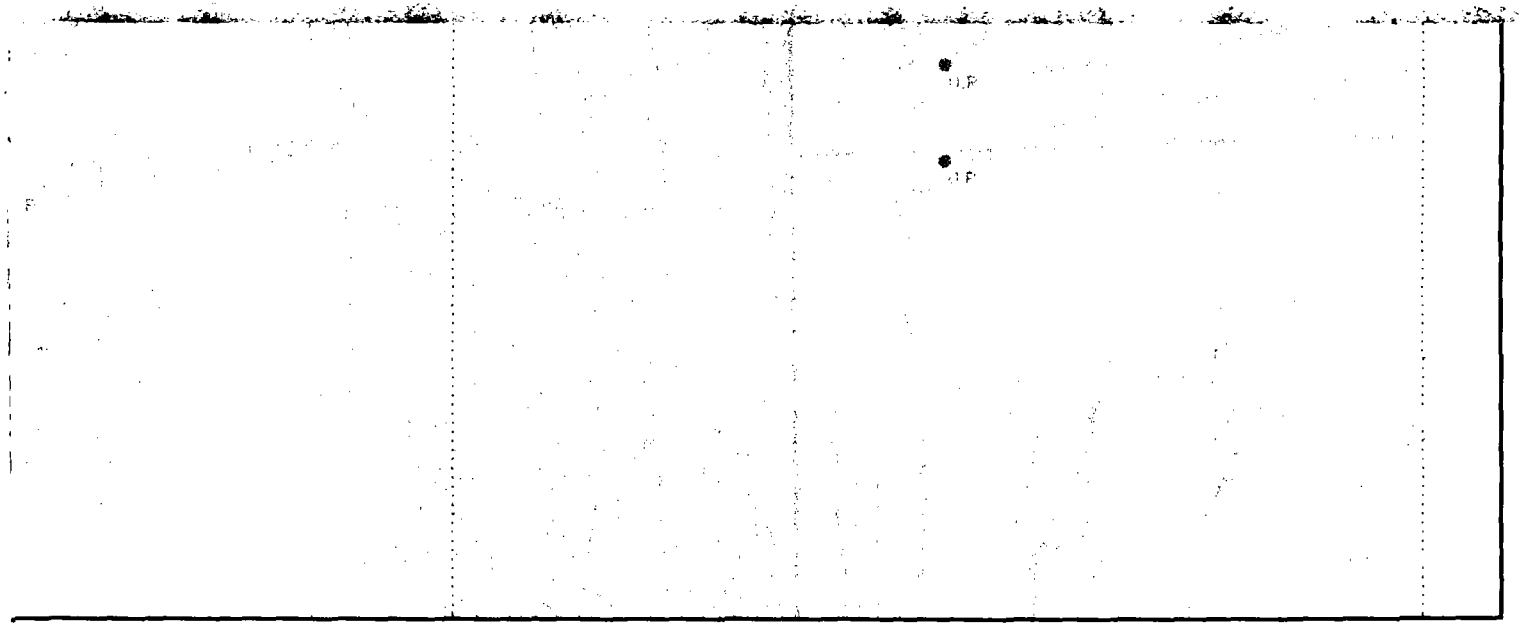
CHRONOLOGY OF MAJOR EVENTS
METAMORA LANDFILL SITE
LAPEER COUNTY, MICHIGAN

Date	*Event*
September 28, 1990	ROD signature
April 1991	Consent Decree and Scope of Work
November 1993 – February 1994	Source Removal and Disposal Program – Phase I
January 1994 – December 1994	Source Removal and Disposal Program – Phase II
September 1994 – October 1994	Soil Characterization Program
August 1996	ROD Amendment
January 1998	Submit Final (100%) Design Report
March 1998	Submit Addendum to the Final (100%) Design Report
July 1998 – December 1998/November 1999 – March 2000	Site preparation activities
June 2000	Submit Conceptual Site Model Report
January 2001	Submit Revised Final (100%) Design Report
March 8, 2001	U.S. EPA approves Revised Final (100%) Design Report
April 9, 2001	Submit Addendum to Revised Final (100%) Design Report
April 11, 2001	Contractor Notice to proceed
April 12, 2001 – April 30, 2001	Mobilization, Site preparation, and clearing/grubbing activities
April 12, 2001 through project completion	Implement erosion & sediment control measures
April 19, 2001	Site mobilization meeting
April 23, 2001 – June 19, 2001	Construct grading fill layer
April 26, 2001 – September 5, 2001	Construct perimeter access road
May 7, 2001	U.S. EPA approves Amendment to Revised Final (100%) Design Report
May 14, 2001	Sheet pile wall pre-installation meeting
May 15, 2001 – May 25, 2001	Install sheet pile wall
May 21, 2001 – August 31, 2001	Install gas vents and probes
May 31, 2001	GCL/FML pre-installation meeting
June 4, 2001 – June 29, 2001	Construct bedding soil layer
June 4, 2001 – June 22, 2001	Place topsoil on stormwater retention pond perimeter slopes
