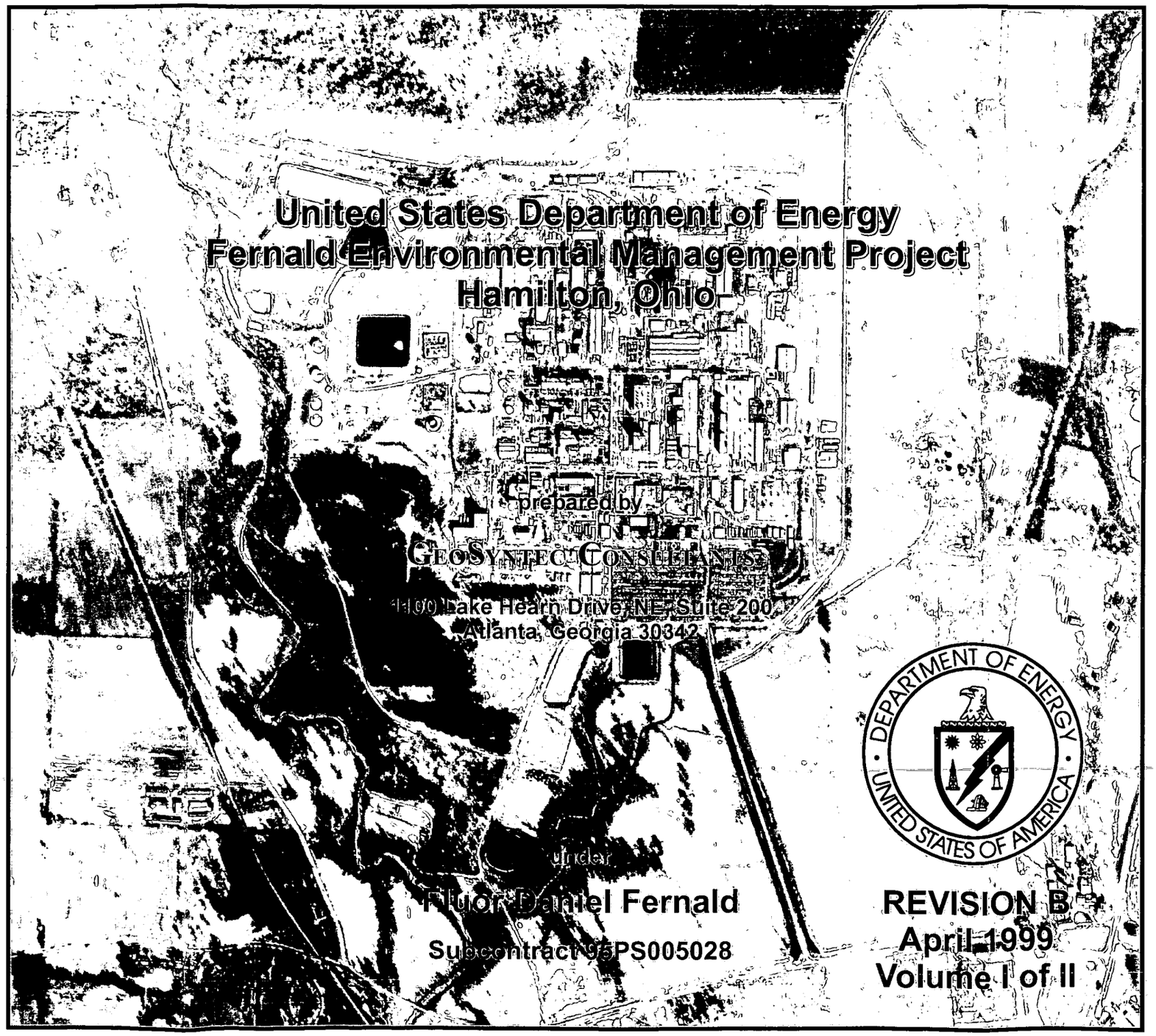
Document No. 20110-RP-0002

2194

EVALUATION OF LEACHATE TRANSMISSION SYSTEM

ON-SITE DISPOSAL FACILITY



United States Department of Energy
Fernald Environmental Management Project
Hamilton, Ohio

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under

Fluor Daniel Fernald

Subcontract 95PS005028

REVISION B
April 1999
Volume I of II

No. 5

2194

EVALUATION OF LEACHATE TRANSMISSION SYSTEM ON-SITE DISPOSAL FACILITY FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Revision B
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United States Department of Energy

Fernald Environmental Management Project
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(FDF Project No. 20100)

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2

2194

TABLE OF CONTENTS

3

TABLE OF CONTENTS

EXECUTIVE SUMMARY **ES-1**

1. INTRODUCTION **1**

1.1 Purpose 1

1.2 Components of LTS 1

1.3 Organization of Document 3

2. DESIGN BASIS **4**

2.1 Design Criteria Package 4

2.1.1 Overview 4

2.1.2 ARARs 4

2.1.3 Design Criteria 5

2.2 Design Plans and Specifications 10

2.2.1 Overview 10

2.2.2 Plans 11

2.2.3 Specifications 12

2.3 Field Design Changes 13

3. CONSTRUCTION **16**

3.1 Overview 16

3.2 Construction Quality Control/Quality Assurance 17

3.3 Technical Specifications 18

3.3.1 General 18

3.3.2 Trenching and Backfilling 19

3.3.3 HDPE Manholes, Pipes, and Fittings 19

3.4 Contractor Submittals 20

3.5 LTS Installation 22
3.5.1 Overview 22
3.5.2 Butt Fusion Welds 22
3.5.3 Electrofusion Couplings 23
3.5.4 Sleeve Installation 25
3.5.5 Backfilling 25
3.6 Preliminary Hydrostatic Pressure Testing 26
3.7 Final Hydrostatic Pressure Testing 27
3.8 LTS Nonconformance Reports 29
3.9 LTS Gravity Piping to OSDF Cells 29
3.9.1 Overview 29
3.9.2 Installation 30
3.9.3 Electrofusion Coupling Failure Analysis 31
3.9.4 Pressure Testing 32
3.10 Record Drawings 32
4. FIELD PERFORMANCE OF LTS 43
4.1 Inspection and Maintenance Activities 43
4.1.1 Summary of OSDF Systems Plan 43
4.1.2 LTS Inspection and Maintenance Activities 43
4.1.4 Recordkeeping 45
4.2 LTS Inspection and Maintenance Records 45
4.3 Field Investigation, Identified Problems, and Repairs 47
4.3.1 Field Investigation 47
4.3.1.1 Introduction 47
4.3.1.2 LCS Manhole MH-3 to Excavation No. 1 48
4.3.1.3 Excavation No. 1 to Permanent Lift Station 52

4.3.1.4 LCS Manhole MH-1 to LCS Manhole MH-3 56
4.3.2 Identified Problems 57
4.3.2.1 LCS Manhole MH-3 to Excavation No. 1 57
4.3.2.2 Excavation No. 1 to Permanent Lift Station 58
4.3.2.3 LCS Manhole MH-1 to LCS Manhole MH-3 59
4.3.2.4 Containment Pipe Deflections 60
4.3.3 Repairs 60
4.3.3.1 Procedures Used for Joining Pipe 60
4.3.3.2 Repairs Performed 64
5. RESULTS OF DESIGN CALCULATIONS 67
5.1 Original Design Calculations 67
5.1.1 Overview 67
5.1.2 Flow Capacity 67
5.1.3 Structural Capacity 68
5.1.4 Frost Protection 68
5.2 Calculations in Support of Field Design Changes 68
5.3 Calculations for Existing Pipe 69
5.3.1 Overview 69
5.3.2 Flow Capacity 69
5.3.3 Structural Capacity 70
5.3.4 Discussion 71
6. EFFECT OF CONTAINMENT PIPE PRESSURE ON CARRIER PIPE INTEGRITY 73
6.1 Safe Differential Pipe Pressure 73
6.2 Summary of Observed Carrier Pipe Deflections 73
6.2.1 CCT Video Surveys 73

6.2.2 Permanent Gravity Line 74
6.2.3 Temporary Gravity Line 75
6.3 Deflected Carrier Pipe Performance 75
6.3.1 Technical Literature Review 75
6.3.2 Rate of Deflection 76
6.3.3 Vacuum Analogy 77
6.3.4 Residual Stresses 78
6.3.5 Carrier Pipe Findings 78
7. EVALUATION OF ELECTROFUSION COUPLING 80
7.1 Overview 80
7.2 Construction-Phase Installation Issues 80
7.3 Repair-Phase Installation Issues 81
7.4 Electrofusion Coupling Installation Issues 82
7.4.1 Pipe Cleaning 82
7.4.2 Alignment and Stab Depth 83
7.4.3 Melt Time 84
7.4.4 Moisture 84
7.5 Electrofusion Coupling Findings 85
8. FINDINGS AND CONCLUSIONS 89
8.1 Carrier Pipe (Butt-Fusion Joints) 89
8.2 Containment Pipe (Butt-Fusion Joints) 91
8.3 Electrofusion Couplings 93
8.4 LTS Current Status 98
8.5 Coupling Adjacent to Cells 99

9. RECOMMENDATIONS 100

9.1 Continued Use of LTS 100

9.2 Operations and Monitoring of Existing System 102

9.3 Design Loads 103

9.4 Pipe Materials for Future Construction 103

9.5 Procedures for Joining Pipe 104

9.6 Procedures for Pressure Testing 104

9.7 Procedures for Construction Quality Control/Quality Assurance 104

LIST OF TABLES

Table 2-1 Design Change Notice and Request for clarification of Information
Table 3-1 Leachate Conveyance System Contractor Submittal Requirements
Table 3-2 Non-Conformance Reports
Table 3-3 Summary of Electrofusion Coupling Information Carrier Pipe
Table 3-4 Summary of Electrofusion for Coupling Information and Extrusion HDPE Sleeve Data
Table 3-5 LTS Sag Locations
Table 4-1 Summary of Repairs to Identified Problems: 6" LTS Carrier Pipe
Table 4-2 Summary of Repairs to Identified Problems: 10" LTS Containment Pipe

LIST OF FIGURES

Figure 3-1 Fixed Method / Moveable method
Figure 3-2 Sleeve Method
Figure 3-3 Coupling and Sleeve Locations for LTS Gravity Line into OSDF Cells
Figure 4-1 Repair Locations 1999
Figure 4-2 Summary of Deflection Measurements from Video
Figure 9-1 Monitoring LCS Containment Pipe at Manhole
Figure 9-2 Monitoring LTS Containment Pipe at Manhole
Figure 9-3 Monitoring LTS Containment Pipe at Permanent Lift Station

LIST OF APPENDICES

APPENDIX A	DESIGN DOCUMENTS
	- Leachate Conveyance System Drawings Related to LTS
	- Leachate Conveyance System Technical Specifications Related to LTS
APPENDIX B	DCNs AND RCIs RELATED TO LTS
APPENDIX C	LTS CONSTRUCTION DOCUMENTATION
	- VBS QC Reports and Daily Reports
	- GeoSyntec CQC Report Summary
	- Referenced Standards
	- Central Plastics Electrofusion Manual
	- Pipe Pressure Testing Submittals
	- LTS NCRs
	- Report by Central Plastics
	- Record Drawings
APPENDIX D	POST CONSTRUCTION PRESSURE TEST RESULTS
	- Manhole MH-1 to PLS
	- Manholes to Cells
APPENDIX E	LTS OPERATIONAL DATA
	- Inspection and Maintenance Requirements
	- Petro QC Reports
APPENDIX F	CCT VIDEO SURVEY
	- CCT Video Tables
	- CCT Video Pictures
	- CCT Video Logs
APPENDIX G	CALCULATIONS PACKAGES
	- Original Design Calculations
	- DCN-007 Calculations
	- Existing Pipe Calculations
APPENDIX H	RELATED ASTM STANDARDS

APPENDIX I RECOMMENDED PROCEDURES FOR PIPE JOINING
- Joining with Electrofusion Couplings
- Joining with Extrusion Weld Sleeves

APPENDIX J RECOMMENDED PROCEDURES FOR LTS PRESSURE TESTING
- Pneumatic Pipe Test Procedure
- Hydrostatic Pipe Test Procedure

APPENDIX K RECOMMENDED PROCEDURES FOR LTS CQC/CQA
- HDPE Pipe Joining
- HDPE Pipe Pressure Testing

LTS

SECTION 1

1. INTRODUCTION

1.1 Purpose

The purpose of this report is to present the results of an evaluation by the design engineer-of-record of the current condition of the leachate transmission system (LTS) at the Department of Energy (DOE) On-Site Disposal Facility (OSDF) in Fernald, Ohio. The LTS included in this evaluation extends from OSDF manhole MH-1 to the permanent lift station (PLS). The need for this evaluation arose from the detection by site personnel of the buildup of liquid in the containment pipe of the LTS dual-containment piping system. Investigation of the condition of the LTS by site personnel revealed several locations of isolated damage and deficient electrofusion welding of carrier pipe and containment pipe.

The purpose of this report is also to present an evaluation of the suitability of the LTS for continued use for conveyance of leachate from the OSDF to the PLS. The evaluation is based on a variety of pre-existing and newly-developed data on the condition of the LTS pipes, and repair activities that were recently performed on the system. Based on the evaluation, this report presents conclusions and recommendations that can form the basis for decisions concerning continued use of the LTS for leachate conveyance from the OSDF to the permanent lift station. The report also addresses replacement or rehabilitation measures for components of the system for which problems are identified.

This report was prepared at the request of Fluor Daniel Fernald (FDF) based on the results of a site project meeting attended by representatives of FDF, GeoSyntec, and DOE.

1.2 Components of LTS

For the purpose of this report, the LTS is assumed to consist of certain components of the site leachate conveyance system which is designed to convey leachate generated by the OSDF from the OSDF to the biosurge lagoon. The LTS specifically includes components up to the discharge point into the PLS. Components of the LTS are

presented on the design plans and specifications described in Section 2.2 of this report. There components include:

- leachate collection system (LCS) manholes MH-1, MH-2, and MH-3;
- couplings, valves, and fittings within the manholes;
- dual-containment (i.e., 6-in. carrier and 10-in. containment) HDPE piping system, including couplings, valves, and fittings; from manhole MH-1 to manhole MH-3, this system has a total length of about 800 ft and slopes from MH-1 southward to manhole MH-3 at 0.75 percent average grade; from manhole MH-3 to the PLS, this system has a total length of about 2830 ft and slopes from manhole MH-3 southward to the PLS at 0.56 percent average grade;
- cleanout risers along the dual-containment piping system between MH-1 and the PLS; and
- discharge point from the dual containment system into the PLS.

In the context of this report, the LTS will be understood to also include the dual-containment HDPE piping system between the LCS and leak detection system (LDS) manholes and the OSDF cells. This portion of the LTS includes stub-outs for the LCS, LCS redundant, and LDS pipes installed by the construction contractor for the leachate conveyance system and connection piping between the stub-outs and the cells installed (or to be installed) by the construction contractor for cell construction.

Final design of the LTS was completed in October 1996. Construction of the LTS occurred between August and December 1997. Pressure testing of the LTS was completed on 21 December 1997. The LTS was approved for use in late December 1997 and went into operation on 23 December 1997. The system was operated until late January 1999 when a buildup of liquid was observed in LCS manhole MH-3. On 1 February 1999, operation of the system ceased and liquids in the system began being transferred via tanker truck from MH-3 to the PLS in accordance with the OSDF contingency plan. An investigation commenced at that time into the sources and causes of the observed liquids in the system.

1.3 Organization of Document

The remainder of this report is organized as described below:

- a discussion of the design basis for the LTS, the design plans and specifications issued for construction, and the design changes implemented during construction is presented in Section 2;
- a summary of the records of construction, including construction reports, construction quality control (CQC)/construction quality assurance (CQA) documentation, and results of the original construction-phase LTS pipe pressure tests, is provided in Section 3;
- a review of the operational performance of the LTS is presented in Section 4; this section describes system operations records, observed problems, results of closed-circuit television (CCT) surveys, field investigation and repair actions, and results of post-repair pipe pressure tests;
- calculations performed to evaluate the LTS are presented in Section 5; these calculations were prepared in support of the original design, design changes during construction, and evaluations of the current condition of the LTS;
- a discussion of the effect of the original pipe pressure test procedures on carrier pipe integrity is presented in Section 6;
- a discussion of electrofusion coupling installation procedures and issues is presented in Section 7 along with an evaluation of the suitability of continued use of the installed couplings for both the permanent and temporary gravity lines;
- findings drawn from the evaluations described in this report are given in Section 8; and
- recommendations for future design, construction, CQC/CQA, and operation of the LTS are presented in Section 9.

2. DESIGN BASIS

2.1 Design Criteria Package

2.1.1 Overview

This section presents LTS design criteria as described in Section 2.5.3 of Rev. 0 of the Final Design Criteria Package (DCP) (GeoSyntec, October 1996). LTS design criteria were developed to satisfy applicable or relevant and appropriate requirements (ARARs); functional requirements developed by Fluor Daniel Fernald (FDF) and Department of Energy (DOE) and described in Appendix D of the DCP; and design considerations based on the standard of practice for the use of polyethylene pipe in leachate conveyance applications. The LTS was designed to convey leachate (and liquids in the leak detection system (LDS)) from the OSDF to the PLS. The ARARs and the design criteria for the leachate collection system (LCS) manholes, permanent gravity flow portion of the LTS, and temporary gravity line (TGL) portion of the LTS are summarized in the following paragraphs.

2.1.2 ARARs

ARARs relevant to the LTS were derived from OAC 3745-27-08(C)(5) which states that leachate conveyance and storage structures located outside of the limits of disposal shall be no less protective of the environment than the disposal facility, and shall:

- be monitored, as required by EPA and OEPA ((C)(5)(a));
- for storage tanks, be provided with secondary containment ((C)(5)(b));
- for leachate lines, be provided with double containment ((C)(5)(c)); and
- for storage structures, have a minimum of one week of storage capacity as established by design using assumptions simulating final closure of the facility ((C)(5)(d)).

Additional Ohio EPA ARARs for the LTS are as follows:

- At least one lift station back-up pump shall be kept at the disposal facility at all times (OAC 3745-27-19(K)(2)).
- If authorized, leachate may be temporarily stored within the limits of disposal until the leachate can be treated and disposed (OAC 3745-27-19(K)(4)).

2.1.3 Design Criteria

The LTS design criteria presented below were developed to satisfy these ARARs as well as the functional requirements contained in Appendix D of the DCP and design considerations based on the standard of practice for use of high-grade polyethylene pipe in leachate conveyance systems.

- Liquid in the LDS of an OSDF cell should flow by gravity through a double-wall HDPE pipe (which penetrates the liner system) to a LDS manhole located on the west side of the OSDF (outside the limit of impacted material disposal).
- Each OSDF cell should have its own LDS manhole. The manhole should allow for direct discharge of flow from the LDS carrier pipe (i.e., the inner pipe component of the double-wall pipe) into a primary containment vessel located inside the manhole. The manhole should serve as a secondary containment structure for the primary containment vessel within the manhole. The leak detection manhole should allow for monitoring of liquid collected by the LDS and conveyed by the LDS carrier pipe into the primary containment vessel component of the manhole. The LDS containment pipe (i.e., the outer pipe component of the double-wall pipe) should have a monitoring port and fixed end seal within the LDS manhole.
- The design should isolate the LDS manhole from the LCS manhole during the period of active facility maintenance (i.e., during the initial post-closure period and some or all of the intermediate period described in Section 2.3 of the DCP). The design should allow for accumulated liquids in the primary containment vessel to be pumped (during this period of isolation) from a suction line in the vessel into a gravity flow drain connected to the LTS gravity line. The design

should further allow for the activation of a gravity flow drain from the primary containment vessel to the LTS gravity line should such a line be called for at some future time after final closure of the facility. Each leak detection manhole should have a cleanout (internal or external to the manhole) for maintaining the LDS carrier pipe and a high level alarm for the primary containment vessel of the manhole. The design should also provide access to install a sump pump in the vessel to allow pumping of construction water that drains from the LDS prior to the start of OSDF cell operation.

- Liquid in the LCS of an OSDF cell should flow by gravity through a double-wall HDPE pipe (which penetrates the liner system) to a LCS manhole located on the west side of the OSDF (outside the limit of impacted material disposal). In the manhole, the leachate should discharge directly into the LTS gravity line.

- Each OSDF cell should have its own LCS manhole. Each manhole should have cleanouts (internal or external to the manhole) for maintaining the LTS gravity line, the LCS carrier pipe, and the redundant LCS carrier pipe. The LCS carrier pipe in each manhole should have a sampling port for obtaining leachate samples for environmental analyses. This sampling port should also allow for the monitoring of LCS flows from a cell after its closure. The LCS carrier pipe should have temporary valves for regulating leachate flow into the gravity line during construction and periods of gravity line maintenance, extension, repair, etc. The design should require that the temporary valves be removed from each cell prior to final closure of the OSDF (so that, in the long term, there are no obstructions in the pipe). Each manhole should have an inlet for the redundant LCS carrier pipe. The redundant carrier pipe should have a valve (secured in a closed position) and sampling port (for periodically confirming the absence of liquid in the pipe). The carrier pipe valve should be configured so that it can be opened to allow flow to the leachate transmission gravity line at a future date in the event of a failure of the primary LCS pipe. Both the primary and redundant LCS containment pipes should have monitoring ports and fixed end seals within the LCS manholes.

- The LTS gravity line should consist of double-wall HDPE pipe having a minimum nominal diameter for the carrier pipe of 6 in. (150 mm). The

maximum pipe SDR should be 11. The factors of safety for flow in the LTS gravity line under the various design flow conditions are as follows:

- baseline design flow rate during OSDF operations (i.e., baseline leachate flow rate obtained from leachate generation analysis; this baseline excludes temporary flows from stormwater runoff that is contained in the cell and allowed to percolate directly into the cell LCS; the baseline flow rates was calculated to be 15.8 gpm): the minimum acceptable factor of safety for this condition is 3.0;

- storm design-basis flow rate during OSDF operations (i.e., baseline leachate flow plus temporary flows from stormwater runoff that is contained in the cell and allowed to percolate directly into the cell LCS); the storm design-basis flow rate should be mechanically controlled during active OSDF operations to satisfy following competing criteria: (i) rapid drainage of cell stormwater runoff; (ii) PLS operational requirements; and (iii) maximum acceptable discharge rate to the biosurge lagoon; the minimum acceptable factor of safety for temporary pressure flow in the LTS gravity line for this condition is 1.0, using as a basis the manufacturer's pressure rating for the carrier pipe; the storm design-basis flow rate was set at 200 gpm based on the maximum acceptable discharge rate to the biosurge lagoon; and

- baseline design flow after OSDF closure (i.e., baseline leachate flow obtained from leachate generation analysis; this flow rate was calculated to be 9.7×10^{-4} gpm); the minimum acceptable factor of safety for this condition is 10.0.

- The inner carrier pipe of the LTS gravity line should be continuous over its entire length (i.e., from its upgradient end to its discharge point). The outer containment pipe should be continuous between LCS manholes, and open to the manholes. The LCS manholes should be periodically inspected for the presence of liquid which could be indicative of a possible leak in the LTS carrier pipe or the LCS pipe, valves, or fittings. The LCS manholes should be equipped with liquid level alarms.

- The LTS gravity line should be located on the west side of the OSDF (outside of the limit of impacted material disposal). Once the OSDF is fully developed,

the gravity line should run the length of the OSDF, from the first cell near the north end of the facility to the last cell near the south end. From the last cell, the gravity line should run to the PLS. To promote gravity flow, the gravity line should be constructed with a minimum slope of 0.25 percent. The gravity line should be buried in a trench at a sufficient depth below ground to prevent freezing of liquids in the line and damage due to traffic loads and other stresses. The gravity line should be adequately bedded in the trench.