June 12, 2001 – July 5, 2001	Install GCL/FML
June 21, 2001 – July 21, 2001	Install subsurface drainage piping
June 21, 2001 – August 3, 2001	Construct sand drainage layer
June 26, 2001 – July 11, 2001	Seed and install erosion blanket on stormwater retention pond perimeter slopes
July 17, 2001 – August 7, 2001	Construct common fill layer
July 21, 2001 – September 4, 2001	Install rip rap and gabion ditches
July 22, 2001 – August 10, 2001	Install perimeter toe drain
July 23, 2001 – August 24, 2001	Place topsoil on remaining portions of Site
August 20, 2001 – September 13, 2001	Install Site security perimeter fence
August 28, 2001 – September 20, 2001	Seed and install erosion blanket on remaining portions of Site
September 24, 2001	Substantial Completion Site Inspection
October 2001	Demobilization
July 16, 2002	Final Site Inspection



ILL SITE MICHIGAN	**CRA** **CONESTOGA-ROVERS & ASSOCIATES**					
ON REPORT	Drawn by: JRV	Scale: 1"=100'	Date: DECEMBER 2001	File Nº: CI-DE002	Rev.Nº: 3	
TIONS R 2000	Designed by: BMM/DEH					
	Checked by: JAR	Field book:	Project Nº: 3298-89	Drawing Nº: 1		

03298-89(131)CI-DE002 DEC 20/01



FILL SITE
MICHIGAN

ON REPORT

LAN OF
ORKS

CRA
CONESTOGA-ROVERS & ASSOCIATES

Drawn by: JRV	Scale: 1"=100'	Date: DECEMBER 2001	File Nº: CI-DE003	Rev.Nº: 3
Designed by: JRV				
Checked by: JAR	Field book:	Project Nº: 3298-89	Drawing Nº: 2	

03298-89(131)CI-DE003 DEC 20/01

'ILL SITE
MICHIGAN

ON REPORT

TOURS

CRA
CONESTOGA-ROVERS & ASSOCIATES

Drawn by: JRV	Scale: 1"=60'	Date: DECEMBER 2001	File Nº: CI-DE010	Rev.Nº: 3
Designed by: JRV				
Checked by: JAR	Field book:	Project Nº: 3298-89	Drawing Nº: 3	