- The LTS gravity line and LCS and LDS manholes should be installed in stages, progressively advancing from north to south in conjunction with the progressive development of the OSDF. Each stage may involve the installation of manholes and leachate transmission gravity line for one or several cells. At a given stage, the leachate transmission gravity line should run through all of the LCS manholes previously installed and those installed for a given stage to the southernmost manhole installed in that stage. This southernmost manhole will serve as a connection point to a TGL. The LTS line should discharge directly into the TGL.

- Liquids discharged into the TGL should flow to the PLS at a minimum slope of 0.25 percent. The TGL should consist of double-wall HDPE pipe having a minimum nominal diameter for the carrier pipe of 6 in. (150 mm). The maximum TGL to monitor the rate and volume of liquid sent to the PLS. The TGL should be equipped with cleanout devices spaced along the pipe such that it can be maintained along its entire length. The PLS should be located in proximity to the southwest corner of the OSDF. The PLS should be installed concurrent with construction of the first OSDF cell.

- The pumps for the PLS should be sized to pump liquid through a double-wall forcemain to the biosurge lagoon. The TGL should be designed to carry flow at the storm design-basis flow rate, which will be established as previously discussed in this section of the DCP. (Note: The pumps for the PLS and the forcemain that will convey leachate from the PLS to the biosurge lagoon will be designed as part of a separate design package.)

- Unneeded portions of the TGL should be taken out of service as part of each subsequent stage of construction. At that time, the LTS gravity line should be extended to the next connection to the TGL or to the PLS, as appropriate.

- The PLS shall be protected from adverse effects due to leachate and differential settlement. The PLS shall be equipped with an automatic high level alarm located no greater than 6 ft (2.0 m) above the invert of the gravity line PLS inlet. PLS pumps shall be of adequate capacity and shall automatically commence pumping before the accumulated leachate activates the high level alarm (OAC 3745-27-08(C)(4)(e)). The PLS should also have a valve on the transmission line and a system for automatically closing the valve in the event of a power failure or if liquid levels in the PLS rise to an unacceptably high level (below the rim of the PLS or any level that would cause an electrical short or damage to equipment in the PLS). A valve should be installed to provide a manual means for preventing flow into the PLS. The PLS should be provided with secondary containment. The secondary containment system should be designed so that it can be monitored for the presence of leakage and should be equipped with a liquid level alarm.

- All manholes and the PLS should be designed to withstand (with a factor of safety of 1.4) hydrostatic uplift due to perched ground water. The design-basis perched ground-water contour map should be used for the uplift evaluation.

- Manholes should be designed to have a factor of safety of 2.0 against failure resulting from axial and radial wall stresses. The manholes should be evaluated for their adequacy with respect to radial crushing, radial buckling, axial crushing, and axial buckling (design considerations). To satisfy these design criteria, an analysis should be performed to evaluate the effects of lateral earth pressure and potential hydrostatic forces on the manholes. The analysis should consider the type of backfill material to be used around the manholes and the design-basis perched ground-water levels along the alignment of the LTS.

- The TGL between the LTS gravity line and PLS should be installed in a trench at a depth that does not interfere with the existing utilities. The pipe should be adequately bedded in the trench. Alternatively, the gravity line may be placed on or above existing ground and covered with a soil berm or insulation of sufficient thickness to protect the pipe from traffic loads, freeze-thaw, and other stresses. Layout of the gravity line to avoid interference with the utility corridor should be coordinated with FEMP site-wide planning activities. The

TGL should have adequate strength to resist internal stresses caused by the pressure of the liquid flowing through the line.

- The PLS shall be capable of storing the quantity of leachate generated during an one-week period using design assumptions simulating final closure of the OSDF (OAC 3745-27-08(C)(5)(d)). Potential storm surge flows from an OSDF cell into the LTS gravity line due to heavy precipitation into a newly opened cell should be regulated using throttling valves so that the storm design-basis flow rate upon which the PLS pump design is based is not exceeded.

- The PLS should have sufficient pump capacity to prevent the buildup of liquid in the manhole for the storm design-basis flow rate for the LTS gravity line. The PLS should have redundant pump capacity and automatic controls (with manual overrides) for operating the pumps.

- The PLS pumps should be designed to be conveniently removed from the PLS for periodic maintenance. Extra pumps for the PLS should be maintained on the Fernald Environmental Management Project (FEMP) property for use during periods of pump servicing.

- The PLS should contain pump controls, valves, and mechanical and electrical equipment to achieve the operational objectives described above.

- The Systems Plan for the OSDF should describe the operational and maintenance activities necessary to achieve the operational objectives described above.

2.2 Design Plans and Specifications

2.2.1 Overview

As a part of the final design package, plans and specifications were provided to communicate details necessary to provide assurance that the facility would satisfy requirements of the DCP when completed by a qualified contractor using techniques and procedures meeting standards of the industry. The LTS (including TGL) plans and

specifications were provided as a part of the leachate conveyance system construction documents.

2.2.2 Plans

Leachate Conveyance System drawings related to the LTS gravity line and TGL (Rev. 0, GeoSyntec, October 1996) consist of the following sheets:

X-2A	Legend and Symbols
G-8A	LTS Plan Profile Data I
G-8B	LTS Plan Profile Data II
G-8C	LTS Plan Profile Data III
E-4A	Electrical Details I
E-7A	Electrical Details IV
M-2A	LTS Piping and Instrumentation Design
M-4A	LTS Gravity Line and Manhole Details I
M-5A	LTS Gravity Line and Manhole Details II
M-6A	LTS Gravity Line and Manhole Details III
M-6B	LTS Gravity Line and Manhole Details IV
M-9A	LTS Lift Station Mechanical Details III
S1A	Structural Details I
S3A	Structural Details III
S5B	Structural Fence Details

OSDF Phase I and Phase II drawings related to the piping system between LCS and LDS manholes and the OSDF cells (Rev. 0, GeoSyntec, October 1996 and November 1999, respectively) consist of the following sheets:

G-9A	Cell Outlet Grading Plan (Phase I)
G-9B	Cell Outlet Grading Plan (Phase II)

Plan sheets X-2A, G-8A, G-8B, G-8C, E-4A, E-7A, and M-2A through M-9A from the Leachate Conveyance System drawings and G-9A and G-9B from the Phase I and Phase II drawings are presented in Appendix A of this report.

2.2.3 Specifications

Leachate Conveyance System Technical Specifications (Rev. 0, GeoSyntec, October 1996) consisted of the following:

DIVISION 2: SITE WORK

Section 02100	-	Surveying
Section 02110	-	Clearing, Grubbing, and Stripping
Section 02200	-	Earthwork
Section 02215	-	Trenching and Backfilling
Section 02270	-	Erosion and Sediment Control
Section 02300	-	Boring and Jacking
Section 02605	-	High Density Polyethylene (HDPE) Manholes, Pipes, and Fittings
Section 02831	-	Chain-Link Fences and Gates
Section 02930	-	Vegetation

DIVISION 3: CONCRETE

Section 03100	-	Concrete

DIVISION 13: SPECIAL CONSTRUCTION

Section 13400	-	Instruments and Equipment
Section 13401	-	Programmable Logic Controller

DIVISION 15: MECHANICAL

Section 15000	-	Mechanical
Section 15160	-	Lift-Station Pumps

DIVISION 16: ELECTRICAL

Section 16050	-	Basic Electrical Materials and Methods
Section 16121	-	Medium Voltage Cable
Section 16170	-	Grounding and Bonding
Section 16370	-	Overhead Power Distribution
Section 16462	-	Dry Type Transformer/Panelboards

Sections 02215 and 02605 of the Leachate Conveyance System package are included in Appendix A of this report. The portions of these specification sections related to piping were also used for Phase I and Phase II construction.

2.3 Field Design Changes

Following final design and during construction of the LTS, a number of requests for clarification of information (RCIs) and design change notices (DCNs) were issued in compliance with both FDF and GeoSyntec procedures and the approved OSDF CQA Plan. Table 2-1 provides a summary of RCIs and DCNs applicable to the LTS.

Complete copies of the DCNs and RCIs referenced above are presented in Appendix B of this report.

TABLE 2-1
Design Change Notices and Request for Clarification of Information

Date	Type	Number	Description
01/21/97	DCN	1700-007	Changes SDR of carrier and containment piping for gravity lines "from SDR 11 to SDR 26". DCN indicates that FDF shall obtain all necessary DOE and regulatory agency approvals as required for modification of Final Design Package and DCP.
05/07/97	DCN	1700-021	Changes spacing for support centralizers between the SDR 26 carrier pipe and containment pipe from a "maximum allowable spacing of 4 feet to a maximum nominal spacing of 4.5 feet". This DCN responds to written request of pipe supplier, ISCO Industries, Inc., in a letter dated 28 April 1997.
05/16/97	RCI	1700-015R	Clarified that SDR 11 shop-fabricated fittings, including stub-outs, are acceptable for joining with SDR 17 and SDR 26 piping based on manufacturer's technical bulletins.
05/28/97	DCN	1700-033	Changed Technical Specifications to allow testing of piping after backfilling on a case by case basis when specifically approved in writing by the FDF Construction Manager. Also changed internal testing pressures for gravity line "from 120 psi to 50 psi" and internal testing pressure for force main "from 130 psi to 95 psi" to be consistent with change from SDR 11 to SDR 26 for gravity line and from SDR 11 to SDR 17 for forcemain.
06/04/97	RCI	1700-022R	Additional clarification added to RCI 1700-015R, to allow counter boring of SDR 11 stub-outs at the ends to match the inside diameter of the connecting pipe. Fabrication, and inspection to be completed at manufacturer's shop as part of shop fabrication.
06/27/97	DCN	1700-041	Changed Technical Specifications to add procedures/requirements for placing and compacting pipe bedding sand from the LCS pipe to the cleanout (list

Date	Type	Number	Description
			of cleanouts included) for the gravity line and TGL. DCN provides more detailed requirements for cleanouts.
07/07/97	RCI	1700-029R	Clarified that cleanouts must be pressure tested at 15 psi, as per Technical Specifications.
0/23/97	DCN	1700-045	Change to alignment of the temporary LTS gravity line (TGL) to match existing site conditions.
07/29/97	DCN	1700-047	Change to alignment of the temporary LTS gravity line (TGL) to avoid existing fenced enclosure.
09/02/97	DCN	1700-057	Changed Technical Specifications from two trial welds to a single passing trial weld at each location at the beginning of each day for dual containment piping. This DCN allows successful production-welding by a pipe crew to be used as a basis for reducing number of trial welds. Construction quality control personnel may require additional trial welds based on observations.
09/04/97	DCN	1700-058	Provided procedures to allow compaction of granular pipe embedment fill by flooding or by combination of flooding and vibratory plate compaction when specifically approved in writing by the FDF Construction Manager (for safety reasons).
10/01/97	RCI	1700-034R	Clarification of Technical Specification to confirm that pipe embedment fill meets the requirements for granular filter material.
10/29/97	RCI	1700-036R	Clarification of a method to seal and test containment piping after installation to manholes. This RCI was implemented to provide testing method where FDF Construction Manager allowed construction subcontractor to install piping and manholes prior to testing.
02/25/99	RCI	1700-039R	Clarification of hydrostatic testing method for piping in a dual containment/carrier pipe system.

SECTION 3

3. CONSTRUCTION

3.1 Overview

The LTS was constructed as a part of the construction contract for a leachate conveyance system in 1997. Construction activities for the installation of the leachate conveyance system for the OSDF are generally described in the "*Construction Quality Assurance Final Report, On-Site Disposal Facility, Phase I and Leachate Conveyance System*", Rev. 0, January 1998, prepared by GeoSyntec. The leachate conveyance system includes the leachate collection and leak detection manholes, LTS (including TGL), PLS, and a leachate force main and cleanout manholes from the PLS to the BSL. This report section will focus on the construction of the LTS pipeline.

The prime construction contractor for the leachate conveyance system was Village Building Services, Inc. (VBS), with assistance from Wise Construction Company (Wise), both of Cincinnati, Ohio. FDF served as the construction manager for all LTS work. Work associated with the leachate conveyance system project began on 28 April 1997 and all work necessary to operate OSDF Cell 1 was completed on 22 December 1997. Work on the LTS portion of the system occurred between August and December 1997.

The major components of construction of the leachate conveyance system included the following:

- LTS gravity pipeline (including TGL) from LCS manhole MH-1 to the PLS consisting of a 6-in. diameter HDPE SDR-26 solid-wall gravity carrier pipe inside a 10-in. diameter HDPE SDR-26 solid-wall containment pipe;
- 84-in. diameter HDPE leachate collection and leak detection manholes (MH-1, MH-2, and MH-3) inclusive of fittings, valves, and controls;
- 84-in. diameter HDPE PLS inclusive of fittings, valves, controls, and two 200 gpm pumps;
- LTS force main from the PLS to the BioSurge Lagoon (BSL) consisting of a 4-in. diameter HDPE SDR-17 solid-wall pressure line inside a 8-in. diameter HDPE SDR-26 solid-wall containment pipe;

- four 54-in. diameter HDPE cleanout manholes along the force main;
- manhole stub-outs back toward the cells consisting of approximately 25 ft lengths of SDR-26 HDPE dual-containment pipe;
- piping to connect the aforementioned stub-outs to the OSDF cells consisting of approximately 50 ft lengths of SDR-11 HDPE dual-containment pipe; and
- excavation, backfilling and compaction of the leachate conveyance system trench and manhole excavations.

Available construction contractor quality control documentation related to the LTS that was prepared by VBS is presented in Appendix C of this report.

(Note: Pipe SDR refers to the "standard dimension ratio" which is the ratio of the pipe outside diameter to the minimum pipe wall thickness. SDR 26 pipe has an outside diameter which is 26 times the wall thickness. The SDR rating is an indicator of the strength of the pipe in carrying external structural loads or internal pressure (or vacuum) loads.)

3.2 Construction Quality Control/Quality Assurance

GeoSyntec provided on-site construction-related services during the installation of the various components of the leachate conveyance system. GeoSyntec personnel mobilized to site in March 1997. These activities included resident engineering and CQC/CQA. FDF provided on-site QA and construction management during the installation of the leachate conveyance system. The documentation of the CQC monitoring and testing activities for the installation of the leachate conveyance system are presented in the CQA Final Report [GeoSyntec, 1998].

The CQC/CQA activities included the following:

- review of changes to drawings and specifications through the RCI and DCN process;

- pipe conformance testing and documentation including review of pipe and manhole manufacturing certificates and quality control data for compliance with the project specifications;
- periodic field monitoring activities of pipe installation to include:
  - delivery, storage, installation, and testing activities associated with the LTS and other components of the leachate conveyance system;
  - HDPE pipe butt-fusion welding and electrofusion welding procedures, as well as periodic monitoring of the construction of connection sleeves and mechanical flanged connection procedures;
  - trenching and excavation for the leachate conveyance system, including piping, manholes, and permanent lift station;
  - placement and compaction of embedment fill for pipes and manholes;
  - hydrostatic final pressure testing of the leachate conveyance system, including HDPE piping, manholes, and PLS;
  - placement and compaction of granular material over and around piping systems, manholes, and PLS; and
  - backfilling and grading of the construction area.

A summary of CQC monitoring reports for the LTS is also presented in Appendix C of this document.

3.3 Technical Specifications

3.3.1 General

Technical specifications for the Leachate Conveyance System, Rev. 0 were prepared by GeoSyntec in October 1996 and provided as part of the Certified for Construction Design Package. A complete list of the technical specifications for the leachate conveyance system is provided in Section 2.3 of this report. An important part

of each specification section includes a requirement for contractor submittals. More detailed information regarding the contractor submittal process is covered in Section 3.4 of this report. The remainder of this section provides a summary of specific information from technical specification Section 02215, Trenching and Backfilling, and Section 02605, HDPE Manholes, Pipes and Fittings. These standards are included in Appendix C.

3.3.2 Trenching and Backfilling

Specification Section 02215 provides requirements for embedment fill material, trench backfill material, bentonite powder or granules, underground warning tape, pipeline marker signs, and equipment necessary to perform LTS trench work. Part 3 of the specification requires that embedment fill be placed in 7-in. ±1-in. thick loose lifts, with each lift compacted with a minimum of four passes of a vibratory plate compactor. Once the pipe is placed on the compacted embedment fill, additional pipe embedment fill is placed on the sides of the pipe and hand tamped to ensure intimate contact between the pipe and embedment fill is maintained below the spring line of the pipe. Embedment fill is then placed until it is even with the top of the pipe and compacted with a minimum of four passes of a vibratory plate compactor. Specifications prohibit compaction on top of the pipe unless a minimum of 12 inches of trench backfill separate the compactor from the top of the pipe.

DCN 1700-058, dated 4 September 1997, provided procedures to allow compaction of granular embedment fill by flooding or by a combination of flooding and vibratory plate compactor when specifically approved in writing by the construction manager. This DCN was intended for implementation for safety reasons only. Refer to Section 3.5 for specific pipe sections that were compacted by use of the flooding method.

3.3.3 HDPE Manholes, Pipes, and Fittings

Specification Section 02605 Part 2 provides product requirements for HDPE Manholes, Pipes, and Fittings. Products supplied and installed for the LTS were generally in compliance with the technical specifications with the following exceptions:

- DCN 1700-007 dated 21 January 1997 changed the SDR of carrier and containment piping for gravity lines from SDR 11 to SDR 26. This DCN responded to a value engineering study performed by FDF.

- DCN 1700-021, dated 7 May 1997, changes spacing for support stabilizers between the carrier pipe and containment pipe from a maximum allowable spacing of 4 ft to a maximum nominal spacing of 4.5 ft. This DCN responded to a written request (letter dated 28 April 1997) of the pipe supplier, ISCO Industries, Inc.

Specification Section 02605 Part 3 provided execution requirements for HDPE Manholes, Pipes, and Fittings. The excavation procedures were generally in compliance with the technical specifications with the following exceptions:

- DCN 1700-033, dated 28 May 1997, changed technical specifications to allow testing of piping after backfilling on a case by case basis when specifically approved by the construction manager. This DCN also changed testing pressures for the gravity line to be consistent with the change in pipe SDR.

- DCN 1700-057, dated 2 September 1997, changed technical specifications from two trial welds to a single passing trial weld at each location at the beginning of each day for dual containment piping. This DCN allowed successful production welding by a pipe crew to be used as a basis for reducing number of trial welds. CQC personnel retained authority to require additional trial welds based on observations.

It should be noted that the specifications require fabrication and installation of joints in compliance with ASTM D 2657, ASTM F 1055, and the manufacturer's recommendations. It should also be noted that hydrostatic testing is to be conducted in accordance with ASME B 31.9 §937.1 to §937.3. These standards are included in Appendix G. Also contained in Appendix G is ASTM F 1290 "Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings". This latter standard was not included in the technical specification.

3.4 Contractor Submittals

The technical specifications provided a performance specification for the LTS gravity flow system. This specification defined the features and related reference standards and requirements for the materials and workmanship required for the installation and testing of the system. These performance specifications required the

construction contractor to submit shop drawing, material specifications, technical data and certification for the leachate piping material, and procedures for the installation and testing of the leachate system piping and other components. The general procedure for approval of the submittals was as follows:

- the construction contractor provided construction submittal to FDF;
- submittals were tracked by submittal number, document number, and item description and controlled by Construction Document Control (CDC) and FDF Construction Contracts Manager (CCM);
- submittals were reviewed concurrently by FDF and GeoSyntec;
- FDF and GeoSyntec comments were collected and FDF prepared final comments for CDC to transmit back to the contractor; and
- upon resolution of comments to the satisfaction of the construction manager, FDF approved the submittal.

Contractor submittals approved by the construction manager comprise these general categories:

- shop drawings for the LTS pipes, support centralizers, fittings, appurtenances, clean outs and manholes;
- hydrostatic testing procedures for manholes, pipes, and fittings;
- manufacturer's data on polyethylene resin used in the manufacture of the high density polyethylene (HDPE) piping and manholes, including quality control data and material certifications;
- documentation of training and certification of personnel performing HDPE pipe joining;
- an Earthwork Work Plan which included methods and equipment used for trenching and backfilling of the LTS piping;

- specifications and test results for fill materials used for the embedment of the LTS piping; and
- hydrostatic and pneumatic test records (shop and field).

Table 3-1, Leachate Conveyance System Contract Submittal Requirements, lists the required submittals for the LTS piping, the corresponding contractor submittals by number, and submittal and approval dates for each document.

3.5 LTS Installation

3.5.1 Overview

The installation of the LTS gravity pipeline began in July 1997. The dual-containment LTS pipe was fabricated by ISCO Industries, Inc., Louisville, Kentucky in 40-ft long sections. The 6-in. diameter carrier pipe was centered within the 10-in. diameter containment pipe using centralized extrusion-welded plates spaced at 4.5 ft intervals (see DCN 1700-021). The pipe was manufactured by Phillips Driscopipe, Wellford, South Carolina. Pipe shipments received on 10 July 1997 and 16 July 1997 were noted in the CQC daily reports to be poorly packaged with some pipe being out of round and damaged. Subsequent difficulty welding out of round sections was noted in the CQC daily reports.

VBS performed installation of the dual containment LTS gravity pipeline, both temporary and permanent. As many as three crews simultaneously installed the LTS gravity line. One crew began just north of the PLS and worked north. Another crew began near manholes MH-1 to MH-3 and worked south. A third crew began work around stations 16+00 to 18+00. Due to the use of multiple pipe installation crews working at different locations, only 60 to 70 percent of LTS pipe installation was directly observed by CQC personnel.

3.5.2 Butt Fusion Welds

The butt-fusion welding technique was used to connect the LTS gravity line in 200-ft to 400-ft long sections in a designated work area. The pipe was dragged to its designated location and then lowered into the trench. CQC daily reports noted some difficulty in welding the long sections of pipe. The crew working at the middle of the

LTS generally pre-assembled the pipe in 400-foot lengths with the cleanout sections butt-fused at the end. Once the 400-ft sections were moved and lowered into the trench, an electrofusion coupling was used to join the carrier pipe. An electrofusion coupling or pipe sleeve was used to join the containment pipe to adjoining pre-assembled sections.

3.5.3 Electrofusion Couplings

Electrofusion couplings were installed in general conformance with procedures given by Central Plastics Company, manufacturer of the couplings. Construction contractor personnel were trained in the installation of electrofusion couplings by the pipe fabricator, ISCO Industries, Inc. The Central Plastics Company procedure is given in the document "Electrofusion Systems Operating and Training Manual", a copy of which is provided in Appendix C.

As noted in the manual, an electrofusion control box is used by the installer to supply electrical current to energize the heating elements in the coupling. The heating element melts a controlled amount of polyethylene in a "fusion zone". The heat also creates pressure in the fusion zone. The combination of pressure and heat causes the coupling and pipe to fuse together. During installation, the installer monitors the control box for diagnostic messages of inadequate control conditions (e.g., input voltage, output voltage, electrical current, lead contact, fitting short) monitors the process as the coupling is heated. Page 8 of the manual provides a list of diagnostic fault messages programmed in the control box along with remedial and probable causes. If a diagnostic message occurred during an electrofusion weld, the construction contractor undertook corrective actions.

The manual also calls for pipe ends (i.e., the portion of the circumference of the pipe in the fusion zone) to be scraped clean prior to electrofusion coupling installation. In lieu of scraping, the construction contractor used emery cloth and/or surface grinding machine with grit paper to clean the pipe ends. This cleaning method was taught to VBS pipefitters by the ISCO representative during on-site training sessions monitored by FDF QA personnel. A formal submittal of the procedures for electrofusion coupling installation was not required. However, copies of the procedure document published by Central Plastics Company was obtained by CQC personnel and made available to installers.

A sketch illustrating the actual procedures used for electrofusion coupling of fixed sections of carrier and containment pipe is presented in Figure 3-1. The "fixed procedure" was used for couplings where relative movement between the carrier and containment pipe was not possible. Where relative movement between the carrier and containment pipes was possible, a "movable procedure" was used. The basic steps of the electrofusion "fixed procedure" consist of:

- trim carrier and containment pipe lengths to proper dimension;
- drill holes in aligned containment pipe at planned locations of electrode connections on coupling for carrier pipe;
- clean carrier and containment pipe ends and slide the 6-in. and 10-in. couplings onto the upstream pipe ends (break the lugs in the 10-in. coupling and slide past the containment pipe end and drilled holes);
- align the upstream and downstream carrier and containment pipe ends including fitting and aligning carrier pipe into 6-in. coupling;
- recheck for proper alignment over joint;
- pass the control box electrodes through the containment pipe holes and fuse the carrier coupling;
- after completion of carrier pipe cool down, remove the electrodes and close the holes in the containment pipe by extrusion welding a bead into the holes and grind the area to be flush with the outer containment pipe; it is noted that some (number unknown) of the containment pipe holes used for electrodes were not welded closed prior to the electrofusion coupling being positioned;
- slide the containment coupling over the joint and center the coupling on the joint;
- connect the control box electrodes and fuse the containment coupling; and
- monitor the control box during the fusion process for diagnostic messages indicating a problem and take corrective action as appropriate; as a result of

diagnostic messages, several (number unknown) couplings were cut out and replaced.

The steps used in the assembly of electrofusion coupling on carrier and containment pipe where the carrier pipe on one side of the joint was free to move relative to the containment pipe is shown on Figure 3-1 as the "moveable procedure". These steps are similar to those above except that the 1-in. holes need not be drilled and the containment coupling need not be slid farther than the lugs allow onto the pipe.

The procedures described above were used by the construction contractor for installation of the electrofusion couplings. The technical specifications (Section 02605) did not require that the construction contractor provide the construction manager with a written procedural submittal for this work.

3.5.4 Sleeve Installation

An alternate procedure for joining sections of the 10-in. diameter containment pipe involved the use of a 12-in. sleeve, typically SDR 15.5 or 17, as approved in submittal No. 24 R3. Sleeves were often used to join the 8-in. diameter containment pipe in the leachate conveyance system pressure line due to the availability on-site of 10-in. pipe and to the convenience of using sleeves over couplings. Because 12-in. diameter pipe was not generally readily available on site, the use of sleeves was not as common for the LTS gravity line. However, sleeves were generally used where a single sleeve could be used in lieu of more than one coupling. A sketch illustrating the sleeve procedure used is presented in Figure 3-2. The sleeve was extrusion welded to the 10-in containment pipe. Sleeves were not used for joining carrier pipes.

3.5.5 Backfilling

After the pipes were connected in the trench, they were then backfilled with embedment fill to approximately one foot over the pipe crown. The embedment fill was covered with trench backfill to the ground surface. Compaction of granular embedment fill and trench backfill was in accordance with Technical Specifications except as noted (see DCN 1700-058). A flooding compaction procedure was used from approximately station 24+75 to 25+55 and 31+00 to 32+50. Refer to nonconformance reports 1700-003 and 1700-005 for details of the compaction. LTS pipe was not pressure tested prior to backfilling (per DCN 1700-033).

3.6 Preliminary Hydrostatic Pressure Testing

The contract technical specifications require that the LTS be hydrostatically tested prior to acceptance to ensure the system does not contain leaks. The contract technical specifications were amended by DCN-033 for SDR 26 pipe and required the carrier pipe to hold pressure for three hours if buried. Prior to the start of pressure testing, the construction contractor submitted a pipe testing procedure as required by Section 02605 of the technical specifications. This procedure was approved by the GeoSyntec resident engineer, FDF project engineer, and FDF construction manager. A copy of the procedure is presented in Appendix C. The approved procedure addressed the testing of dual containment pipe, but did not provide any requirement to maintain pressure in the carrier pipe while testing the containment pipe.

Pressure testing to evaluate the LTS for potential leaks began in late October 1997 after the entire line was installed and covered with backfill. Preliminary testing was performed by the construction contractor to evaluate the line prior to formal pressure testing. These tests were not observed or documented by the CQC personnel or FDF QA personnel. The pressures used in the pre-tests are not known.

According to construction documentation by VBS, preliminary pressure testing of the LTS gravity line was conducted in three sections: (i) LCS manhole MH-1 to LCS manhole MH-2; (ii) LCS manhole MH-2 to LCS manhole MH-3; and (iii) LCS manhole MH-3 to the PLS. A leak was suspected between LCS manhole MH-3 and the PLS in the carrier pipe. The contractor was unsuccessful in locating the leak by testing the pipe in relatively short sections. On 7 November 1997, the construction contractor filled the carrier pipe from the PLS back to manhole MH-3 with green colored water. Green colored water flowed through the containment pipe into the PLS indicating a leak in the carrier pipe. The construction contractor again tried to locate the source of the leak by pressure testing small sections of the pipe using inflatable plugs. During preliminary pressure testing on 17 November 1997, an inflatable plug was "blown out" or blown down the line around approximate station 31+55. An excavation was performed on 18 November 1997 to try to remove the plug. After the excavation and cutting of the pipe, the construction contractor and FDF personnel noted the carrier pipe at this location was out of round for a length of approximately 4 ft on both sides of the cut. Non-conformance report was written by FDF (NCR 97-0429) to describe the ovality of the

carrier pipe. The pipe ends were reformed and the pipe repaired using an electrofusion coupling.

In an effort to locate the suspected leaks in the carrier pipe, the construction contractor filled the containment pipe with water under low pressure while concurrently running a closed circuit television (CCT) video camera through the carrier pipe, starting at LCS manhole MH-3. The pressure in the containment pipe during video did not exceed 5 psi. The video tape, belonging to the construction contractor, is unavailable.

The construction contractor located two leaks were located in the carrier pipe. The first leak was found approximately 24 ft south of the clean out at station 12+00. The leak was due to burn through of an extrusion weld of the pipe centralizer. A second leak was located in the carrier pipe just south of the wye to the OSDF Equipment Wash Facility sump located at approximately station 13+20. The leak was attributed to a butt-fusion joint with a slight misalignment and inadequate fusion. Both leaks were repaired by cutting and fitting a new section of pipe, which was joined at both ends using electrofusion couplings. Wise Services, Inc performed the repair at station 12+24. VBS repaired the leak south of the OSDF Equipment Wash Facility.

3.7 Final Hydrostatic Pressure Testing

VBS began formal hydrostatic testing of the LTS gravity line on 2 December 1997. The testing was monitored by CQC personnel. The hydrostatic testing procedure generally consisted of filling the pipe of interest from the upstream end with water, bleeding out air at both the cleanouts and upstream valve, followed by applying the specified pressure. The pressure was measured for all tests at the upstream end.

During pressure testing of the dual-containment (4-in. and 8-in diameter) leachate conveyance system forcemain (i.e., prior to the start of LTS work) CQC personnel verbally informed the VBS quality control inspector that when testing dual containment piping systems, pressure should be maintained in the interior pipe. It is noted however, that no analysis was performed to evaluate the hydrostatic buckling pressure of the carrier pipe to support this recommendation. The recommendation was provided by CQC personnel "to be safe". This recommended procedure appeared to be used consistently by VBS during initial forcemain construction. Forcemain containment pipe testing was performed on sections of pipe between manholes prior to connection of the

dual-containment pipe to adjoining sections in the manhole. This facilitated dual pipe pressurization during the containment pipe pressure tests. Pressure testing of the forcemain was initially performed as each section between manholes was constructed. As work progressed, schedule issues began to affect work sequence, and pressure testing lagged significantly behind construction (see DCN 1700-033). At the time of pressure testing of the LTS in December 1997, VBS followed the approved procedure, but as previously mentioned, the procedure did not include the step requiring pressurization of the carrier pipe with the containment pipe. The considerations (or lack thereof) that went into the construction contractor's decision not to pressurize the LTS carrier pipe in December 1997 (as he had previously done in testing the forcemain) have not been identified by the investigation described in this report. FDF and GeoSyntec personnel were not aware that the missing step had the potential to induce unconstrained buckling of the SDR 26 carrier pipe.

The first test was performed on the carrier pipe from LCS manhole MH-3 to the PLS. This length of the carrier pipe was tested at 53.3 psi for approximately 28.5 hours. The test pressure was monitored with a gauge affixed near the upstream end of the pipe being tested. Test pressure at the downstream end of the pipe was thus higher than at the gauge location by an amount proportional to the elevation drop along the tested section. As such, the maximum pressure in the pipe has been calculated to be 60.4 psi, which is less than the 64 psi rated operating pressure of the pipe. Over the duration of the test period, the pressure decreased at a rate of 0.1 psi/hour which was considered acceptable and approved by CQC and FDF for 2800 ft of pipe.

On 6 December 1997, the remaining length of the LTS carrier pipe, from LCS manhole MH-1 to LCS manhole MH-3, was pressure tested. The carrier pipe from LCS manhole MH-1 to LCS manhole MH-3 was tested at an initial pressure of 53.2 psi. The pressure was applied to the carrier pipe for a period of 22.4 hours. The gauge location was at the upstream location of the pipe. As such, the maximum pressure in the pipe has been calculated to be 55.8 psi which is less than the 64 psi rated operating pressure of the pipe. The average pressure loss with time of 0.1 psi/hour was considered acceptable and approved by CQC and FDF.

On 11 December 1997, VBS began hydrostatic testing of the 10-in. diameter containment pipe of the LTS gravity line. The containment pipe from LCS manhole MH-2 to LCS manhole MH-3 was tested at a pressure of 22 psi for a period of three

hours. No pressure loss was noted, and hence this section of the containment pipe was accepted and approved.

The LTS containment pipe from LCS manhole MH-3 to the PLS was also tested on 11 December 1997. This section of the LTS was initially pressurized to 20 psi. For this 2800-ft long section of pipe, the test pressure at the downstream end was about 7 psi higher than at the upstream end. Over the first hour of the test, no drop in pressure was observed. When checked 30 minutes later, a 1 psi drop in test pressure was indicated by the pressure gauge. At that time a small leak was observed in the fixed-end seal which was used for the test gauge. After 2 hours of testing, the pressure had dropped an additional 0.7 psi, and after 3 hours, an additional 0.7 psi. Due to the minor leakage observed at the fixed-end seal used for the gauge, a small pressure drop was observed. CQC and FDF considered these results acceptable and approved the pipe for use.

The containment pipe from LCS manhole MH-1 to LCS manhole MH-2 was pressure tested on 15 December 1997 by VBS and Wise. The test pressure was 17.5 psi for a period of three hours. No pressure loss was noted, and the section of pipe was subsequently approved.

The reports of final pressure testing are presented in Appendix D.

3.8 LTS Nonconformance Reports

Table 3-2 provides a summary of GeoSyntec and FDF nonconformance reports (NCRs) applicable to the LTS. Copies of the NCRs are provided in Appendix C.

3.9 LTS Gravity Piping to OSDF Cells

3.9.1 Overview

The LTS gravity pipeline has another dual containment pipeline component that conveys leachate from the OSDF Cells 1, 2, and 3 to the leachate collection and leak detection manholes (MH-1, MH-2, and MH-3). Cells 1 and 2 have been constructed and Cell 3 has not. The leachate conveyance system construction contractor, VBS, initially installed piping (SDR 26) to a tie-in point located approximately 25 ft east of

manholes MH-1, MH-2, and MH-3. East of the tie-in point, the OSDF Phase 1 construction contractor, Petro Environmental Technologies (Petro), installed piping (SDR 11) to the liner penetration boxes located at the Cells 1 and 2 and to a point near the future location of the liner penetration boxes for Cell 3. Electrofusion couplings were used by both construction contractors to complete their portion of the pipelines. The locations of couplings or sleeves along these portions of pipe are presented on Figure 3-3. A description of the pipeline installation and final pressure testing is discussed in this section.

3.9.2 Installation

VBS installed the SDR 26 piping between manholes and the location of the tie-in to SDR 11 piping. Central Plastics Company electrofusion couplings, and pipe sleeves fabricated on-site, were used to join cleanouts and sections of pipe at these locations. The electrofusion couplings were installed using the same procedures as those used for the mainline. During initial installation, repairs had to be made due to leaks found in several couplings at all three manhole locations. Photographs of the Cell 1 constructions are available which show which couplings were replaced and which were repaired by backwelding. The carrier and containment piping between LCS/LDS manhole MH-1 and OSDF Cell 1 were tested and placed into service in December 1997. The liner system of Cell 2 was scheduled for construction in Summer/Fall 1998 and Cell 3 was scheduled for Summer/Fall 1999. Given this schedule, final testing and repair of the pipe sections installed by VBS between LCS/LDS manholes and Cells 2 and 3 were scheduled for replacement/repair during Spring 1998. When repair/replacement activities were undertaken in Spring 1998, VBS cut out two pairs of leaking couplings (6 in. and 10 in.) near manholes MH-2 and sent the couplings to Central Plastics Company for evaluation. The Central Plastics Company evaluation is discussed below.

In Spring 1998, ISCO was retained by FDF to tie SDR 26 pipe previously installed by VBS to the SDR 11 piping previously installed by Petro between manholes MH-2 and Cell 2. ISCO used electrofusion couplings to make the connection to the LDS piping and LCS redundant piping. Petro used an electrofusion coupling to make the connection to the LCS piping at MH-2. Couplings and sleeves used to tie-in the SDR 26 pipe at manholes MH-3 with Cell 3 piping were installed in 1998 by Petro. Procedures used by ISCO and Petro in 1998, were in general conformance with manufacturers recommendations including pipe cleaning, scraping or grinding, pipe and

joint alignment and fusion using Central Plastics Company or Friamat Inc. fusion processors. However, it is believed that no special adjustments were made for fusion welding of the SDR 26 pipe to the SDR 11 pipe at the tie-in point.

Couplings in Cell 1 and 2 located behind the liner penetration boxes beneath the secondary HDPE cell liner were installed by Petro on SDR 11 pipe. Procedures were in general accordance with manufacturers requirements. However, one 10 in. coupling installed in 1997 at Cell 1 (on redundant LCS pipe) did leak during a pressure test and was repaired by backwelding. Backwelding, in the context of this report, means welding the two ends of the coupling to the pipe (around the entire circumference of the pipe) using extrusion welding procedures. Backwelding was used rather than cutting out and replacing the coupling to preserve the integrity of the carrier pipe and to avoid introducing additional couplings on the containment pipe. The connections in the carrier pipe behind the liner penetration boxes beneath the secondary liner consisted of only butt-fusion joints. Both the carrier and containment piping from the manholes into the cell passed air pressure testing at the specified test pressure of 15 psi. The 15 psi pressure was used for both carrier and containment piping attached to the liner penetration boxes because the liner penetration boxes had been designed for and tested at the 15 psi pressure. Testing was performed through the boxes after final installation. The SDR 11 carrier piping for all cells had been tested above ground at a minimum hydrostatic pressure of 120 psi prior to installation.

3.9.3 Electrofusion Coupling Failure Analysis

As noted above, VBS installed short sections of dual containment SDR 26 HDPE pipe between the LDS and LCS manholes and from the manholes approximately 25 ft toward the landfill cells. In the Spring of 1998, during the completion of piping around manhole MH-2, two sets of suspect 10 in. and 6 in. electrofusion couplings previously installed by VBS were removed and sent to Central Plastics Company for laboratory review. The couplings had failed initial pressure tests in the field. Central Plastics Company used both pressure and destructive tests to try to determine the cause of the leaks in the couplings. Central Plastics Company concluded that the failure of the couplings resulted from improper pipe preparation and introduction of holes in the ten-inch containment pipe. The Central Plastics Company report is included in Appendix C.

3.9.4 Pressure Testing

The final pressure testing between the manholes and cells consisted of performing air pressure tests at minimum 15 psig for both 6-in. carrier pipe and 10-in. containment pipe. The 6-in. and 10-in. SDR 11 carrier and containment pipes, respectively were butt-fused by Petro and had already been hydrostatically tested at minimum 120 psig and 15 psig, respectively. Copies of the approved final tests to include Petro's above ground tests are provided in Appendix D.

Final pressure tests between manhole MH-1 and Cell 1 were performed by Petro and Wise for the 6-in. carrier and 10-in. containment pipes between 06 December 1997 and 14 December 1997. Petro performed final pressure tests between manholes MH-2 and Cell 2 between 5 September 1998 and 18 September 1998. Final pressure tests between MH-3 and Cell 3 are not completed because Cell 3 has not yet been constructed.

3.10 Record Drawings

Record drawings (i.e., "as-builts") of the LTS have been prepared based on survey information provided by FDF and results of CCT videos analyzed by GeoSyntec. The record drawings are presented as Figures 3-4a, 3-4b, and 3-4c in this report and are contained in Appendix C. Survey information for the as-built LTS gravity line was prepared by B. L. Payne Surveyors. GeoSyntec was provided the survey data for the LTS gravity line on 10 March 1999. The survey data consists of horizontal coordinates and elevations along the top of the containment pipe at the containment pipe joints. Figures 3-3a, 3-3b, and 3-3c show the plan and profile data for the top of the as-built containment pipe prior to backfilling. The slope between surveyed points along the LTS is also provided in these figures.

The location and descriptions of the joints for the containment pipe were taken from survey information, construction photos, and field notes. Joints shown on the carrier pipe were taken from CCT video (performed during the periods of 16 to 19 February 1999 and 2 to 4 March 1999) and construction field notes for repaired sections after the videos. The locations of joints shown in the figures are approximate and provided for information only.

Tables 3-3 and 3-4 provide detailed information related to the electrofusion couplings and sleeves used during the 1997 installation of the LTS gravity line from LCS manhole MH-1 to the PLS. Station information is approximate and provided for information only. Central Plastics Company manufactured the electrofusion couplings used in 1997. Most couplings used were PE3408 with some being PE2406 (PE 2406 was accepted by NCR-0006.) Sleeves consisted of 12-in. diameter HDPE pipe having a SDR of either 15.5 or 17. The alignment and installation procedure column refers to the information available in the construction documentation. In many cases, only partial observation of the sleeve or coupling installation was feasible. In these cases, only the observed activities are listed in the alignment/installation procedure column. Information relating to the plugging of 1-in. holes in the containment pipe, length of sleeves used, and welding procedures is also provided.

The as-built slope of the LTS gravity line between LCS manholes MH-1 and MH-3, prior to backfilling, is generally in conformance with the specifications. However, between manhole MH-3 and the PLS, several sections have "sags" or grade reversals. According to Section 02605 of the technical specifications, the gravity line is to always maintain a positive slope. According to the survey information provided by B. L. Payne Surveyors, the LTS gravity line at the stations listed below in Table 3-5 do not meet the positive slope requirement of the technical specifications. These minor grade reversals will not measurably impact the flow capacity of the LTS gravity line. Flow capacity is primarily controlled by the overall pipe grade and minor grade variations in the run will tend to be self-compensating.

TABLE 3-1
LEACHATE CONVEYANCE SYSTEM CONTRACTOR SUBMITTAL REQUIREMENTS

Submittal Requirement	Contractor Submittal No.	Date Submitted by Contractor	Engineer Review Date/Status[1]	Date Approved by FDF
Shop Drawings: Manholes, Pipes, Support Centralizers, Fittings, Supports, Gussets and Appurtenances	1700-589-024 R1 1700-589-024, R3 1700-589-025, R1	05/22/97 08/06/97 04/22/97	To be completed 8-14-97/A 4-24-97/A	06/19/97 08/14/97 04/24/97
Materials List	Not determined	Not determined	*	Not determined
Names of Suppliers and Proposed Delivery Dates to the Site.	Not determined	Not determined	*	Not determined
Hydrostatic Testing Procedures for Manholes, Pipes and Fittings	1700-589-090, R1 1700-589-090, R2 1700-589-091, R1	06/02/97 06/12/97 08/27/97	6-5-97/A 6-18-97/* 8-29-97/A	06/16/97 06/05/97 08/20/97
HDPE Manufacturer's List of Completed Facilities	1700-589-060, R0	03/20/97	4-9-97/B	05/13/97
HDPE Manhole Manufacturer's Quality Control Procedures/Program	1700/589/060, R0 1700/589/077, R1	03/20/97 04/16/97	4-9-97/B 4-17-97/C, B	05/13/97 04/24/97
Origin and Identification of Polyethylene Resin Used in Manhole HDPE Manhole Manufacturer's Certifiable Values and Corresponding Test Procedures for HDPE Material Properties	1700-589-060, R0	03/20/97	4-9-97/B	05/13/97
Quality Control Certificates for Resin/ Quality Test Results for Resin	1700-589-077, R4 1700-589-077, R6 1700-589-077, R7 1700-589-077, R8 1700-589-077, R9	05/08/97 06/23/97 07/29/97 08/01/97 08/05/97	* 6-26-97/A 7-30-97/A 8-5-97/A 8-7-97/A	05/09/97 06/26/97 07/31/97 08/15/97 08/15/97

48

2194

Submittal Requirement	Contractor Submittal No.	Date Submitted by Contractor	Engineer Review Date/Status[1]	Date Approved by FDF
Certification that No Reclaimed Polymer is Added to Resin During Manufacturing of HDPE Products	1700-589-060, R0	03/20/97	4-9-97/B	05/13/97
	1700-589-077, R1	04/16/97	4-17-97/C, B	04/24/97
Certification of Compliance for HDPE Manholes	1700-589-060, R1	06/12/97	6-13-97/A	06/16/97
	1700-589-060, R2	06/16/97	6-18-97/A	06/19/97
	1700-589-060, R3	07/24/97	7-31-97/A	08/01/97
	1700-589-060, R4	07/28/97	7-31-97/A	08/01/97
	1700-589-060, R5	08/01/97	8-5-97/A	08/12/97
	1700-589-060, R6	08/14/97	8-15-97/A	08/18/97
Certification of Compliance for HDPE Pipes, Fittings and Appurtenances	1700-589-077, R4	05/08/97	*	05/09/97
	1700-589-077, R5	06/12/97	6-13-97/A	06/19/97
	1700-589-077, R6	06/19/97	6-26-97/A	06/26/97
	1700-589-077, R7	07/29/97	7-30-97/A	07/19/97
	1700-589-077, R8	08/01/97	8-5-97/A	08/15/97
	1700-589-077, R9	08/05/97	8-7-97/A	08/15/97
	1700-589-077, R10	08/25/97	8-25-97/A	08/29/97
Documentation of Training and Certification of Personnel Performing HDPE Pipe Joining	1700-589-079, R0	04/30/97	5-1-97/A	05/14/97
	1700-589-079, R1	05/08/97	5-15-97/A	05/14/97
	1700-589-079, R2	06/30/97	*	11/23/98
	1700-589-079, R3	0/01/97	*	11/23/98
Earthwork Work Plan	1700-589-086, R2	08/14/97	8-15-97/A	08/18/97
List of Equipment for Trenching and Backfilling	1700-589-086, R2	08/14/97	8-15-97/A	08/18/97

1. Legend:
   Status A – Reviewed
   Status B - Reviewed, proceed with work incorporating comments
   Status C – Change submittal as noted and resubmit
   Status 10 – Information Only
   * - No Status

2194

TABLE 3-2
NON-CONFORMANCE REPORTS

DATE	NUMBER	ASSESSMENT ACTIVITY	NONCONFORMANCE	RESOLUTION
10-Jul-97	1700-002	Construction Quality Control	Compaction of materials over dual containment pipe prior to testing without written construction manager approval (not in accordance with DCN 1700-033.)	Letter NCR approved by FDF.
7-Sep-97	1700-003	Construction Quality Control	Lifts of pipe embedment not compacted by flooding per DCN 1700-058.	Approved by FDF since pipeline temporary and intent of specification met.
7-Sep-97	1700-004	Construction Quality Control	Temporary cleanout was placed with the cleanout lateral facing in the opposite direction of the design flow.	Since pipeline temporary, accepted.
16-Sep-97	1700-005	Construction Quality Control	Pipe embedment fill compaction unsatisfactory and not per DCN 1700-058.	Approved by FDF since intent of specification met.
28-Sep-97	1700-006	Construction Quality Control	The specified couplings were not used for electrofusion.	Accept PE2406 couplings.
24 Nov 97	FDF 1700-0429	Inspection	Out-of-round carrier pipe.	Accept after pressure test.