03298-89(131)CI-DE010 DEC 20/01

FILL SITE
MICHIGAN

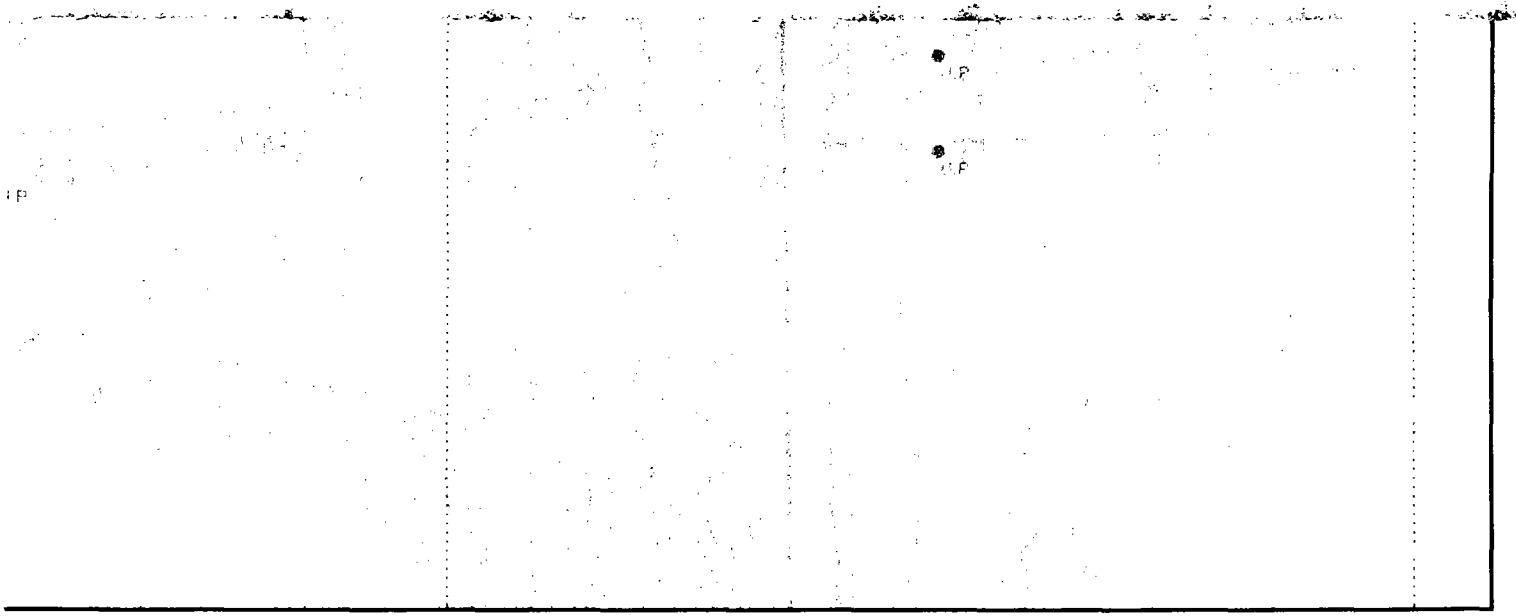
ON REPORT

ILT

CRA
CONESTOGA-ROVERS & ASSOCIATES

Drawn by: JRV	Scale: 1"=60'		Date: DECEMBER 2001	File Nº: CI-DE009	Rev.Nº: 1
Designed by: BMM/DEH					
Checked by: JAR	Field book:	Project Nº: 3298-89		Drawing Nº: 4	

03298-89(131)CI-DE009 DEC 20/01



FILL SITE
MICHIGAN

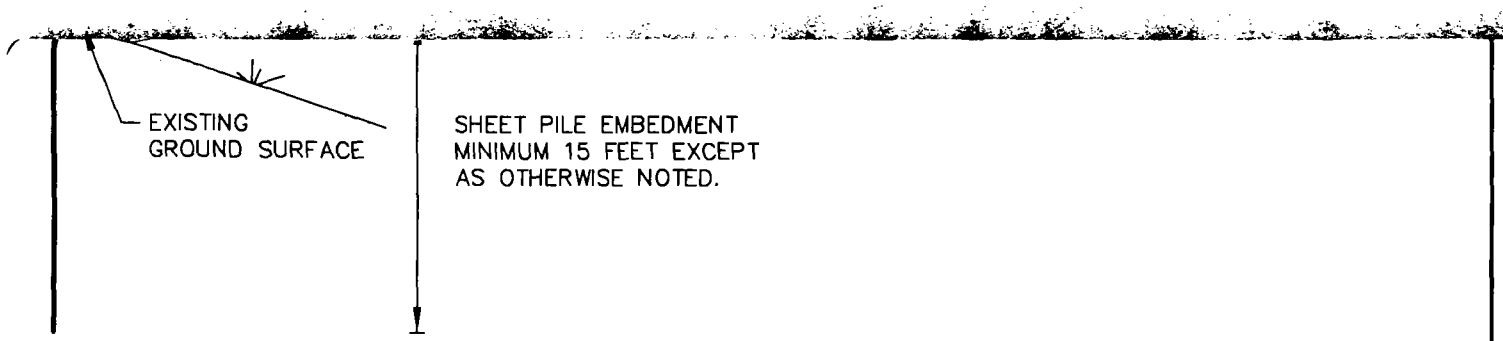
ON REPORT

)NS

CRA
CONESTOGA-ROVERS & ASSOCIATES

Drawn by: JRV	Scale: 1"=100'	Date: DECEMBER 2001	File Nº: CI-DE005	Rev.Nº: 3
Designed by: JRV				
Checked by: JAR	Field book:	Project Nº: 3298-89	Drawing Nº: 5	