TABLE 3-3
SUMMARY OF ELECTROFUSION COUPLING INFORMATION CARRIER PIPE

Repair Designation (Note 1)	Station	Installation Date	Manuf.	Installer	Cleaning Procedure	Alignment/ Install. Procedure	Welding Procedure	Connection Type	Comments
C_61	36+14	22 Sep 97	Central Plastics Company	VBS			Inside containment pipe	6-in. Electrofusion Coupling	Noted in CQC daily report
C_62	36+08	22 Sep 97	Central Plastics Company	VBS		Alignment OK		6-in. Electrofusion Coupling	Observed by CQC
C_63	36+04	22 Sep 97	Central Plastics Company	VBS		Alignment OK		6-in. Electrofusion Coupling	Observed by CQC
C_64	32+06	12 Sep 97	Central Plastics Company	VBS	Not Observed			6-in. Electrofusion Coupling	Process not observed. *Original placement.
C_65	31+87		Central Plastics Company					6-in. Electrofusion Coupling	
C_69	23+87	18 Sep 97	Central Plastics Company	VBS	Not Observed	Alignment OK		6-in. Electrofusion Coupling	Observed by CQC
C_610	20+20	27 Sep 97	Central Plastics Company	VBS	Not Observed	Alignment OK		6-in. Electrofusion Coupling	Observed by CQC

5

2194

TABLE 3-3
SUMMARY OF ELECTROFUSION COUPLING INFORMATION CARRIER PIPE
(CONTINUED)

Repair Designation (Note 1)	Station	Installation Date	Manuf.	Installer	Cleaning Procedure	Alignment/ Install. Procedure	Welding Procedure	Connection Type	Comments
©$_6$11	15+72	30 Sep 97	Central Plastics Company	VBS	Not Observed	Alignment OK		6-in. Electrofusion Coupling	Observed by CQC
©$_6$12	13+59		Central Plastics Company					6-in. Electrofusion Coupling	
©$_6$18	11+86		Central Plastics Company					6-in. Electrofusion Coupling	
©$_6$19	11+77		Central Plastics Company					6-in. Electrofusion Coupling	
©$_6$20	8+02	25 Sep 97	Central Plastics Company	VBS	—	OK		6-in. Electrofusion Coupling	Observed by CQC
©$_6$21	7+80		Central Plastics Company					6-in. Electrofusion Coupling	
©$_6$22	7+66	27 Sep 97	Central Plastics Company	VBS	—	OK		6-in. Electrofusion Coupling	Observed by CQC

52

2194

TABLE 3-3
SUMMARY OF ELECTROFUSION COUPLING INFORMATION CARRIER PIPE
(CONTINUED)

Repair Designation (Note 1)	Station	Installation Date	Manuf.	Installer	Cleaning Procedure	Alignment/ Install. Procedure	Welding Procedure	Connection Type	Comments
$C_6$23	4+10	26 Sep 97	Central Plastics Company	VBS	—	OK		6-in. Electrofusion Coupling	Observed by CQC
$C_6$24	4+02	23 Sep 97	Central Plastics Company	VBS	—	OK		6-in. Electrofusion Coupling	Not witnessed
$C_6$25	3+73	24 Sep 97	Central Plastics Company	VBS				6-in. Electrofusion Coupling	Observed by CQC
$C_6$26	0+16		Central Plastics Company					6-in. Electrofusion Coupling	
$C_6$27	0+8	22 Sep 97	Central Plastics Company	VBS	—	OK		6-in. Electrofusion Coupling	Observed by CQC
$C_6$28	36+15	20 Sep 97	Central Plastics Company	VBS				6-in. Electrofusion Coupling	Observed by CQC

NOTES:
1. See Figure 3-4 (a, b, c) for locations of repairs.

53

2194

TABLE 3-4
SUMMARY OF ELECTROFUSION COUPLING INFORMATION AND EXTRUSION HDPE SLEEVE DATA: CONTAINMENT PIPE

Repair Designation (Note 1)	Station	Installation Date	Manuf.	Installer	Cleaning Procedure	Alignment/ Install. Procedure	Welding Procedure	Connection Type	Comments
$C_{10}1$	36+14	22 Sep 97	Central Plastics Company	VBS			Holes in 10" Plugged	10-in. Electrofusion Coupling	Observed by CQC
$C_{10}2$	36+08	22 Sep 97	Central Plastics Company			Alignment OK		10-in. Electrofusion Coupling	Observed by CQC
$C_{10}3$	36+04	22 Sep 97	Central Plastics Company			Alignment OK		10-in. Electrofusion Coupling	Observed by CQC
$S_{10}4$	32+07	12 Sep 97	Driscopipe	VBS			10 HDPE Sleeve (extrusion)	12-in. HDPE Sleeve	Observed by CQC. Sleeve covered 6" coupling #4 @ original placement
$S_{10}5$	31+98		Driscopipe					12-in. HDPE Sleeve	
$C_{10}6$	31+90		Central Plastics Company					10-in. Electrofusion Coupling	

54

2194

TABLE 3-4
SUMMARY OF ELECTROFUSION COUPLING INFORMATION AND EXTRUSION HDPE SLEEVE DATA: CONTAINMENT PIPE
(CONTINUED)

Repair Designation (Note 1)	Station	Installation Date	Manuf.	Installer	Cleaning Procedure	Alignment/ Install. Procedure	Welding Procedure	Connection Type	Comments
$S_{10}9$	28+10	7 Sep 97	Driscopipe	VBS			10" HDPE Sleeve Extr.	12-in. HDPE Sleeve	Observed by CQC. Gun #4431201 welded 270°F surfaces grinded
$C_{10}10$	23+85	18 Sep 97	Central Plastics Company	VBS				10-in. Electrofusion Coupling	Observed by CQC
$C_{10}11$	20+01	27 Sep 97	Central Plastics Company	VBS		Alignment OK		10-in. Electrofusion Coupling	Observed by CQC
$C_{10}12$	15+77	30 Sep 97	Central Plastics Company	VBS		Alignment OK		10-in. Electrofusion Coupling	Observed by CQC
$C_{10}17$	12+80		Central Plastics Company					10-in. Electrofusion Coupling	
$C_{10}18$	11+78		Central Plastics Company					10-in. Electrofusion Coupling	

55

2194

TABLE 3-4
SUMMARY OF ELECTROFUSION COUPLING INFORMATION AND EXTRUSION HDPE SLEEVE DATA: CONTAINMENT PIPE
(CONTINUED)

Repair Designation (Note 1)	Station	Installation Date	Manuf.	Installer	Cleaning Procedure	Alignment/ Install. Procedure	Welding Procedure	Connection Type	Comments
$C_{10}19$	8+02	25 Sep 97	Central Plastics Company	VBS	—	OK		10-in. Electrofusion Coupling	Observed by CQC
$C_{10}20$	7+87		Central Plastics Company					10-in. Electrofusion Coupling	
$C_{10}21$	7+65	27 Sep 97	Central Plastics Company	VBS	—	OK		10-in. Electrofusion Coupling	Observed by CQC
$C_{10}22$	4+19	26 Sep 97	Central Plastics Company	VBS	—	OK	10" Coupling	10-in. Electrofusion Coupling	Observed by CQC
$C_{10}23$	4+0013	26 Sep 97	Central Plastics Company	VBS		OK	9" Long HDPE Sleeve	10-in. Electrofusion Coupling	Observed by CQC
$C_{10}24$	4+08	26 Sep 97	Central Plastics Company	VBS		OK	10" Coupling	10-in. Electrofusion Coupling	Observed by CQC
$C_{10}25$	4+02	23 Sep 97	Central Plastics Company	VBS				10-in. Electrofusion Coupling	Observed by CQC

21194

TABLE 3-4
SUMMARY OF ELECTROFUSION COUPLING INFORMATION AND EXTRUSION HDPE SLEEVE DATA: CONTAINMENT PIPE
(CONTINUED)

Repair Designation (Note 1)	Station	Installation Date	Manuf.	Installer	Cleaning Procedure	Alignment/ Install. Procedure	Welding Procedure	Connection Type	Comments
$C_{10}26$	3+82		Central Plastics Company					10-in. Electrofusion Coupling	
$C_{10}27$	3+74	24 Sep 97	Central Plastics Company	VBS				10-in. Electrofusion Coupling	
$C_{10}28$	0+10		Central Plastics Company					10-in. Electrofusion Coupling	
$C_{10}29$	0+05		Central Plastics Company					10-in. Electrofusion Coupling	
$C_{10}30$	36+15	20 Sep 97	Central Plastics Company	VBS				10-in. Electrofusion Coupling	Observed by CQC

NOTES:
1. See Figure 3-4 (a, b, c) for locations of repairs.

2194

TABLE 3-5
LTS SAG LOCATIONS

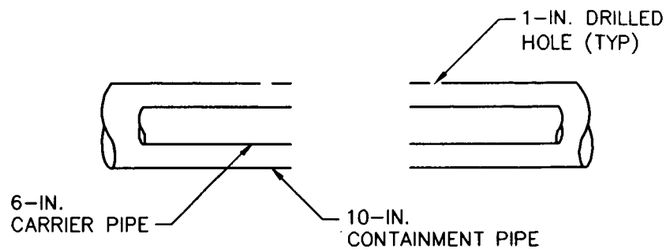
Station #	Slope	Ponded Water In Video
0+90 to 1+28	0.13%	No
13+38 to 13+78	0.37%	No
27+51 to 28+05	0.37%	Yes
30+46 to 30+62	1.27%	Yes
31+12 to 31+37	0.24%	No
32+52 to 32+67	0.59%	Yes
32+67 to 32+91	0.04%	Yes
33+21 to 33+30	2.18%	Yes
34+07 to 34+45	0.21%	Yes
34+83 to 35+16	0.89%	Yes
35+16 to 35+60	0.11%	Yes

Note: Water in the bottom of the carrier pipe at these locations is not an indication of a leak.

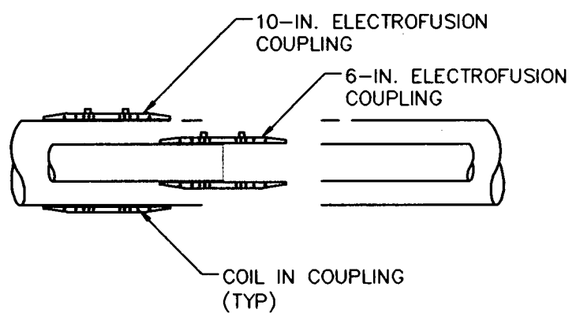
FIXED METHOD

UPSTREAM PIPE DOWNSTREAM PIPE

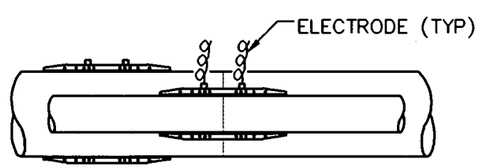
STEP 1: Trim, clean, and prepare both pipes to proper dimensions. Drill 1" holes in containment pipe for electrode connections on carrier pipe.



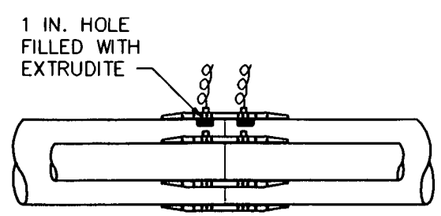
STEP 2: Slide 6-in. and 10-in. couplings onto the upstream pipe ends. Break lugs on 10-in. and slide pass 1" holes.



STEP 3: Align the upstream and downstream pipe ends of both carrier and containment pipes. Move the downstream carrier coupling and center on the joint. Pass the electrodes through the 1" holes and fuse coupling to the carrier pipe.



STEP 4: Extrusion weld the 1" holes in the containment pipe and grind the area flush. Center the containment coupling on the joint and fuse the containment coupling to the pipe.

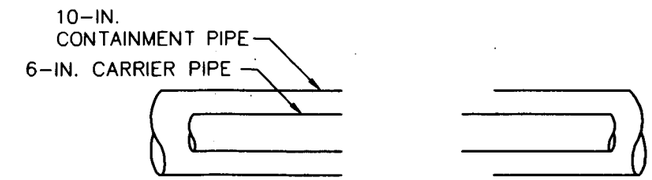


MOVEABLE METHOD

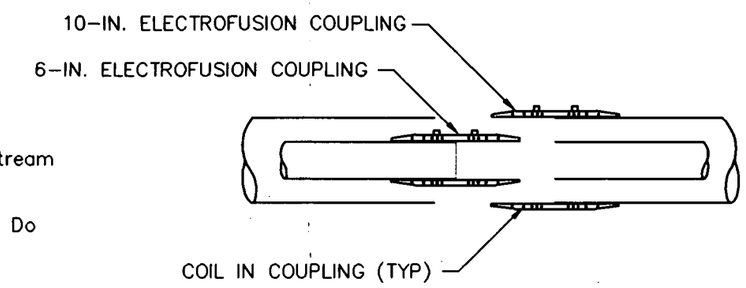
2194

UPSTREAM PIPE DOWNSTREAM PIPE

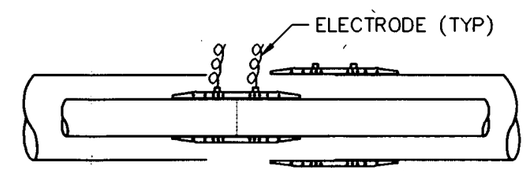
STEP 1: Trim, clean and prepare both pipes to proper dimensions



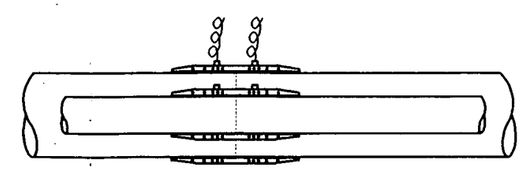
STEP 2: Slide 6-in. coupling into the upstream pipe end. Slide 10-in. coupling into the downstream pipe end. Do not break lugs.



STEP 3: Align the upstream and downstream pipe ends of the carrier pipe. Move the downstream carrier pipe into the coupling and center on the joint. Fuse the carrier pipe.



STEP 4: Align the upstream and downstream pipe ends of the containment pipe. Move the downstream containment pipe and coupling and center on the joint. Fuse the containment coupling to the pipe.



59

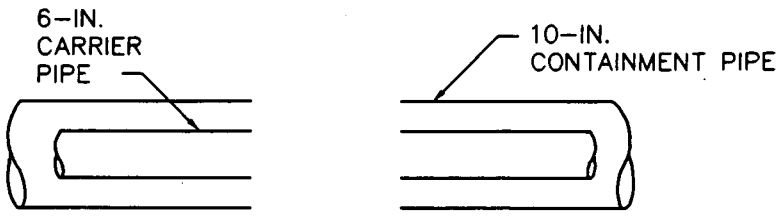
GEOSYNTEC CONSULTANTS
ATLANTA, GA

PROJECT NO. GQ0573-3.2	FIGURE NO. 3-1
DOCUMENT NO. F9930006	FILE NO. F99-A172.DWG

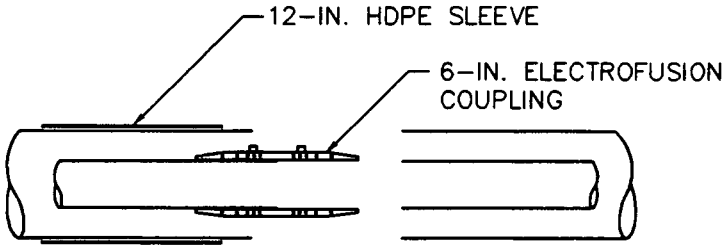
SLEEVE METHOD

UPSTREAM PIPE DOWNSTREAM PIPE

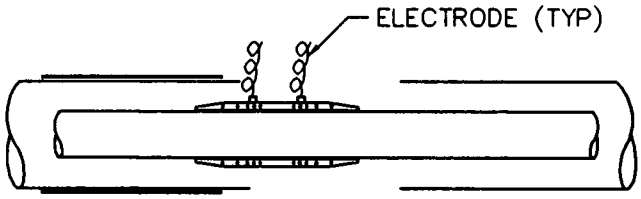
STEP 1: Trim, clean and prepare both pipes to proper dimensions



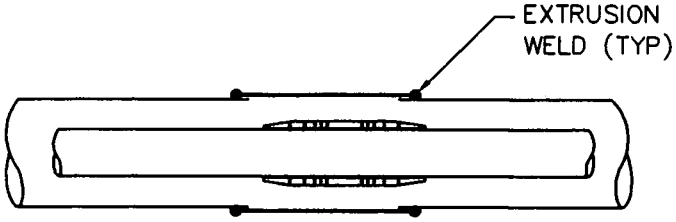
STEP 2: Slide 6-in. coupling and 12-in. sleeve onto the upstream pipe end.



STEP 3: Align the upstream and downstream pipe ends of the carrier pipe. Center the carrier coupling on the joint and fuse the carrier pipe.



STEP 4: Align the upstream and downstream pipe ends of the containment pipe. Center the containment sleeve on the joint. Extrusion weld around pipe on both ends of sleeve.



60

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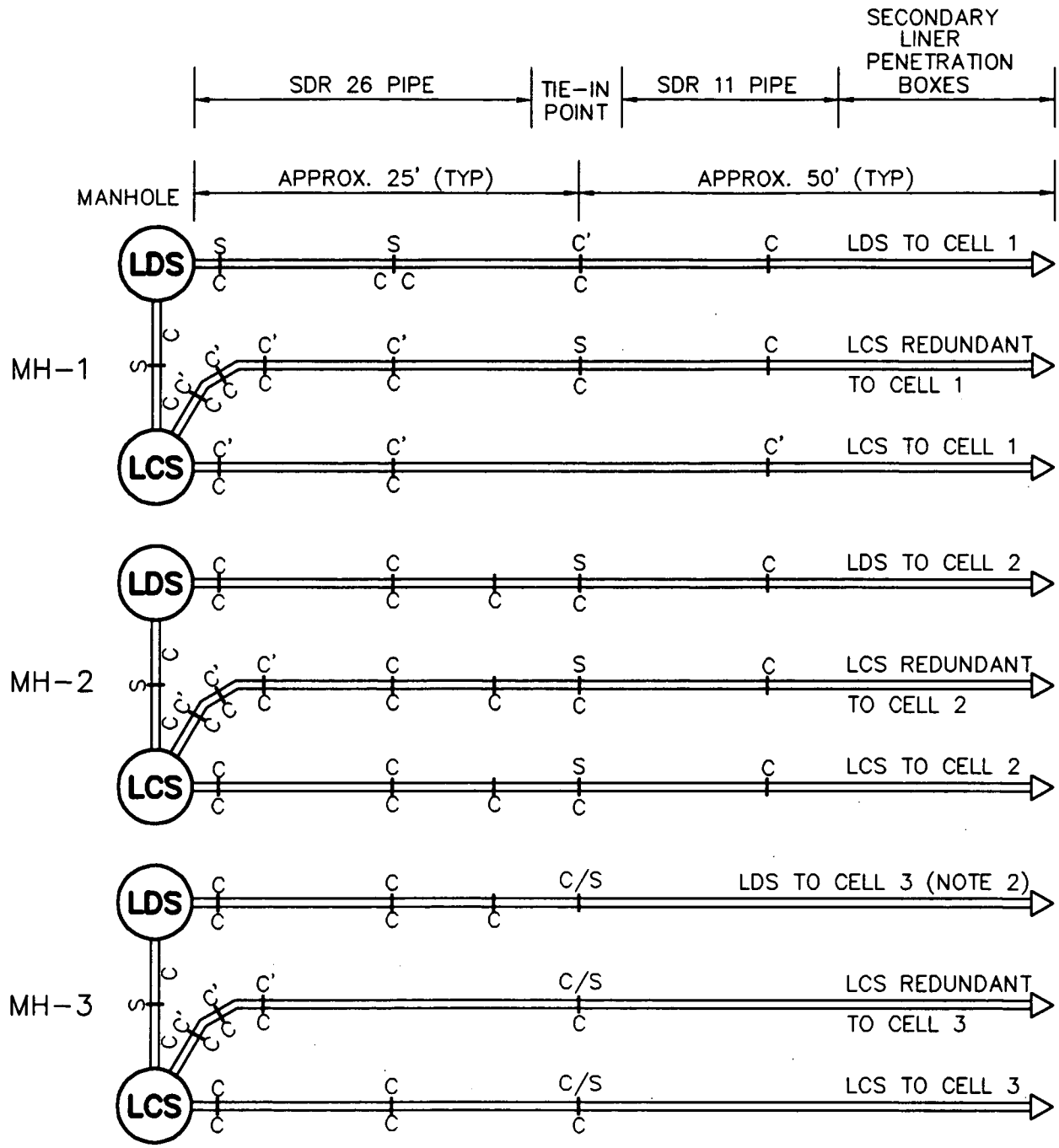
ATLANTA, GEORGIA

FIGURE NO.	3-2
PROJECT NO.	GQ0573-3.2
DOCUMENT NO.	F9930006
FILE NO.	F99-A173.DWG

COUPLING AND SLEEVE LOCATIONS FOR LTS GRAVITY LINE INTO OSDF CELLS

2194



LEGEND

C	REFERS TO CONTAINMENT PIPE
C	REFERS TO CARRIER PIPE
C	COUPLING
C'	COUPLING WITH BACKWELD
S	SLEEVE

NOTES:

1. SOME 10-INCH COUPLINGS SHOWN HAVE BEEN BACKWELDED OR REPLACED WITH PIPE SLEEVES DURING ORIGINAL REPAIRS.
2. CELL 3 HAS NOT BEEN CONSTRUCTED.

61

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO.	3-3
PROJECT NO.	GQ0573-03.1
DOCUMENT NO.	F9930006
FILE NO.	0573F004

SECTION 4

SECTION 4

62

4. FIELD PERFORMANCE OF LTS

4.1 Inspection and Maintenance Activities

4.1.1 Summary of OSDF Systems Plan

The OSDF Systems Plan (FDF, Rev. 0, May 1997) describes the operations, inspection, and maintenance activities that will be performed at the OSDF. Section 3.0 of the Systems Plan describes the activities that apply to the leachate management system components (i.e., LCS, LDS, and LTS) up to the LTS gravity line or temporary gravity line (TGL) discharge point into the permanent lift station (PLS). The inspection and maintenance (IM) requirements for the LCS and LDS are presented in Section 3.4 of the OSDF Systems Plan. For the LTS, the IM requirements are presented in Section 3.6 of the System Plan. The record keeping requirements for these IM activities are presented in Section 3.8 of the Systems Plan. The requirements of these sections of the Systems Plan are summarized below.

4.1.2 LTS Inspection and Maintenance Activities

The OSDF Systems Plan requires that the leachate management system be inspected and maintained by the construction contractor. The inspection and maintenance activities are to be performed in accordance with the schedule and activity requirements for each of the leachate management system components (LCS, LDS, and LTS) presented in the following tables of the OSDF Systems Plan:

- Table 3-1: *Leachate Collection and Leak Detection Systems Inspection and Maintenance Activities*;
- Table 3-2: *LDS/LCS Manholes and LTS Gravity Line Inspection and Maintenance Activities*; and
- Table 3-3: *LTS Gravity Line Inspection and Maintenance Activities,*

These IM requirements continue until leachate is no longer generated and an alternate activity schedule has been approved by EPA and OEPA. Copies of Tables 3-1, 3-2, and 3-3 are included in Appendix E of this document. Conditions to be inspected include:

- liquid in the LDS containment pipe (weekly during active period);
- liquid in the LCS containment pipe (weekly during active period);
- liquid in the redundant LCS containment pipe (weekly during active period);
- video inspection of the LDS and LCS pipes for crushing and clogging (prior to the start of active operations, then annually);
- liquid in the LTS gravity line containment pipe (weekly during active period);
- LTS gravity line clogging or crushing (annually);
- confirm LCS/LDS manhole signage, manhole cover structural integrity, manhole cover seal integrity, and general structural condition of manholes (weekly during active period); and
- liquid in the TGL containment pipe (weekly during active period).

It is noted that Table 3-3 contains specific requirements for monitoring of accumulating flow meters and liquid level transmitters that are not relevant to the leachate management system final design. These requirements were developed as part of the OSDF pre-final design package, when the design included a temporary lift station at the location of LCS manhole MH-3. The design of the temporary lift station included centrifugal pumps, an accumulating flow meter, and a liquid level transmitter. The temporary lift station was removed from the design as part of the preparation of the final design package. The requirements in the Systems Plan (FDF, Rev. 0, May 1997) for the temporary lift station components are thus not relevant.

In addition to the above conditions, Section 3.6 of the Systems Plan requires that manholes, pipes, valves, connections, sampling ports, monitoring ports, pumps, etc. be routinely inspected and maintained to provide for proper OSDF operation. The plan also requires that mechanical and electrical equipment be calibrated, operated, maintained, and serviced in accordance with manufacturer's instructions for the equipment.

4.1.4 Recordkeeping

The OSDF Systems Plan requires that the construction contractor maintain written records of all monitoring activities, inspections, and maintenance repairs in accordance with the detailed requirements of the Systems Plan. Specifically, the Systems Plan requires that after each IM activity, a draft report that includes an executive summary, copies of field logs, photographs, checklist forms, and other pertinent data be submitted to FDF for review, approval, and forwarding to DOE. Following review and approval, final copies of the inspection report and associated documents are to be submitted to EPA and OEPA.

4.2 LTS Inspection and Maintenance Records

For the active period of operation, the construction contractor responsible for the operation, inspection, and maintenance of the leachate management system is Petro. The following records of leachate management system IM activities prepared by Petro have been received and reviewed, and are presented in Appendix E of this document.

- A weekly inspection record for LDS manhole MH-1 for inspection dates from 23 December 1997 through 27 August 1998.
- Daily Petro Quality Control Reports (DQCRs) numbered as follows:
  - 121, 122, 123, 127, 128, 129, 130, 132, 134, 136, 137, 138, 142, 144, 145, 146, 147, 148, 149, 150, 151, 152, 158, 159, and 162. These reports include the results of inspections performed for select days between 20 November 1998 and 5 February 1999.
- Weekly Petro Inspection Checklists for the LDS/LCS manholes MH-1 and MH-2 dated as follows:
  - 17 November 1998, 23 November 1998, 4 December 1998, 14 December 1998, 21 December 1998, 28 December 1998, 18 January 1999, and 5 February 1999.

A review of these records is presented below.

- The Weekly Inspection Record for LDS manhole MH-1 indicates that liquid quantities greater than 165 gallons and less than 465 gallons (except for 1,765 gallons reported for 27 July 1998) were noted in the primary containment vessel and secondary containment vessel of LDS manhole MH-1 and were removed weekly by pumping to the LCS 2-in. diameter riser pipe.

- The DQCRs indicate that liquid quantities generally exceeding 200 gallons were commonly removed from LCS manholes MH-1, MH-2, and MH-3, and from the primary containment vessel in LDS manhole MH-2, by pumping.

- The Weekly Inspection Checklists (WICs) for LDS/LCS manholes MH-1 and MH-2 indicate that:

  - the manhole covers and seals are intact;

  - the positions of the butterfly valves in the manholes had been acceptable until the week of 5 February 1999 when the positions of the valves were adjusted for repair work on the leachate management system;

  - odor/bacterial growth in the LDS primary containment vessels has not occurred; and

  - the condition of the submersible level transmitters and appurtenances was acceptable unless liquid was being pumped from a manhole.

Review the WICs, it is not clear:

  - if the liquids in the LDS primary containment vessels were from the LDS carrier pipe or another source since the description of the "condition to check" on the WICs states "Leakage from Primary Containment Vessel";

  - if the LDS, LCS, redundant LCS, LTS, and TGL containment pipes were monitored for liquids; and

- where the liquids in the manholes originated (e.g., storm water, surface inflow, leakage from the LDS, LCS, redundant LCS, LTS or TGL carrier or containment pipes, etc.).

4.3 Field Investigation, Identified Problems, and Repairs

4.3.1 Field Investigation

4.3.1.1 Introduction

On 23 and 24 January 1999, heavy rainfall occurred in the area of the OSDF. In response to the heavy rainfall, valve V910 (located approximately at station 36+12 just upgradient of the PLS) in the LTS was placed in the closed position to prevent liquids from entering the PLS. The initial indication of a problem with the LTS began as part of a routine inspection by FDF personnel on 25 January 1999. Liquid accumulation was observed during this inspection in LCS manhole MH-3 to the approximate height of the manhole. FDF thereafter began an investigation of the source of the observed liquid.

On 27 January 1999, an initial dye test was performed on the LTS between LCS manhole MH-1 and the PLS. The initial test involved pouring five gallons of yellow dye into the vent line at LCS manhole MH-1 and allowing the dye to flow through the carrier pipe of the LTS to the PLS. The test was performed with valve V910 in the carrier pipe in the open position. Approximately 1.5 hours after initiating this initial dye test, dye was observed in the PLS and no dye was observed in LCS manholes MH-1, MH-2, or MH-3, nor at the OSDF Equipment Wash Facility (EWF) sump. A subsequent dye test was performed with the same conditions as the initial test, except valve V910 was placed in the closed position. This subsequent test created hydrostatic pressure (approximately 9.5 psi) in the LTS carrier pipe due to the elevation difference (approximately 22 feet) between LCS manhole MH-1 and valve V910. Approximately two hours after the initiation of this subsequent dye test, dye was observed in LCS manhole MH-3 entering the manhole through the fixed end seal weep holes in the annular space between the LTS carrier pipe and LTS containment pipe on the down-gradient side of the manhole. The observance of dye in LCS manhole MH-3 indicated that dye had moved from the LTS carrier pipe to the LTS containment pipe

and flowed under hydrostatic pressure to LCS manhole MH-3. Therefore, a leak existed in the LTS carrier pipe between LCS manhole MH-3 and valve V910.

Subsequent field investigations were performed to locate the source of the leak in the carrier pipe. The field investigations included performing air-pressure tests, hydrostatic-pressure tests, and CCT video surveys of sections of the carrier pipe between LCS manhole MH-3 and the PLS. The results of the CCT video surveys are presented in Appendix F.

Problems with the LTS carrier and containment pipes were identified during the field investigations. The problems include electrofusion coupling deficiencies, construction-induced damage, and out-of-roundness (i.e., ovality) of the carrier pipe. The identified problems with the various sections of the LTS are described in detail in Section 4.3.2. The on-going repair activities associated with the identified problems are presented in Section 4.3.3. The results of post-repair testing of the LTS are presented in Section 4.3.3. Figure 4-1 presents the locations of the LTS, manholes, PLS, field investigation excavations, and identified problems.

The remainder of this section presents a summary of the subsequent field investigations through 18 March 1999. Further, field investigation was postponed on 19 March 1999.

4.3.1.2 LCS Manhole MH-3 to Excavation No. 1

In response to the results of the dye tests, CCT video surveys were performed. The first CCT video survey, performed on 29 January 1999, occurred in the EWF sump carrier pipe going south towards the wye connection to the LTS. This survey detected water turbulence approximately 48 ft south of the EWF sump. The second CCT video survey performed on 29 January 1999 began at the cleanout at approximately station 12+00 and proceeded north along the carrier pipe a distance of approximately 106 ft. This survey identified a suspect joint in the LTS carrier pipe approximately 11.5 ft towards LCS manhole MH-3. The final CCT video survey performed on 29 January 1999 occurred in the EWF sump carrier pipe going south toward the wye connection to the LTS (note: second survey of this pipe). This final survey identified a section of the carrier pipe filled with liquid after approximately 57.5 ft.

Subsequent CCT video surveys were performed on 30 January 1999. The camera was first inserted into the cleanout near station 12+00 going north approximately 113 ft. The camera was then inserted into the EWF sump carrier pipe going south towards the wye connection to the LTS (note: third survey of this pipe). This third survey identified the same problem as the first survey performed on 29 January 1999. A suspected leak (i.e., water turbulence) was identified approximately 47 ft south of the EWF sump near the wye to the LTS. The final CCT video survey performed on 30 January 1999 went south from LCS manhole MH-3 approximately 260 ft. No problems were identified in this final survey of 30 January 1999.

Based on the results of the CCT video surveys, an excavation (Excavation No. 1) was performed by Petro from 6 to 9 February 1999 in the area of the wye connecting the LTS to the EWF sump at approximately station 13+20. After exposing the wye and the connecting pipes, Wise began an investigation of the LTS between LCS manhole MH-3 and Excavation No. 1.

Wise drilled drain holes in the containment pipe on 11 February 1999 to allow the remnant liquid from the dye tests to drain from the pipes. The wye was then removed from the LTS. The removed wye and the replacement wye were both subjected to low-head hydrostatic pressure tests to identify potential leaks. No leaks were detected in either the removed or replacement wyes.

An air pressure test was performed on the containment pipe between Excavation No. 1 and LCS manhole MH-3 on 11 February 1999. The containment pipe did not pass this test as air pressure was not maintained overnight. The test was repeated on 12 February 1999 with plugs installed in the carrier pipe. The results of this subsequent test indicated no loss in pressure. This indication suggested that a leak existed in the carrier pipe.

Hydrostatic pressure tests were performed on the containment pipe between LCS manhole MH-3 and Excavation No. 1 on 12 February 1999. These tests were performed concurrently with a CCT video survey of the carrier pipe. The CCT video survey proceeded north from Excavation No. 1 approximately 105 ft where liquid was encountered entering the carrier pipe. This leak was located near station 12+05 downgradient of a cleanout.

An excavation (Excavation No. 3) was performed by Petro at the cleanout location near station 12+00 on 13 February 1999.

On 16 February 1999, a subsequent hydrostatic pressure test was performed on the containment pipe from Excavation No. 1 to LCS manhole MH-3. Concurrent with this test, a CCT video survey was performed beginning at Excavation No. 1 and proceeding north. After approximately 108 ft (i.e., approximately station 12+05), a leak was confirmed at an electrofusion coupling in the carrier pipe (the same location identified by CCT video survey on 12 February 1999).

On 25 February 1999, a hydrostatic pressure test of the carrier pipe between Excavation No. 2 (see Section 4.3.1.3 for description of events leading to construction of Excavation No. 2) and LCS manhole MH-3 was performed. Weep holes were drilled into the containment pipe north and south of the wye in Excavation No. 1. A steady stream of liquid flowed from the north weep hole, this indicating a leak in the carrier pipe between Excavation No. 2 and LCS manhole MH-3.

On 26 February 1999, a hydrostatic pressure test was performed on the containment pipe between Excavation No. 2 and LCS manhole MH-3. Leaks were found at the LCS manhole MH-3 fixed end seal and at the 12-in. containment pipe sleeve on the northwest leg of the wye in Excavation No. 1. These leaks were repaired by Wise on 27 February 1999.

On 3 March 1999, a hydrostatic pressure test was performed on the containment pipe from Excavation No. 2 to LCS manhole MH-3. At test initiation, the pressure in the containment pipe was 5.0 psi at the low point in this section of pipe. During the hydrostatic pressure test, CCT video surveys were performed on the LTS carrier pipe between Excavation No. 2 and LCS manhole MH-3. During the first CCT video survey, the camera was pulled from LCS manhole MH-3 to Excavation No. 2, a distance of approximately 752 ft. The camera was pulled too quickly through the carrier pipe to identify potential problems, so a second CCT video survey was performed while pulling the camera at a reduced speed. The second CCT video survey initiated at Excavation No. 2 and proceeded to LCS manhole MH-3. A suspected leak was detected approximately 275 ft north of Excavation No. 2 (i.e., approximately 5 ft north of the wye in Excavation No. 1).

On 4 March 1999, a CCT video survey was performed on the EWF sump carrier pipe. This survey initiated at the EWF sump and extended approximately 23 ft south towards the wye connection to the LTS.

On 12 March 1999, Excavation No. 1 was expanded to the northwest and two electrofusion couplings upgradient of the replaced wye were exposed. A 10-ft section of the LTS containing both of these electrofusion couplings was removed. The stub ends created by the removal of the 10-ft section of the LTS were prepared for pressure testing. An air pressure test of the carrier pipe from Excavation No. 1 to LCS manhole MH-3 was performed at 50 psi, but only 21.5 psi pressure was achieved. Air was felt exiting a weep hole in the containment pipe at the northwest stub in Excavation No. 1. This result suggested that the carrier pipe from Excavation 1 to LCS manhole MH-3 contained a leak.

On 13 March 1999, the northwest stub at Excavation No. 1 was shortened by 3.5 ft and a new air pressure test flange was attached. An air pressure test was then performed on the carrier pipe between Excavation No. 1 and LCS manhole MH-3. The pressure in the carrier pipe at test initiation was 22 psi. After three minutes the pressure had dropped to 20 psi.

On 14 March 1999, Excavation No. 3 was expanded to the southeast to expose the electrofusion couplings observed on the CCT video survey performed on 3 March 1999. Three electrofusion couplings in the containment pipe were exposed from approximately station 12+10 to approximately station 12+25.

On 15 March 1999, the approximate 15-ft section of LTS containing the three electrofusion couplings was removed. Examination of this removed section of containment pipe identified three 6-in. electrofusion couplings on the carrier pipe. The middle electrofusion coupling was observed to be yellow and vertically misaligned with the adjoined carrier pipe to the southeast. A 1.5-in. deep dent was observed in this removed section of the LTS containment pipe. Masonry bricks were found stacked beneath the containment pipe in the location of the dent.

On 16 March 1999, a hydrostatic pressure test was performed on the carrier pipe between Excavation No. 3 and LCS manhole MH-3. The pressure in the LTS carrier pipe at test initiation was 55 psi. After one hour, the pressure had dropped to 52 psi. The test was stopped and a leak at a relief valve was fixed and the hydrostatic pressure

test was repeated. The carrier pipe was repressurized to 51 psi. After one hour and 15 minutes, the pressure in the carrier pipe remained at 51 psi.

On 18 March 1999, a hydrostatic pressure test was performed on the carrier and the containment pipes between Excavation No. 3 and LCS manhole MH-3. The carrier and containment pipes were pressurized to 18 psi and 14.5 psi, respectively. Leaks were observed at the fixed end seal on the containment pipe stub at the northwest end of Excavation No. 3 and at the 12-in. sleeve used on the repair southeast of the cleanout. Extrusion welds were made to these leaks by Wise, and the hydrostatic pressure test was repeated. The carrier and containment pipes were pressurized to 18 psi and 15 psi, respectively. After two hours both pipes had maintained the initial test pressures.

The apparent cause of the problems identified from the field investigation between LCS manhole MH-3 and Excavation No. 1 are presented in Section 4.3.2.1.

4.3.1.3 Excavation No. 1 to Permanent Lift Station

Wise performed an air pressure test on the containment pipe between Excavation No. 1 and the PLS on 12 February 1999. The air pressure test did not pass. Consequently, an inspection of the cleanouts south of Excavation No. 1 was performed. Liquid ponded in the cleanout protective valve cover at approximately station 16+00 was observed to be bubbling. Air was also heard at the cleanout near station 20+00. No problems were identified at the remaining cleanouts (i.e., near stations 23+60, 28+00, and 32+00) along this section of the LTS.

As a result of the aforementioned inspection of the cleanouts, the upper 2 to 3 ft of the cleanout near station 16+00 was exposed and a water and soap solution was applied to the cleanout. No leaks (i.e., bubbles) were identified. An excavation (Excavation No. 2) to further expose this cleanout and the adjoining pipes was performed by Petro on 12 February 1999.

On 16 February 1999, air pressure was applied to the containment pipe between Excavation No. 1 and the PLS. While the pressure was applied, a water and soap solution was applied to the joints and welds on the north side of the cleanout near station 16+00. No leaks were identified. Two attempts were made to blow a tag line with a parachute from the cleanout near station 32+00 to Excavation No. 1 to prepare for a CCT video survey of this section of the LTS. Both attempts to install the tag line

were unsuccessful. The CCT video survey operators believed that the parachutes encountered an obstruction in the carrier pipe. Consequently, an attempt was made to blow a tag line with a plastic dart through same section of the LTS. The plastic dart appeared to stop at the same location as the parachutes, which was approximately 1650 ft north of the cleanout near station 32+00. This distance was subsequently wheel taped along the LTS to locate the dart (i.e., suspected obstruction). The location where the parachutes and dart stopped was in the immediate vicinity of the cleanout near station 16+00. Excavation No. 2 then was expanded to the south of the cleanout. The tag line and dart were freed and blown to Excavation No. 1. The containment pipe between Excavation No. 1 and the PLS was pressurized and a water and soap solution was applied to the 10-in. electrofusion coupling south of the cleanout in Excavation No. 2. This test identified a leak at the 10-in. electrofusion coupling. The 10-in. electrofusion coupling on the containment pipe and 6-in. electrofusion coupling on the carrier pipe were removed.

Additional CCT video surveys of this section of the LTS were performed on 17 February 1999. The first survey was performed from Excavation No. 1 to Excavation No. 2. This first CCT video survey could not be completed since the large diameter camera could not be pulled through the carrier pipe due to the identified ovality of the pipe. Consequently, a second CCT video survey was performed using a smaller camera. The results of the second CCT video survey confirmed the ovality of the carrier pipe but did not identify any other problems (i.e., leaks) in this section of the carrier pipe. A third CCT video survey was performed. This survey originated at the cleanout near station 32+00 and proceeded north in the carrier pipe. The camera (i.e., the small camera) came off its skid and became wedged in the carrier pipe approximately 150 ft north of the cleanout (i.e., near station 30+50) and could not be pulled back to the cleanout using the tag line.

On 18 February 1999, Petro performed an excavation (Excavation No. 4) approximately 135 ft north of the cleanout near station 32+00 to retrieve the wedged camera. The exposed containment pipe in Excavation No. 4 appeared damaged. Very little pipe embedment fill (i.e., between 0 to 12 in. thick) was also observed over the top of the containment pipe. Excavation No. 4 was expanded to the north and hand excavation of the pipe was performed, a 1-in. long tear in the containment pipe was identified. This tear appeared to be construction-induced damage.

On 27 February 1999, the carrier pipe and containment pipe between Excavation No. 2 and Excavation No. 4 were air pressure tested. No leaks were detected during this test.

On 1 March 1999, an air pressure test was performed on the carrier pipe between Excavation No. 4 and the PLS. The carrier pipe was pressurized to 15.5 psi, and the containment pipe was pressurized to 15 psi. After three hours, the pressures in the carrier pipe and containment pipe were 15.5 psi and 15 psi, respectively.

On 2 March 1999, a hydrostatic pressure test was performed on the containment pipe between Excavation No. 4 and the PLS. The pressure in the containment pipe was 2.8 psi at the test initiation. During the hydrostatic pressure test, three CCT video surveys were performed inside the carrier pipe. In the first CCT video survey, the camera was pulled approximately 340 ft south from Excavation No. 4. In the second CCT video survey, the camera was pulled from Excavation No. 4 south to valve V910, a distance of approximately 537 ft. Out-of round pipe sections and ponded water were observed in some locations of the pipe during these first two CCT video surveys. The third CCT video survey initiated at the PLS and proceeded north towards valve V910. The camera became stuck approximately 5 ft north of the PLS due to carrier pipe.

On 3 March 1999, a hydrostatic pressure test was performed on the containment pipe between Excavation No. 2 and Excavation No. 4. The pressure in the containment pipe was 5.0 psi near station 30650 believed to be the low point of this section of pipe. During the hydrostatic pressure test, two CCT video surveys of the carrier pipe were performed. The first CCT video survey initiated at Excavation No. 2 and proceeded to Excavation No. 4. The second CCT video survey initiated at Excavation No. 2 and proceeded to Excavation No. 4. The camera was submerged during the majority of these two surveys. Thus, identification of any potential problems in the carrier pipe difficult.

On 4 March 1999, a hydrostatic pressure test was performed on the LTS containment pipe between Excavation No. 2 and Excavation No. 4. The pressure in the containment pipe was 4.0 psi near station 30+50 believed to be the low point of this section of pipe. During the hydrostatic pressure test, two CCT video surveys of the carrier pipe were performed. The first CCT video survey initiated at Excavation No. 2 and proceeded to Excavation No. 4. The second CCT video survey initiated at Excavation No. 4 and proceeded to Excavation No. 2.

On the afternoon of 4 March 1999, the fixed end seal in the containment pipes and the plugged ends of the carrier pipes in Excavation No. 4 were removed by Wise in preparation for repair of the LTS.

On 13 March 1999, an air pressure test was performed on the carrier pipe between Excavation No. 2 and the PLS. The carrier pipe was pressurized to 25 psi at test initiation. After three minutes the pressure had dropped to 20 psi.

On 14 March 1999, a hydrostatic pressure test of the carrier pipe between Excavation No. 2 and the PLS was performed. The pressure in the carrier pipe at the test initiation was 57 psi. After 11 minutes the pressure had dropped to 54 psi. The test was consequently terminated.

On 15 March 1999, a hydrostatic pressure test of the carrier pipe between Excavation No. 2 and the PLS was performed. The pressure in the carrier pipe at test initiation was 55 psi. After three hours the pressure in the carrier pipe was 42 psi. The carrier pipe was subsequently repressurized to 54 psi. After one hour and 40 minutes the pressure in the carrier pipe had dropped to 44.5 psi. A hole was drilled into the containment pipe at Excavation No. 4 to check for liquid, but no liquid was observed. The liquid in the carrier pipe was allowed to remain pressurized overnight.

On the morning of 16 March 1999, the pressure in the carrier pipe between Excavation No. 2 and the PLS had dropped to 21 psi. During the afternoon of 16 March 1999, the hydrostatic pressure test of the carrier pipe between Excavation No. 2 and the PLS was repeated. The pressure in the carrier pipe at test initiation was 55 psi. After two hours the pressure in the carrier pipe had dropped to 41.5 psi.

On 17 March 1999, an excavation (Excavation No. 5) was begun by Petro near station 31+65. This excavation was performed to expose an electrofusion coupling near the cleanout in this area. When the LTS was exposed, a deep dent was observed in the containment pipe. The dent did not appear to pierce the containment pipe.

The probable cause of the problems identified from the field investigation between Excavation No. 1 and the PLS are presented in Section 4.3.2.2.

4.3.1.4 LCS Manhole MH-1 to LCS Manhole MH-3

On 13 March 1999, a hydrostatic pressure test of the carrier pipe between LCS manhole MH-1 and LCS manhole MH-3 was performed. The pressure in the carrier pipe at test initiation was 56 psi. After two hours and 30 minutes, the pressure had dropped to 46 psi. The carrier pipe was allowed to remain pressurized overnight.