03298-89(131)CI-DE005 DEC 20/01



)ETAIL

:ILL SITE MICHIGAN	**CRA** **CONESTOGA-ROVERS & ASSOCIATES**					
ON REPORT	Drawn by: JRV/DEH	Scale: AS SHOWN	Date: DECEMBER 2001	File Nº: CI-DE007	Rev.Nº: 3	
-S	Designed by: AW					
	Checked by: JAR	Field book:	Project Nº: 3298-89	Drawing Nº: 6		

03298-89(131)CI-DE007 DEC 20/01

FILL SITE
MICHIGAN

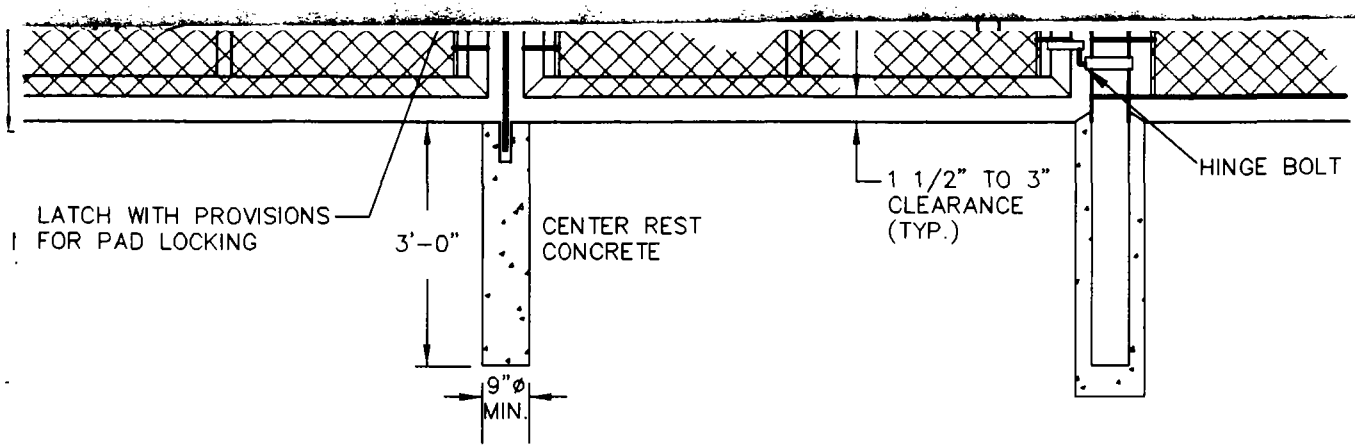
ION REPORT

) AND
DETAILS

CRA
CONESTOGA-ROVERS & ASSOCIATES

Drawn by: JRV	Scale: 1"=100'	Date: DECEMBER 2001	File Nº: CI-DE004	Rev.Nº: 3
Designed by: BMM/DEH				
Checked by: JAR	Field book:	Project Nº: 3298-89	Drawing Nº: 7	

03298-89(131)CI-DE004 DEC 20/01



TYPICAL DOUBLE GATE DETAIL

N.T.S.

FILL SITE MICHIGAN	**CRA** **CONESTOGA-ROVERS & ASSOCIATES**					
ON REPORT	Drawn by: JRV	Scale: AS SHOWN	Date: DECEMBER 2001	File Nº: CI-DE008	Rev.Nº: 3	
, PROBE, ETAILS	Designed by: RAC					
	Checked by: JAR	Field book:	Project Nº: 3298-89	Drawing Nº: 8		

03298-89(131)CI-DE008 DEC 20/01

:ILL SITE MICHIGAN	**CRA** **CONESTOGA-ROVERS & ASSOCIATES**					
ON REPORT	Drawn by: JRV/DEH	Scale: AS SHOWN	Date: DECEMBER 2001	File Nº: CI-DE006	Rev.Nº: 3	
:TAILS	Designed by: BMM/DEH					
	Checked by: AW	Field book:	Project Nº: 3298-89	Drawing Nº: 9		

03298-89(131)CI-DE006 DEC 20/01