On the morning of 14 March 1999, the pressure in the carrier pipe from LCS manhole MH-1 to LCS manhole MH-3 was observed to be 24 psi. The carrier pipe was subsequently repressurized to 54 psi. After 50 minutes the pressure in the carrier pipe had dropped to 48 psi. Liquid was observed to be discharging from the containment at the north side of LCS manhole MH-2. The test was terminated and green dye was added to the liquid inside the carrier pipe. The carrier pipe was subsequently repressurized to 53 psi. Liquid again discharged from the containment pipe on the north side of LCS manhole MH-2, but no green dye was observed. After three hours the pressure in the carrier pipe had dropped to 42 psi and the containment pipe was observed to continue to discharge liquid. Green dye was not visible in the liquid discharge from the containment pipe.

On 18 March 1999, a hydrostatic pressure test was performed on the containment pipe between LCS manhole MH-1 to LCS manhole MH-3. Yellow-green dye was added to the liquid in the containment pipe. The pressure in the containment pipe was 3.0 psi at test initiation. During this test, CCT video surveys of the carrier pipe were performed. The first survey initiated at LCS manhole MH-1 and proceeded to LCS manhole MH-3. The second survey initiated at LCS manhole MH-3 and terminated at LCS manhole MH-2. The carrier pipe appeared to have limited ovality but other problems were not identified. The third survey initiated at LCS manhole MH-2 and terminated at LCS manhole MH-3. The fourth survey initiated at LCS manhole MH-2 and terminated at LCS manhole MH-1. During this fourth survey the pressure in the containment pipe was increased to 5 psi.

The probable cause of the problems identified from the field investigation between LCS manhole MH-1 and LCS manhole MH-3 are presented in Section 4.3.2.3.

4.3.2 Identified Problems

Problems with the LTS were identified from the results of the field investigations discussed above. The problems consisted of electrofusion coupling deficiencies, construction-induced damage, and ovality of the carrier pipe. The remainder of this section presents a description of the identified problems.

4.3.2.1 LCS Manhole MH-3 to Excavation No. 1

During the field investigations of this section of the LTS, a leak was identified at an electrofusion coupling in the carrier pipe near station 12+05 in Excavation No. 3. Upon initial examination, it appeared that this leak resulted from inadequate engagement of the carrier pipe and electrofusion coupling during installation. A small gap (estimated to be 1/16 in.) existed between the end of the carrier pipe and the electrofusion coupling. Subsequent examination of the removed joint confirmed that the end of the carrier pipe had separated from the electrofusion coupling. Further examination revealed a single fusion bead on the end of the carrier pipe. This observation indicated that the carrier pipe was minimally engaged into the electrofusion coupling to produce a very narrow area of fusion.

Also evident from examination of the aforementioned pipe joint was a lack of adequate pipe surface preparation prior to installation of the electrofusion coupling. There were only minor scratches observed on the pipe surface and no removal of the surface sheen or gloss as required by the manufacturer's procedure for electrofusion coupling installation.

Results of a CCT video survey performed on 3 March 1999 identified a potential leak located approximately 5 ft north of the wye in Excavation No. 1. The potential leak was believed to originate from an electrofusion coupling on the carrier pipe. A section of the LTS containing the suspect electrofusion coupling was removed from near station 13+10 to station 13+20. As of the date of this document, this section of the LTS has not been repaired. However, it has been concluded that a leak did not exist in the station of the LTS removed. The actual leak was located further upgradient and is discussed below.

Results of air pressure tests an the carrier pipe on 12 and 13 March 1999 indicated a leak in the carrier pipe between Excavation No. 3 and LCS manhole MH-3. The leak

was believed to be at an coupling located south of the cleanout near station 12+00. A section of the LTS from approximately station 12+10 to 12+25 was removed from Excavation No. 3. This section of the LTS contained six electrofusion couplings; three on the carrier pipe and three on the containment pipe. The middle carrier pipe electrofusion coupling was observed to be yellow and vertically misaligned with the adjoining pipe segments. The containment pipe electrofusion located at the same location (i.e., station) was also vertically misaligned. As of the date of this document, this section of the LTS in Excavation No. 3 has not been repaired.

During review of the CCT video survey performed at this section of LTS, the carrier pipe was observed to be out-of-round. Calculations of the percent ring deflection of the carrier pipe were prepared by GeoSyntec based on the results of the CCT video surveys. These calculations are presented in Appendix E next to the photographs from the CCT video survey used to prepare the calculations. The results of the percent ring deflection calculations at corresponding LTS stations are presented in Figure 4-2.

4.3.2.2 Excavation No. 1 to Permanent Lift Station

During the field investigation of this section of the LTS, a leak was identified at electrofusion coupling on the LTS containment pipe near station 16+05 in Excavation No. 2. The electrofusion coupling and short lengths of the containment pipe on either side of the electrofusion coupling were removed and subjected to x-ray examination. Results of the x-ray examination indicated a small area of incomplete fusion between the electrofusion coupling and containment pipe. This area of incomplete fusion appeared to be the result of inadequate surface preparation as indicated by light-colored spots observed in the x-ray. This joint (i.e., electrofusion coupling to containment pipe) also exhibited a lack of shallow bumps on the inside area of the containment pipe where the light-colored spots showed on the x-rays. These shallow bumps were observed in other SDR 26 pipe joints that incorporated electrofusion couplings that were removed as part of leak repair activities.

During construction of Excavation No. 4, a leak was identified in the containment pipe adjacent to a carrier pipe centralizer near station 30+50. The source of this leak was an approximate 1-in. long tear oriented perpendicular to the containment pipe axis. The exterior of the pipe also had longitudinal scratches and denting extending

approximately 3 ft on both sides of the tear. It appears that the tear was caused by construction equipment (i.e., construction-induced).

Construction-induced damage to the LTS was found near the station 31+65 in Excavation No. 5. A dent was observed in the containment pipe in this excavation. It appears that the dent was caused by construction equipment (i.e., construction induced). As of the date of this document, no leaks have been attributed to this observed damage.

CCT video surveys of the LTS carrier pipe from Excavation No. 1 to the PLS revealed that the carrier pipe was out-of-round. The average percent ring deflection of the carrier pipe in this section of the LTS is presented in Figure 4-2 and Appendix E. Review of Figure 4-2 indicates that the percent ring deflection of the carrier pipe increases from Excavation No. 1 to the PLS (i.e., with distance along the length of the pipe). This increase in placement ring deflection with distance along the length of the pipe is likely the result of the hydrostatic pressure increase which occurs along the length of the pipe due to the elevation difference between stations.

Based on the air pressure tests and hydrostatic pressure tests performed from 13 to 17 March 1999, a leak is suspected in the carrier pipe between Excavation No. 2 and the PLS. Due to the postponement of the field investigation on 19 March 1999, as of the date of this document, no additional leaks have been identified between Excavation No. 1 and the PLS.

4.3.2.3 LCS Manhole MH-1 to LCS Manhole MH-3

Based on the results of hydrostatic pressure tests performed on the carrier pipe between LCS manhole MH-1 and LCS manhole MH-3, a leak is suspected to exist in the carrier pipe between LCS manhole MH-1 and LCS manhole MH-2. CCT video surveys performed in this section of the carrier pipe have not confirmed the existence of this suspected leak. As of the date of this document, no leaks have been confirmed in this section of the LTS due to the postponement of the field investigation on 19 March 1999.

CCT surveys of the CTS carrier pipe from LCS manhole MH-1 to LCS manhole MH-3 revealed that the carrier pipe was out-of-round, albeit less so than for the TGL. Calculated ring deflection, in this section of the LTS are presented in Figure 4-2 and Appendix E.

4.3.2.4 Containment Pipe Deflections

The containment pipe was observed to not be deflected beyond an amount typical for this type of construction activity. Measurement in the field on exposed sections of pipe, obtained during 1999 repair operations, indicated pipe deflections in the range of 1.2 to 3.9 percent. These deflection values are well within the acceptable limit of 6.5 percent for buried SDR 26 pipe reported by the pipe manufacturer, Driscopipe.

4.3.3 Repairs

Descriptions of the procedures used to join pipe and the repairs performed as of 18 March 1999 are presented in this section. The descriptions were prepared based on conversations with CQC personnel and a review of CQC personnel Daily Field Reports for 26 January 1999 through 18 March 1999.

4.3.3.1 Procedures Used for Joining Pipe

Repairs to the LTS carrier and containment pipes were performed using three different procedures for joining pipe. These procedures included butt-fusion welding, electrofusion couplings, and extrusion welded sleeves. The procedure used for butt-fusion welding is presented in Section 02605 of the technical specifications. The procedures used to join pipe with electrofusion couplings or extrusion welded sleeves are described below.

<u>Procedures Used to Join Pipe with Electrofusion Couplings</u>

The general procedure used to join pipe with electrofusion couplings is described below.

- The ends of the in-place and replacement pipes were squared.
- Burrs or shavings from the squaring or cutting of the pipe ends were removed.
- The inside and outside of the pipe ends were cleaned with a cloth to remove dirt or contaminants.

- The exterior surface of the pipe ends was scraped to remove any oxidation, surface contamination, or surface sheen. The scraping was performed using a tool approved by the pipe supplier and electrofusion coupling manufacturer. The area which was scraped included the segment of pipe to be joined to the electrofusion coupling and any segment of pipe that the coupling may have been temporarily slid over.

- In the event that a pipe to be welded was out-of-round (i.e. oval), a C-clamp was placed on the end of the pipe to return the pipe end to a circular shape.

- The exterior surface of each pipe to be joined with the electrofusion coupling was marked at a distance from the pipe end equal to half the length of the coupling.

- The electrofusion coupling was then slid onto one of the pipe ends up to the measurement marks.

- The pipe end and electrofusion coupling were then covered with plastic. The plastic was taped to the pipe and covered the electrofusion coupling to prevent possible contamination of the pipe or electrofusion coupling surfaces.

- Alignment clamps were then installed to maintain the stab depth of the pipe into the electrofusion coupling during the fusion cycle.

- The ends of the replacement and in-place pipes were then aligned vertically and horizontally.

- The sequence processor was programmed for the coupling type by scanning in the UPC (i.e., bar) code on the electrofusion coupling into the sequence processor.

- The diagnostic check programmed in the sequence processor was then performed.

- If the diagnostic check passed, then the leads from the sequence processor were attached to the electrofusion coupling nodes.

- The fusion cycle was then initiated by pressing the start button on the sequence processor.

- When the fusion cycle was complete, the leads from the sequence processor were disconnected from the electrofusion coupling.

- The device used to align the pipes and electrofusion coupling was allowed to remain in place to secure the pipes and coupling during the sequence processor recommended cooling time.

- After the cooling time had elapsed, the ends of the electrofusion coupling and the in-place and replacement pipes were prepared for backwelding (i.e., extrusion welding) of the electrofusion coupling to the pipes. This preparation included: (i) grinding the exterior surface of the pipe with a hand-held grinder to remove oxidation and surface sheen; (ii) beveling the ends of the electrofusion couplings using the hand-held grinder; (iii) and wiping the surfaces of the pipe and electrofusion coupling to be welded with a cloth to remove dirt, contamination, burrs, or shavings.

- The ends of the electrofusion coupling were then backwelded to the in-place and replacement pipes.

Procedures Used to Join Pipe with Extrusion Welded Sleeves

The general procedure used to join pipe between two fixed ends of containment pipe using an extrusion weld HDPE pipe sleeve is described below.

- An excavation under the repair location was made to allow access for extrusion welding. The excavation was approximately 3-ft deep.

- Prior to joining the inner carrier pipe with either the butt-fusion or electrofusion coupling procedures described above, the distance between the outer containment pipe ends (i.e., the length between the ends of the two pipes to be joined) was measured. A 12-in. diameter SDR-15.5 or 17 HDPE pipe was then cut to a distance equal to this measured length plus 12 in. (i.e., gap length plus 12 in.) to allow for a minimum 6-in. overlap at each pipe end.

- The ends of the sleeve were then squared.
- A bevel was then made around the circumference of the inside edge of both ends of the sleeve.
- Burrs or shavings from the squaring or cutting of the sleeve ends were removed.
- The sleeve was then placed on the containment pipe and slide along the pipe to allow clearance for joining the carrier pipe.
- The carrier was then joined using either the butt-fusion or electrofusion coupling procedures described above.
- The inside and outside of the sleeve ends and the exterior surface of the containment pipe were cleaned with a cloth to remove dirt or contaminants. The surfaces to be welded (i.e., sleeve ends and outer containment pipe surface) were then ground using a hand-held grinder to remove any oxidation or surface sheen.
- The surfaces to be welded were then wiped with a cloth to remove any grit, burrs, or shavings.
- The sleeve was then slid and centered over the gap in the containment pipe.
- The outer containment pipe and sleeve were then vertically and horizontally aligned.
- The beveled ends of the sleeve were then extrusion welded to the in-place containment pipe.
- The repair was then allowed a minimum of 30 minutes to cool down prior to moving the pipe.

4.3.3.2 Repairs Performed

The repairs to the problems identified with LTS carrier and containment pipes included installation of replacement pipes between fixed ends of in-place pipe. The replacement pipes were joined to the in-place pipes using the pipe joining procedures described in Section 4.3.3.1. The as-built plan and profile locations and the type of pipe joining procedures used to repair an identified problem are presented on Figures 3-4a, 3-4b, and 3-4c in Appendix C. These figures were prepared by CQC personnel to document the repairs performed. A summary of the repairs, including the repair designation location, installation date, manufacturer, installer, and CQC personnel comments, to the LTS carrier and containment pipes are presented in Tables 4-1 and 4-2, respectively.

TABLE 4-1
SUMMARY OF REPAIRS TO IDENTIFIED PROBLEMS:
6" LTS CARRIER PIPE

Repair Designation (Note 1, 2, 3)	Station	Installation Date	Manufacturer	Installer	Connection Type	Passed Post-Repair Testing	Welding Procedure Followed? (Note 4)	Field Comments
$C'_6 6$	30+55	11 Mar 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report
$C'_6 7$	30+50	11 Mar 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report
$C'_6 8$	30+37	8 Mar 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report
$C_6 13$	13+35	20 Feb 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report
$C'_6 14$	13+25	20 Feb 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report
$C'_6 15$	13+15	20 Feb 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report
$C'_6 16$	12+07	19 Feb 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report
$C'_6 17$	12+04	19 Feb 99	Friatec	Wise	6" electrofusion coupling	No	Yes	Noted in CQC daily report

NOTES:
1. See Figure 3-4 (a, b, c) for locations of repairs.
2. See Section 4.3.3 for welding procedures.
3. "C'" denotes an electrofusion coupling which has been backwelded.
4. "S" denotes an extrusion-welded HDPE sleeve.

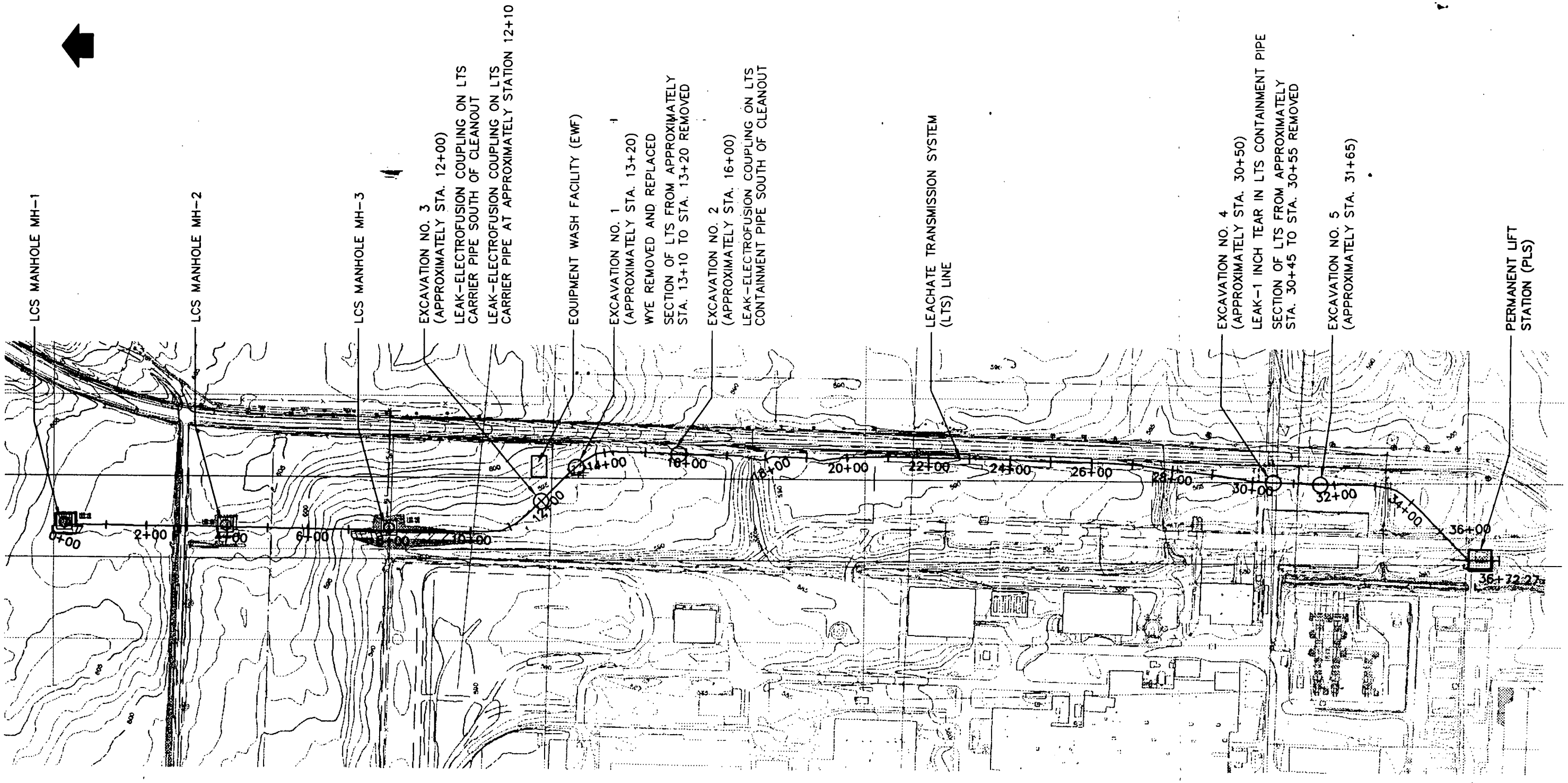
2194

TABLE 4-2
SUMMARY OF REPAIRS TO IDENTIFIED PROBLEMS:
10" LTS CONTAINMENT PIPE

Repair Designation (Note 1)	Station	Installation Date	Manufacturer	Installer	Connection Type	Passed Post-Repair Testing	Welding Procedure Followed? (Note 2)	Field Comments
$S'_{10}7$	30+55	11 Mar 99	Driscopipe	Wise	12" HDPE sleeve	No	Yes	Noted in CQC daily report
$C'_{10}8$	30+37	11 Mar 99	Fusamatic	Wise	10" electrofusion coupling	No	Yes	Noted in CQC daily report
$S_{10}13$	13+35	22 Feb 99	Driscopipe	Wise	12" HDPE sleeve	No	Yes	Noted in CQC daily report
$S_{10}14$	13+25	22 Feb 99	Driscopipe	Wise	12" HDPE sleeve	No	Yes	Noted in CQC daily report
$S_{10}15$	13+15	22 Feb 99	Driscopipe	Wise	12" HDPE sleeve	No	Yes	Noted in CQC daily report
$S_{10}16$	12+07	20 Feb 99	Driscopipe	Wise	12" HDPE sleeve	No	Yes	Noted in CQC daily report

NOTES:
1. See Figure 3-4 (a, b, c) for locations of repairs.
2. See Section 4.3.3 for welding procedures.
3. "C'" denotes an electrofusion coupling which has been backwelded.
4. "S" denotes an extrusion-welded HDPE sleeve.

21194



87

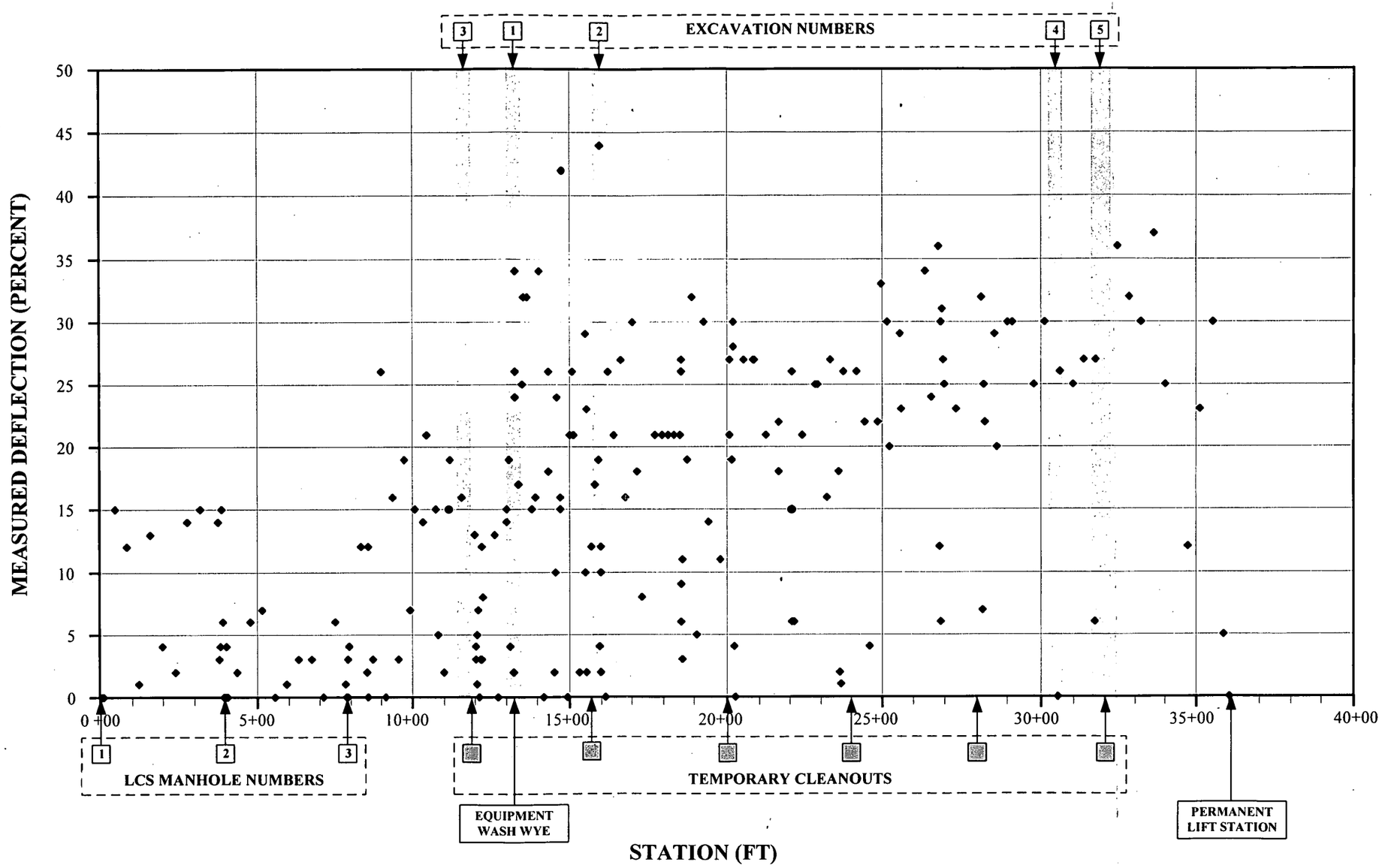
REPAIR LOCATIONS - 1999

0 250
SCALE IN FEET

GEOSYNTEC CONSULTANTS
ATLANTA, GA

PROJECT NO. GQ0573-3.2	FIGURE NO. 4-1
DOCUMENT NO. F9930006	FILE NO. F99-A171.DWG

SUMMARY OF DEFLECTION MEASUREMENTS FROM VIDEO



88

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FLUOR DANIEL FERNALD
LEACHATE TRANSMISSION SYSTEM INVESTIGATION

PROJECT NO. GQ0573-3.2	DATE: 31 MARCH 99	FIGURE N0. 4-2

5. RESULTS OF DESIGN CALCULATIONS

5.1 Original Design Calculations

5.1.1 Overview

The purpose of this section is to provide a summary of calculations performed to evaluate the performance of the LTS permanent gravity line and TGL. These calculations are presented in Sections 10.1 of the Final Design OSDF Calculation Package, Rev. 0 (GeoSyntec, May 1997). During early stages of OSDF development, the permanent gravity line will transfer leachate and liquids collected from the OSDF cells to the TGL which in turn flows to the PLS. During later stages of the OSDF development and after closure, the permanent gravity line will transfer flows directly to the PLS. Calculations for both the permanent and temporary gravity lines were performed to evaluate: (i) flow capacity; (ii) structural stability; and (iii) frost protection. The original calculations assume the use of SDR 11 HDPE pipe. Detailed calculations and results are presented in Appendix G.

5.1.2 Flow Capacity

The carrier pipe flow capacity was estimated to verify it could handle design flow rates with adequate factors of safety. Manning's and Darcy-Weisbach equations were used to calculate the flow capacities of the line under gravity and pressure flow conditions, respectively. These capacities were compared to baseline design flow rates for active-operations and post-closure conditions and to the storm design-basis flow rate (i.e., 15.8 gpm, 9.7×10^{-4} gpm, and 200 gpm, respectively). Additionally, the factor of safety against hydraulic rupture of the carrier pipe (under pressure flow conditions) was calculated.

The results of the design calculations indicate the permanent carrier pipe can convey the design flows with acceptable factors of safety. The gravity flow capacity was calculated to be 140 gpm and 97.5 gpm for the permanent and temporary gravity lines, respectively. These capacities exceed the design basis flow rates for both active operations and post-closure conditions. The pressure flow capacity was calculated to be 334 gpm and to occur when Cell 6 is active (identified during design as the critical

design condition for stormwater flow). The pressure flow capacity of the system during the period of TGL operation was calculated to be 273 gpm and to occur when Cell 1 is active. These capacities exceed the storm design flow rate. The factor of safety against hydraulic rupture of the carrier pipe was calculated to be 19.7.

5.1.3 Structural Capacity

Structural stability (i.e., resistance to wall crushing, wall buckling, and excessive ring deflection) of the containment pipe was evaluated using standard methods for flexible buried pipe. The calculations utilized the conservative assumptions that soil arching did not occur due to the trench configuration above the pipe. The calculations assumed an external containment pipe stress due to a truck with a wheel load of 20,000 lb and 8 ft of overburden material. This wheel load corresponds to a heavy, 35 ton truck with a load approximately split between front and rear axles. The results of the design calculations indicate the containment pipe has factors of safety for wall crushing, wall buckling, and ring deflection of 37, 31, and 10, respectively. These factor of safety are more than adequate.

5.1.4 Frost Protection

Soil minimum cover thickness required to protect the LTS gravity line from frost was also evaluated using modified Berggren Method. The results indicate that a minimum of 2 ft of soil or 3 ft of granular material (i.e., pipe bedding) is required for frost protection.

5.2 Calculations in Support of Field Design Changes

The purpose of section is to provide a summary of calculations performed in support of DCN 1700-007 which allowed an increase in the SDR of pipe used for LTS construction. Calculations were performed to evaluate the structural stability of the pipe. Flow capacity was not evaluated because design lines and grades were the same as for the original design. SDR rated pipe has a fixed outside diameter and a varying inside diameter. Thus, flow capacity increases with increasing SDR number for a constant slope. Frost calculations were not performed because the pipe was evaluated under a minimum of 3 ft of overburden. The calculations assumed an external stress due to a truck with a wheel load of 20,000 lb and 3 ft of overburden material, the results

of the design calculations indicated the containment pipe has adequate factors of safety for wall crushing, wall buckling, and ring deflection of 8.2, 2.4, and 6.9, respectively for SDR-32.5 pipe. These factors of safety are above the minimum acceptable value for design of 2.0. Based on these results, a HDPE pipe with a SDR number of 32.5 or less meets structural design requirements. A pipe with SDR 26 was ultimately selected for construction. Design calculations and results are presented in Appendix G.

5.3 Calculations for Existing Pipe

5.3.1 Overview

The purpose of this section is to provide a summary of calculations performed for the as-built LTS pipe. These calculations were performed as part of the March 1999 investigation described in this report. Calculation procedures followed were substantially similar to the calculations for the original design except that SDR-26 was used to estimate pipe properties. Calculations were performed to evaluate flow capacity of the carrier pipe based on the pipe's actual deformed shape. Calculations were also performed to evaluate the structural stability of the pipe based on the deflected shape of the containment pipe observed in excavations. Frost protection is independent of pipe SDR and was therefore not recalculated. Detailed calculations and results are presented in Appendix G.

5.3.2 Flow Capacity

The carrier flow capacity was estimated to verify that the deflected pipe could handle design flow rates with adequate factors of safety. Manning's and Darcy-Weisbach equations were used to calculate the flow capacities of the line under gravity and pressure flow conditions, respectively. These capacities were compared to baseline design flow rates for active-operations and post-closure conditions and to the storm design-basis flow rate (i.e., 15.8 gpm, 9.7×10^{-4} gpm, and 200 gpm, respectively). Additionally, the factor of safety against hydraulic rupture (under pressure flow conditions) was calculated.

The post-repair calculations were performed using data for the as-built lines and grades. The average slope of the as-built TGL is calculated to be 0.58 percent. This slope is less than the slope between the cells which averages approximately 0.75

percent. Therefore, the TGL slope was used for gravity flow capacity calculations. SDR rated pipe has fixed outside diameter and a varying inside diameter. Thus, flow capacity increases with increasing SDR for a constant slope.

The results indicate that the TGL can convey the design flows with acceptable factors of safety. The gravity flow capacity was calculated to be 201.6 gpm and 179.6 gpm for the round and 20 percent deflected pipe, respectively. Flow capacities for other levels of deflection are presented in the detailed calculations in Appendix G. These flow capacities exceed the design basis flow rates for both active-operations and post-closure conditions. The pressure flow capacity was calculated to be 366 gpm and 294 gpm for the round pipe and 20 percent deflected pipe respectively, both of which exceed the storm design flow rate of 200 gpm. The factor of safety against hydraulic rupture due to static head and surge pressure was calculated to be 8.2 and 3.7, respectively. The slope of the pipe generally decreases in the direction of the PLS, therefore surging/vacuum pressures should not develop in the pipe.

5.3.3 Structural Capacity

For the existing pipe operating conditions, a 40,000 lb wheel load was assumed along with various overburden depth ranging from 3 ft to 25 ft. This wheel load was calculated to an upper bound for the list of equipment provided by FDF as possibly operational in this area of the site. The list of equipment provided by FDF is given in Table 5-1. Based on deflection data for the containment pipe obtained from measurements of the pipe in repair excavations (see Appendix G), a pipe deflection of 3.9 percent was used to reduce the allowable wall buckling pressure. This is the maximum deflection of the range of deflections (1.2 to 3.9 percent) obtained in the field using calipers. The results of the existing pipe calculation indicated the containment pipe line has adequate factors of safety for wall crushing of 5.8 and 13.8, wall buckling of 2.6 and 7.1, and ring deflection of 9.4 and 22.5 for 3 ft and 10 ft of overburden, respectively. The calculations also indicate that the pipe can support a maximum of 25 ft of soil overburden (at an average unit weight of 125 pcf) while satisfying minimum structural stability factor of safety criteria.

5.3.4 Discussion

Based on these calculation results, the as-built, post-repair HDPE SDR 26 carrier pipe has adequate design flow capacity. The as-built, post-repair HDPE SDR 26 containment pipe has adequate structural capacity with respect to wall crushing, wall buckling, and ring deflection.

Table 5 - 1
CONSTRUCTION EQUIPMENT
CONSIDERED FOR
CALCULATION OF LTS
PIPE STRUCTURAL STABILITY

Equipment	Gross Vehicle Weight (lb)	Front Axle (lb)	Back Axle (lb)	Maximum Wheel Load (lb)
CAT D8 DOZER	84,026	-	-	5,436 [5]
CAT 350 TRACKHOE (330L)	73,877	-	-	2,607 [5]
CAT 826G COMPACTOR [1]	69,733	41,840 [6]	27,893 [6]	20,920
CAT D25 OR D30 ARTICULATING TRUCK [2]	108,278	47,642	66,050	33,025
CAT 637 SCRAPER	112,090	58,915	57,166	28,583
5000 GALLON WATER WAGON (D20D)	112,754 [3]	75,545	37,209	37,773
VOLVO 990 FRONT END LOADER [7]	45,500 [6]	27,300 [6]	18,200 [6]	13,650
35 TON (D350D)	124,221	69,564	27,329 [4]	34,782

[1] 826C COMPACTOR was used
[2] D30 was used
[3] GVW = 72,754 lb (CAT D20D) plus 20 tons water was used
[4] 22% GVW for Center same as Back Axle
[5] Maximum Wheel Load equivalent for 20" x 18" area
[6] 60/40 weight distribution between axles was assumed
[7] CAT 966F Loader was used

SECTION 6

6. EFFECT OF CONTAINMENT PIPE PRESSURE ON CARRIER PIPE INTEGRITY

6.1 Safe Differential Pipe Pressure

As previously discussed, pressure testing of the containment piping of the LTS was apparently conducted without first applying a pressure equal to the test pressure within the carrier pipe. These conditions led to the application of an external hydrostatic pressure on the exterior of the carrier pipe (which is equivalent to the creation of a vacuum within the carrier pipe). Based on manufacturer's literature, any external pressure/internal vacuum in excess of the pipe's safe maximum differential pressure will produce unconstrained buckling of the pipe.

The amount of pipe deflection induced by this pressure is a function of multiple variables including the magnitude of the differential pressure, the duration of pressure application, and temperature. Table 6-1 presents maximum safe pressures reported by Driscopipe. It is noted that the safe differential pressure would be about 8 percent higher for a temperature of 60°F compared to 73.4°F. A temperature of 60°F is likely closer to the actual in-situ temperature of the pipe. Also, a shorter three hour load duration produces a maximum safe pressure approximately 50 percent higher than the 24 hour value. With these adjustments, the maximum safe differential pressure for SDR 26 pipe is about 13 psi for a three hour load duration, 9 psi for a one day load duration, and 4.5 psi for a one week or longer load duration. For comparison, the maximum safe differential pressure of SDR 11 pipe is about one order of magnitude (10 times) larger than SDR 26 pipe.

6.2 Summary of Observed Carrier Pipe Deflections

6.2.1 CCT Video Surveys

As a result of liquid observed in late January 1999 in LCS manhole MH-3, the LTS was taken out of service and an investigation was conducted to ascertain the condition of the system. As a part of the investigation, the LTS was examined throughout its length using a closed circuit television (CCT) camera. Leaking sections were identified in several areas, these areas were repaired and the pipe was subjected to additional

pressure testing. Evidence recorded during the CCT video examination and obtained when leaking sections of pipe were removed for replacement indicate that the LTS carrier pipe has been deflected to various degrees. The principal cause of this deflection is external hydrostatic pressure (i.e., hydrostatic pressure in the containment pipe) during both short-term pressure tests and longer-term conditions when the LTS containment pipe was not maintained in a drained condition. Measurements made from CCT video recordings have been summarized previously in Figure 4-2 and are discussed in more detail below. It is noted that deflection measurements obtained from analysis of CCT video survey images may be slightly inflated due to distortion of the video image. The principal axes of the deflection varies along the pipe length as a results of the orientation of any initial out-of-roundness of the pipe, other pipe variability that would create an initiation point for the unconstrained buckling of the carrier pipe.

6.2.2 Permanent Gravity Line

CCT video examination of the permanent gravity line carrier pipe revealed pipe deflections ranging from 0 to 26 percent as previously summarized on Figure 4-2. Pipe deflections were typically less adjacent to manholes, where the pipe was jointed to SDR 11 pipe, and at the locations of electrofusion couplings. The test pressure used to test the containment pipe was 17.5 psi between LCS manholes MH-1 and MH-2, and was 22 psi between LCS manholes MH-2 and MH-3 as indicated in test reports presented in Appendix D. The containment pipe was also filled with water which exerted an additional hydrostatic pressure of approximately 1.2 psi on the pipe at the lower elevation manhole. Thus, the total pressure exerted on the permanent gravity line varied from 17.5 psi at LCS manhole MH-1 to 18.7 psi at LCS manhole MH-2 during the 15 December 1997 test; and varied from 22 psi at LCS manhole MH-2 to 23 psi at LCS manhole MH-3 during the 11 December 1997 test. No variation in deflection due to the additional hydrostatic pressure was noted for either test. The estimated maximum safe differential pressure during these tests is estimated to be 9 psi (approximate 22 hour test durations). Thus, the safe differential pressures were exceeded by an approximate factor of two. Observed deflections varied from 0 to 15 percent between LCS manholes MH-1 and MH-2 and 0 to 7 percent between LCS manholes MH-2 and MH-3 as shown in Figure 4-2.

6.2.3 Temporary Gravity Line

CCT video examination of the TGL carrier pipe revealed deflections ranging from 0 to 44 percent as shown in Figure 4-2. Average pipe deflections were generally larger in the TGL than permanent gravity line. Pipe deflections were typically less adjacent to manholes, electrofusion couplings, and cleanouts. The test pressure used to test the containment pipe was 20 psi measured at LCS manhole MH-3 as indicated in test reports presented in Appendix D. The pipe annulus was also filled with water which exerted an additional hydrostatic pressure of 0 to 7 psi from LCS manhole MH-3 to the PLS. Thus, the total test pressure exerted on the TGL varied from 20 psi at LCS manhole MH-3 to 27 psi at the PLS. This pressure trend correlates to the gradually increasing deflection observed along the pipe alignment towards the PLS. The estimated maximum safe differential pressure for this test is estimated to be 13 psi (1.5 hour test). Thus, the safe differential pressure during test was exceeded by an approximate factor of two.

6.3 Deflected Carrier Pipe Performance

6.3.1 Technical Literature Review

There is considerable evidence to suggest that extreme deformation of an HDPE pipe is not of significant concern for an application such as a wastewater gravity flow line as long as the deflection happened slowly and flow capacity of the carrier pipe has not been diminished below the required value. The primary body of this evidence comes from several ASTM standard guides and specifications, which refer to extreme deformation of plastic pipe. Among the applicable standards are:

- ASTM F 1041: Standard Guide for Squeeze-Off of Polyolefin Gas Pressure Pipe and Tubing. This standard guide indicates that:
    - squeeze-off is defined as a technique to control flow through a pipe by the compressing action of a mechanical or hydraulic device;
    - applicable pipe includes 6-in. diameter SDR 26 HDPE of the cell classification used for the LTS; and

- notes that over-squeeze protection should be provided and the safe limit is defined as seventy percent of two pipe wall thickness' (or in other words, the pipe can be squeezed completely shut);

- ASTM D 2513: Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings. This standard specification indicates that:

  - applicable polyethylene material designation codes include PE2406 and PE3408;

  - applicable pipe sizes include 6-in. diameter and SDR 26; and

  - pipe must show no evidence of leakage or visible damage after 1000 hours of sustained pressure category testing subsequent to being squeezed-off and then rounded by squeezing in a perpendicular plane.

- ASTM F 1533: Standard Specification for Deformed Polyethylene (PE) Liner. This standard specification indicates that:

  - applicable polyethylene material designation codes include PE2406 and PE3408;

  - applicable pipe sizes include 6-in. diameter and SDR 26; and

  - a deformed liner is defined as PE manufactured in a deformed shape that reduces the cross-sectional area for insertion into other conduits.

The above standards give a measure of confidence that the LTS carrier pipe has not been rendered unusable by the external pressure applied during previous pipe testing. The standards are applicable to the size, dimension ratio, and polyethylene material designation codes that are used in the LTS carrier pipe. The standards describe a deformation condition more extreme than is thought to have existed in the LTS carrier pipe. The standards are included in Appendix G for reference.

6.3.2 Rate of Deflection

The critical factor to evaluate potential damage to HDPE pipe due to deflection is the rate at which the deflecting occurs. Guidelines by pipe and squeeze off tool

manufacturers suggest squeeze off and release times of 5 min [Plexco, 1993] to 15 min [Williamson, 1999].

Squeeze off time is defined as the time compression of the pipe begins until the pipe is compressed to 70 percent of two pipe wall thicknesses. During pressure testing, compression of the carrier pipe would occur as the pressure in the containment pipe was increased and water was added to the pipe annulus. Conservatively assuming that the carrier pipe is completely flattened, the entire volume of the carrier pipe would need to be introduced to the annulus. For the TGL, the volume between manholes is approximately 4,275 gallons. Operational records indicate the annulus was filled with a 1-in. diameter hose. Assuming a maximum flow rate of 15 gpm (typical for a 1-in. diameter hose) the pipe would progressively deflect over a period of approximately 5 hours, considerably longer than the suggested minimum squeeze off time of 15 min.

Relaxation of the compressed pipe has been shown to be the most important factor to prevent excessive strain and tearing of the inside pipe wall [Plexco, 1993, p. 60]. This relaxation should occur over a time period not shorter than the release time. If the pipe is pressurized and forced to re-round too fast, the pipe could be damaged due to brittle cracking. Relaxation at a rate slower than the release time avoids brittle cracking. For the LTS, after pressure testing, the containment pipe was gravity drained through a 5/8-in. diameter valve at a rate of approximately 5 to 10 gpm. Thus, 7 to 14 hours would be required to drain the annulus and release the pressure on the carrier pipe. This time exceeds the minimum recommended release time.

6.3.3 Vacuum Analogy

Polyethylene pipe is commonly used for vacuum applications. Under excessive vacuum, the mode of buckling where the safe differential pressure is exceeded is not immediate closure or collapse but rather progressive deflection of the pipe into an oval shape. Failure of a vacuum pipeline is considered to occur when the maximum pipe diameter in a deflected pipe is 120% of the original pipe diameter, (i.e., $D_{max} = 1.2 \times D_o$) [Driscopipe,, 1998]. This failure condition is based on a system operated continuously under a vacuum and is approximately the point that progressive collapse could be expected if the vacuum were to be maintained over the long term. A gravity pipeline is not subjected to continuous vacuum conditions and could be expected to remain operable beyond the above stated 20 percent deflection provided the flow capacity is

not restricted. The calculated flow capacity of the existing deflected pipe was described in Section 5.3.2 of this report.

6.3.4 Residual Stresses

When a polyethylene pipe is deflected into an oval shape and then allowed to relax (as is the case in the LTS carrier pipe) residual stresses still remain in the deflected portions of pipe. The stresses are highest in that portion of the circumference of the pipe having the smallest radius of curvature. These residual stresses are less than the stress that would cause failure of the pipeline. However, GeoSyntec is uncertain whether the stresses could be of sufficient magnitude to induce long-term brittle stress cracking of the pipe. HDPE materials are prone to long-term brittle cracking if the stresses to which they are subjected are too high. GeoSyntec does not have a concern regarding long-term brittle cracking of the TGL due to the relatively short service lift of this component of the system. For the permanent gravity line, measured deflections are relatively small (15 percent or less) and, thus, residual stresses in this section of pipe should be low. GeoSyntec recommends, however, that an analysis of residual stresses in the permanent gravity line carrier pipe be performed if this pipe is to be relied upon to serve the intended design lift of the LTS (200 years or more). Alternatively, consideration can be given to relieving stresses by heating the pipe under low pressure.

6.3.5 Carrier Pipe Findings

In summary, based on evaluation of testing procedures and the historical use of pipe squeeze-off by the natural gas industry, it is concluded that the carrier pipe is not significantly affected by the deflection imposed by hydrostatic testing and can continue in-service. A check should be made of the acceptability of residual stress levels in the pipe for any portion of the pipe intended to provide service for the full design lift of the OSDF (200 years or more). Should GeoSyntec be requested to further evaluate residual stresses in the permanent gravity line carrier pipe, the firm would retain the services of an expert in this field. A potential expert has been identified during preparation of this report: Dr. Andre Sommer, Department of Chemistry, Miami (Ohio) University.

TABLE 6-1
Safe Maximum Differential Pressure
(Vacuum/External Pressure)
(psi)

	Pipe SDR						
Service Life	**7**	**11**	**17**	**19**	**21**	**26**	**32.5**
1 day	189	87	28	21	16	8	4
1 month	108	64	15	12	11	4	2
1 year	100	48	14	9	8	4	2
50 years	88	42	13	10	7	4	2

Source: Driscopipe, Polyethylene Piping Systems Manual, 1998. These values are for a service temperature of 73.4°F.

SECTION 7

7. EVALUATION OF ELECTROFUSION COUPLING

7.1 Overview

Repair activities associated with the LTS have been focused mainly on areas where the piping has been joined using electrofusion couplings. Many of the questions regarding long-term survivability and performance of the LTS relate directly to the installed electrofusion couplings. In this section of the report, an evaluation of issues regarding the electrofusion couplings, which surfaced during the initial construction of the LTS and later during repair operations, will be discussed.

7.2 Construction-Phase Installation Issues

During the initial construction of the LTS, the primary technique for joining HDPE was butt-fusion welding. However, at multiple locations along the LTS, electrofusion couplings were used to join the pipe. The electrofusion couplings were used primarily near locations where the piping connected to appurtenances such as clean-out risers, manholes, or where runs of previously buried butt-fused pipe had to be joined.

The number of electrofusion couplings used in the construction of the LTS is relatively large. Ideally, these couplings should be used only one time in the installation of a single-pipe system between fixed appurtenances such as manholes. If the pipe laying proceeds from one direction, all joints can be butt-fused except the last joint. The last joint must be electrofused or joined with some form of slip coupling because there is no room for the heat disc required for butt-fusion at the last joint. For a double-containment piping system, a continuous containment pipe prevents access to the carrier pipe since at the last containment pipe the ends are fixed. This lack of access was the rationale used by the LTS construction contractor for cutting holes through the containment pipe in order to gain access to the carrier pipe coupling. An alternative to the cutting of holes through the containment pipe was the use of a sleeve which could be slid away from the gap in the containment pipe to allow access to the carrier pipe coupling.

For reasons of scheduling, work force utilization, availability of work areas, or contractor preference, the construction contractor on the LTS used numerous

electrofusion couplings on the carrier pipe and electrofusion couplings or sleeves on the containment pipe during initial construction. Since the electrofusion technique is a more complicated procedure requiring more manual tool manipulation than the butt-fusion technique, the potential for field problems increase.

During the initial construction phase, several problems arose with the use of the electrofusion couplings. Those problems were primarily associated with coupling failure either during the electrofusion process or later during the pressure testing process. Manifestations of problems during the fusion process included error message codes received from the electrofusion control box furnished by Central Plastics Company, the manufacturer of the couplings. Usually these failure codes indicated that the coupling must be cut out and replaced. Couplings were replaced during the construction phase due to control box error codes. The coupling repair procedure, either generated additional electrofusion couplings or alternate repair techniques were employed. These alternative techniques involved the use of a sleeve which was extrusion welded to the pipe. Sleeves were used only for the containment pipe

7.3 Repair-Phase Installation Issues

During the repair phase of the LTS, the primary technique for joining HDPE pipe was electrofusion couplings because this phase involved fitting repaired sections between fixed ends of previously installed pipe. Three of the four newly discovered leaks on the LTS were associated with electrofusion couplings. At the leak near Station 16+00, an electrofusion coupling on the containment pipe was found to be leaking due to insufficient bonding as revealed by x-ray examination. At the leak near Station 12+05, an electrofusion coupling on the carrier pipe was found to be leaking due to insufficient bonding caused by a lack of stabbing depth. At the leak near Station 12+23, an electrofusion coupling on the carrier pipe was found to be leaking due to a vertical misalignment of the upstream and downstream pipes. These leak occurrences in pipe previously passing pressure testing has prompted a re-examination of the procedure by which the electrofusion couplings were originally installed and a review of manufacturer's installation recommendations.

The installation procedure used during the construction phase had specific requirements for preparation to include: (i) pipe cleaning prior to electrofusing; (ii) pipe end alignment; and (iii) pipe stabbing into the coupling for correct distance. In

trying to understand the repair-phase discovery of leaking joints, these installation procedures were more closely examined. In the 25 August 1998 report by Central Plastics Company, a concern was raised about two 1-in. diameter holes cut into the containment pipe within the electrofusion zone for gaining access to the carrier pipe coupling electrodes. As described subsequently, these holes may have adversely affected fusion quality for the 10-in. electrofusion couplings. Additionally, on 12 March 1999 concern was raised by Friatec Incorporated about the use of electrofusion coupling melt times established for SDR 17, or thicker wall pipe, for joining SDR 26 pipe instead of the shorter melt time normally specified for the thinner wall pipe. A final potential issue related to the presence of moisture within the coupling during the melt. If moisture was present, it would reduce weld integrity.

7.4 Electrofusion Coupling Installation Issues

7.4.1 Pipe Cleaning

Strict adherence to the manufacturer's recommended installation procedures is critical to the successful joining of plastic pipes using the electrofusion coupling technique. The first procedural step is cleaning. The proper cleaning of the pipe ends wherever the coupling will come into contact is essential to fusing the plastic of the pipe with the plastic of the coupling. When a pipe comes to a jobsite, it may have a variety of substances on its exterior, such as die lubricants. On the jobsite, the pipe will pick up additional substances such as dust and soil. Exposure of the pipe to the environment causes the exterior surfaces to begin the process of oxidation. In order for the molecules of plastic in the pipe to fuse with the molecules of plastic in the coupling there must be no intervening film of foreign substance or oxidized plastic. This film of foreign matter and oxidized molecules of plastic are removed from the pipe through a process of cleaning by scraping the surface of the pipe end. If the pipe end is not properly cleaned by scraping, the fusion process will be inhibited from fully taking place.

It has been confirmed by field CQC and QA personnel that during initial construction, the pipe ends, were cleaned by a procedure of sanding with emery cloth or grinding with grit paper. While this procedure can be effective, if properly executed, the process of grinding could lead to flat spots on the pipe which may or may not be sufficient to impact the fusion process. While sufficient fusion occurred to withstand

handling, installation, and pressure testing stresses, the fusion was not sufficient to in all cases withstand long-term pipe stresses due to temperature fluctuations or ground movement. The report of Central Plastics Company states that the tested couplings failed due to inadequate cleaning of pipe. For the containment pipe, another contributing factor was the holes which had been cut in the pipe. In a 23 March 1999 telephone conversation with Central Plastics Company, a company representative confirmed his previous conclusion that inadequate cleaning and the holes in the containment pipe were the primary factors leading to the failure of electrofusion couplings he tested in his laboratory.

7.4.2 Alignment and Stab Depth

The second critical aspect of the manufacturer's recommended installation procedure entails proper alignment of the pipe axis both upstream and downstream of the pipe joint and inserting the pipe to the proper stab depth. Proper fusing of plastics in the electrofusion process involves both heat and pressure. The heat makes the molecules of plastic sufficiently active to promote Brownian motion across the interface and a fusion of the plastic. The heat also causes the materials to expand and come into intimate contact along the entire boundary to be fused. If the pipes are not properly aligned, this pressure is misdirected or released and not useful in providing the intimate contact on all areas where required. If the pipes are not properly stabbed, the width of the fusion zone will be insufficient and again pressure will be uncontained and therefore ineffective in promoting the proper fusion. Pipes which had holes cut in the area of fusion may also be susceptible to this lack of intimate contact because the holes may have provided a pressure relief for the expanded materials. An example of a coupling in which short-stabbing was a problem occurred on the carrier pipe at station 12+05. An example of poor coupling alignment is the yellow carrier pipe coupling removed from between stations 12+10 and 12+25.

Short-stabbing or inadequate coupling alignment could occur during initial installation or due to thermal expansion/contraction between the time of installation and fusion. For example, if a coupling was correctly stabbed (but not fused on the day it was stabbed) and then fused the following morning, a contraction of the pipe due to

temperature fluctuations might cause the pipe to be pulled out (or nearly out) of the coupling. CQC personnel have indicated several probable instances when couplings were installed one day, but not fused until the next day.

7.4.3 Melt Time

The third issue to be addressed relating to the electrofusion couplings is the heat time applied to the SDR 26 pipe. The actual heat time used was appropriate for pipe having SDR between 9 and 17. As constructed, the electrofusion coupling control box probably supplied more heat energy to the coupling coils than required by the SDR 26 pipe to which the couplings were intended to join. As a result, the pipe was probably softened more than it should have been. The implications of a too soft pipe are a possible reduction in required fusion pressures and a physical displacement of plastic due to viscous flow. Indications of viscous flow were not noted in any of the couplings which have been removed to date. In-pipe CCT videos were examined for signs of viscous flow. While some rippling of the inside pipe surface was observed (as previously described in Section 4.3.2.2), no evidence of viscous flow was noted. The potential for a lowering of the fusion pressure due to excessive softening is not considered a probable source of concern because the softening would have been progressive radially away from the fusion area and the initial build-up of pressure should have been sufficient to cause fusion. In a 26 March 1999 telephone conversation with a representative of, Friatec, Inc. the representative indicated that, SDR-26 pipe should have a shorter melt time than lower SDR pipe and that too much melt may cause the pipe material to thin-out and lead to failure when put under pressure. As noted above, however, no evidence of viscous flow from the fusion zone was observed.

7.4.4 Moisture

Water or condensation in the coupling during the melt would reduce the integrity of the electrofusion weld. While there is not direct indication that water was a problem, this possibility cannot be ruled out based on the following observations:

- electrofusion couplings were installed with the pipe at the bottom of the pipe trench; notwithstanding the fact that trenches were pumped out and significant effort was expended to keep work area dry, working conditions at the bottom of the trench were sometimes wet and work space was limited;

- there were at least several instances when electrofusion couplings were installed in misting or light rain conditions; during these times, temporary cover was used to protect the work area; and

- a few electrofusion couplings were left to sit overnight before fusing which could have led to condensate getting into the coupling.

In a 26 March 1999 telephone conversation with a representative of Friatec Inc., the representative indicated that moisture in the fusion zone of electrofusion couplings could cause rippling in the pipe wall (which was observed) and problems with respect to the integrity of the weld.

7.5 Electrofusion Coupling Findings

Based on the available information, GeoSyntec has arrived at the following findings with respect to the electrofusion couplings.

- In GeoSyntec's experience, most landfill related polyethylene pipe welds are made using the butt-fusion technique and electrofusion couplings are typically only used when making fixed connections. The number of electrofusion couplings used for construction of the OSDF LTS is relatively large. The identified reasons for the large number of couplings on the LTS project are: (i) multiple construction contractor crews worked at the same time on different portions of the line (in many landfill installations, one crew works the line from one end to the other); (ii) construction contractor preference; and (iii) initial leakage (discussed below) of electrofusion couplings that typically resulted in the installation of two new couplings in the repair of a coupling leak location.

- Manufacturer's (Central Plastics Company) procedures for installing electrofusion couplings are contained in the document "Electrofusion Systems Operating and Training Manual". The manufacturer's installation procedure calls for "scraping pipe ends to remove any oxidation or surface contamination...Avoid all possible recontamination of the prepared surface". The construction contractor utilized grinding and sanding pipe ends in lieu of the scraping procedure recommended by the coupling manufacturer. The construction contractor utilized grinding and grit paper based on the on-site

training provided by the pipe supplier (ISCO). It is unknown whether the grinding and grit paper procedure taught by ISCO was reviewed or approved by the electrofusion coupling manufacturer (Central Plastics Company). (Note: with respect to preparing polyethylene pipe for electrofusion coupling, ASTM D 1290 states: "Remove the outer surface of the pipe using recommended procedures and tools. Avoid gouging or removing excessive material from the pipe surface. Care should be taken to maintain the specified minimum wall for the pipe. Note 5 – For certain non-pressure applications, removal of the pipe outer surface may not be required. Consult the manufacturer for recommendations.")

- During original construction, several of the in-line electrofusion pipe joints were formed in the configuration shown in Figure 3-1. Installation of the couplings in this configuration is difficult and may produce recontamination of previously cleaned surfaces. Also, the fixed-end installation procedure in this figure required the drilling of two 1-in. diameter holes in the containment pipe (at the location of the coupling) for purposes of final alignment of the carrier pipe coupling and attaching the fusion machine electrodes. These holes are located directly under the fusion zones for the containment pipe coupling. After fusion of the carrier pipe coupling, the holes were to be filled with extrudate and the entire surface prepared for coupling. Evidence indicates that some (number unknown) of these holes were not filled prior to fusion.

- In April or May 1998, two sets (carrier pipe and containment pipe) of electrofusion couplings that exhibited initial leakage of the containment pipe were removed from a location near manhole MH-2 and sent by the construction contractor to the electrofusion coupling manufacturer for evaluation (Central Plastics Company). These couplings apparently had poor surface preparation and the 1-in. diameter holes were not filled with extrudate. The results of the manufacturer's evaluation are presented in Section 3 and the manufacturer's report is contained in Appendix C. The conclusion of the report is that all electrofusion couplings using the installation techniques described above (i.e., 1-in. diameter holes in containment pipe and preparing the pipe as described) "are suspect and could fail due to any number of factors including (but not limited to) pipe expansion/contraction and ground movement." The report indicates "no bonded areas" for the tested samples and "no scraping of the pipe

surface" was evident. These results suggest that for at least the tested samples, the grinding/grit papering preparation procedure used in the field was inadequate. It should be noted that the tested samples were from pipe sections that never passed pressure tests and were known to be leaking and suspect. The report does provide a rationale as to why other sections of pipe initially passed pressure tests and have subsequently leaked. "The main concern for these joints is the long term quality of the joints since the pipe was not scraped. Since the pipe was not scraped, there was no joining of polyethylene materials between the couplings and the pipe. Basically only a compression joint, not a fusion joint, exists between the pipe and fittings. Even though the joints passed an initial pressure test, the long term performance of the joints is questionable. Over time, with seasonal changes and changes in the ground temperature, the pipe will expand and contract. This expansion and contraction of the polyethylene pipe will cause the joints to weaken and probably leak."

- The electrofusion couplings for original construction were heated using fusion equipment supplied to the construction contractor by the pipe supplier (ISCO). The equipment was apparently programmed to a standard setting for melt time. Central Plastics Company apparently makes no adjustment to the melt time for pipe SDR and uses only the standard setting. For SDR 26 pipe, the melt time used results in polyethylene softening through the entire pipe wall thickness. This may create a waviness to the inside of the pipe in the fusion zone. Field personnel have reported seeing a waviness or rippling in this zone. The potential impacts of this overheating, if any, on the long-term integrity of the electrofusion welds have not been definitively established. Potential impacts could include reduced pressure during fusing, pipe wall thinning, or increased residual pipe stress. While these potential impacts may not influence the ongoing operation of the LTS, their potential impact on the ultimate design life of the LTS is unquantified. Conclusions and recommendations at the end of this report address this uncertainty.

- Based on conversation with representatives from Central Plastics Company and Friatec, the impact of using a melt time longer than prescribed appears to be minimal. The representative of Central Plastics Company stated that there was not apparent evidence of over heating in the coupling which he examined. The representative of Friatec Inc. stated that the probable effect of overheating is a

flow of plastic and thinning of the pipe which has not been observed in the joints which have been removed.

8. FINDINGS AND CONCLUSIONS

8.1 Carrier Pipe (Butt-Fusion Joints)

The following findings and conclusions are provided with respect to the 6-in diameter SDR 26 HDPE carrier pipe component of the OSDF LTS between manhole MH-1 and the PLS. These conclusions apply to the pipe and butt-fusion joints, but not electrofusion couplings. Electrofusion couplings are addressed in Section 8.3.

- The original design called for use of SDR 11 pipe. DCN 1700-007 resulted in a change to SDR 26 pipe. Calculations presented in Section 5 of this report demonstrate adequate flow capacity for both the original SDR 11 pipe and the SDR 26 pipe.

- Construction of the carrier pipe occurred between August and December 1997. A discussion of construction activities is presented in Section 3 of this report. The carrier pipe was pressure tested in accordance with the technical specifications and the construction contractor's approved procedures. Testing was performed at a nominal carrier pipe internal pressure of 50 psi for a minimum time period of three hours since the pipe was backfilled, pursuant to DCN 1700-033. Pressure testing occurred in December 1997 and the LTS was placed into service in December 1997.

- The investigation of the LTS carried out between January and March 1999 has not revealed any leakage of the carrier pipe and associated butt-fusion joints. Leakage has been found at several electrofusion couplings along the carrier pipe.

- The results of the CCT video survey performed in February and March 1999 shows that the SDR 26 pipe has significant deflection (out of roundness) along much of its length. This deflection is primarily attributed to unconstrained buckling resulting from the procedure used by the construction contractor to pressure test the LTS containment pipe. The procedure used for the pressure test resulted in an essentially empty, unpressurized carrier pipe while the containment pipe was pressure tested. This procedure resulted in a filling of the annulus between the carrier pipe and the containment pipe with water while the

carrier pipe was empty. The water in the annulus exerted a differential hydrostatic pressure on the carrier pipe.

- As a result of unconstrained buckling due to differential hydrostatic pressure, the carrier pipe deflected into an oval shape. The principal axes of the deflection varies along the pipe length as a result of the location of any initial out-of-roundness of the pipe or other pipe variability that would create an initiation point for the unconstrained buckling.

- The results of the CCT video survey are described in Section 3 of this report and detailed results are presented in Appendix F. Figure 4-2 presents a graphical summary of the results. Based on this figure, the carrier pipe has deflection resulting from the differential hydrostatic pressure conditions described above. Pipe deflections between the PLS and MH-3 at the time of the survey ranged from zero to a maximum of 44 percent. The zero deflection locations generally correspond to the locations of electrofusion couplings. Most deflections are less than 30 percent, with the approximate average deflection ranging from about 7 percent at manhole MH-3 to 20 percent at the PLS. The increase in average deflection moving south from MH-3 to the PLS is thought to be due to the incremental increase in containment pipe hydrostatic pressure during the pressure test resulting from the 16.4 ft drop in pipe elevation between these two locations. It is noted that deflection measurements obtained from analysis of CCT video survey images may be slightly inflated due to distortion of the video image. Measured deflections of carrier pipe from pipe repair locations (typically close to electrofusion couplings) ranged from 9 to 16 percent.

- Carrier pipe deflections between manholes MH-1 and MH-2, and between manholes MH-2 and MH-3, are presented in Figure 4-2. These pipe deflections were based on analysis of CCT video images. Based on the figure, pipe deflections between manholes MH-1 and MH-2 range from zero to 15 percent. Pipe deflections between manholes MH-2 and MH-3 also range from zero to 7 percent.

- The calculations described in Section 5 of this report demonstrate that the range of observed deflections of the carrier pipe will not significantly diminish the flow capacity of the pipe.

- An evaluation of the impact of the measured carrier pipe deflections on the continued performance of the pipe is presented in Section 6 of this report. The information presented in Section 6 includes a general comparison to relevant ASTM standards and guides, and an analysis of the deflection mechanism. Based on this information, the deflection should have no adverse impact on the continued performance of the carrier pipe.

- Based on the foregoing information, GeoSyntec concludes that the carrier pipe (including butt-fusion joints but exclusive of electrofusion couplings) is suitable for continued use in the LTS. GeoSyntec recommends, however, that if the carrier pipe for the existing gravity line is to be relied upon for the full OSDF design life (200 years or more), that a polymer expert be retained to perform an evaluation as to whether residual pipe stresses resulting from the pipe deflections increases the potential for long-term brittle stress cracking of the pipe. GeoSyntec has tentatively identified one such expert, Professor Andre Sommer, Department of Chemistry, Miami University (Ohio).

8.2 Containment Pipe (Butt-Fusion Joints)

The following findings and conclusions are provided with respect to the 10-in. diameter SDR 26 HDPE containment pipe component of the LTS between manhole MH-1 and the PLS. The conclusions apply to the carrier pipe and butt-fusion joints, but not electrofusion couplings. Electrofusion couplings are addressed in Section 8.3.

- The original design called for use of SDR 11 pipe. DCN 1700-007 resulted in a change to SDR-26 pipe. Calculations summarized in Section 5 of this report demonstrate adequate structural capacity for both the original SDR 11 pipe and the SDR 26 pipe. Structural calculations include wall crushing, wall buckling, and ring reflection. The calculations for the SDR 26 pipe conservatively account for the minor amount of deflection in the containment pipe estimated at the locations of repair excavations.

- The containment pipe was constructed between August and December 1997, in conjunction with construction of the carrier pipe and other components of the LTS. The containment pipe was pressure tested as described in Section 3 of this report and as summarized in Section 8.1 above.

- The containment pipe was monitored and operated as described in Section 4 of this report. Of particular note, the portion of the LTS between manholes MH-3 and the PLS was apparently periodically operated between initial start-up (late December 1997) and late January 1999 with the drain port from the containment pipe into the PLS closed. Leakage into the pipe ultimately filled the pipe from the PLS up to a depth of about 9 ft in manhole MH-3. The OSDF Systems Plan requires that the containment pipe remain drained.

- Investigations of the LTS revealed one leak in the containment pipe not associated with an electrofusion coupling. This leak occurred at Excavation No. 4 shown on Figure 4-1. The leak was discovered during excavation to retrieve a CCT video camera that had previously become stuck in the carrier pipe. The uncovered containment pipe showed a 6-ft long longitudinal indentation in the pipe caused by a backhoe bucket or other construction equipment. The indentation produced a 1-in. long tear where it intersected an internal pipe centralizer. It is apparent that the tear was caused by construction equipment. It is not clear whether the tear occurred during original construction or during the repair procedure.

- Where exposed in repair excavations, the containment pipe showed little ovality. Measurements of pipe deflection in the field were made using calipers. Measured pipe deflections ranged from 1.2 to 3.9 percent. These values are less than the allowable buried-pipe ring deflection of 6.5 percent specified by the pipe manufacturer.

- An evaluation of as-built pipe grades, presented in Figures 3-4a, 3-4b, and 3-4c, indicate that the containment pipe as initially constructed contains small sags at various stations as indicated in Table 3-5. Sags observed in the CCT video survey of the carrier pipe correspond at most locations to the containment pipe sag locations in Table 3-5. These sags will not measurably affect the flow capacity of the carrier pipe.

- Based on the information provided in this report, the containment pipe (including butt-fusion joints, but excluding electrofusion couplings) meets applicable design criteria, including wall crushing, wall buckling, and ring deflection. The pipe exhibits little ovality in-situ. Pipe alignment is within acceptable tolerances except for several sags in the TGL noted above.

GeoSyntec concludes that the SDR 26 HDPE containment pipe is suitable for continued use in both the TGL and permanent gravity line.

8.3 Electrofusion Couplings

Electrofusion couplings used in LTS construction have been a major focus of the LTS investigations described in this report since three of the four LTS leakage problems revealed by the investigations are associated with the use of these couplings. The following findings and conclusions are provided with respect to the use of this component of the LTS. It should be noted that the findings and conclusions are applicable to all SDR 26 pipe used in construction, to include the SDR 26 piping installed between the manholes and the cells, to the extent that the same procedures as used in LTS were used on that portion of SDR 26 pipe.

- Electrofusion couplings are an acceptable joining method for HDPE pipe based on Section 02605 of the technical specifications. Section 02605 identifies butt-fusion welding as the other acceptable method for joining HDPE carrier and containment pipe. Section 02605 requires that electrofusion couplings satisfy ASTM F 1055 "Standard Specification for Electrofusion Type Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing." Section 02605 requires that electrofusion couplings be installed in accordance with manufacturer's recommendations. Section 02605 does not reference ASTM F 1290 "Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings."

- During original construction, 20 electrofusion couplings were used to join carrier pipe and 21 electrofusion couplings were used to join containment pipe. Additional couplings were installed during pipe repair activities. The known locations of electrofusion couplings as they currently exist in the LTS pipeline are shown on Figures 3-4a, 3-4b, and 3-4c in Appendix C. A summary of known information for each coupling as they currently exist in the LTS pipeline is presented in Tables 3-3, 3-4, 4-1, and 4-2.

- In GeoSyntec's experience, the number of electrofusion couplings used in a landfill-related polyethylene pipe installation is typically relatively small. Most pipe welds are made using the butt-fusion technique and electrofusion

couplings are typically only used when making fixed connections. The number of electrofusion couplings used for construction of the OSDF LTS is relatively large. The identified reasons for the large number of couplings on the LTS project are: (i) multiple construction contractor crews worked at the same time on different portions of the line (in many landfill installations, one crew works the line from one end to the other); (ii) construction contractor preference; and (iii) initial leakage (discussed below) of electrofusion couplings that typically resulted in the installation of two new couplings in the repair of a single coupling leak location.

- Manufacturer's (Central Plastics Company) procedures for installing electrofusion couplings are contained in the document "Electrofusion Systems Operating and Training Manual". The manufacturer's installation procedure calls for "scraping pipe ends to remove any oxidation or surface contamination...Avoid all possible recontamination of the prepared surface". The construction contractor utilized grinding and grit paper in lieu of the scraping procedure recommended by the coupling manufacturer. The construction contractor utilized grinding and grit paper based on the on-site training provided by the pipe supplier (ISCO). It is unknown whether the grinding and sanding procedure taught by ISCO was reviewed or approved by the electrofusion coupling manufacturer (Central Plastics Company). (Note: with respect to preparing polyethylene pipe for electrofusion coupling, ASTM D 1290 states: "Remove the outer surface of the pipe using recommended procedures and tools. Avoid gouging or removing excessive material from the pipe surface. Care should be taken to maintain the specified minimum wall for the pipe. Note 5 – For certain non-pressure applications, removal of the pipe outer surface may not be required. Consult the manufacturer for recommendations.")

- During original construction, several of the in-line electrofusion pipe joints were made using the "fixed procedure" illustrated on Figure 3-1. Installation of the couplings in this configuration is difficult and may produce recontamination of previously cleaned surfaces. Several of the electrofusion couplings retrieved from the 1999 repair activities exhibited short-stabbing or alignment problems. Also, this installation procedure resulted in the drilling of two 1-in. diameter holes in the containment pipe (at the location of the coupling) for purposes of

aligning the carrier pipe coupling. These holes are located directly under the fusion zones for the containment pipe coupling.

- During original construction (August to late December 1997) several installed electrofusion coupling were replaced or repaired due to problems with the installation.

- In April or May 1998, two sets (carrier pipe and containment pipe) of electrofusion coupling that exhibited initial leakage of the containment pipe were removed from a location near manhole MH-2 and sent by the construction contractor to the electrofusion coupling manufacturer for evaluation (Central Plastics Company). The couplings were tested and a manufacturer's report was issued in August 1998. The results of the manufacturer's evaluation are presented in Section 3 and the manufacturer's report is contained in Appendix C. The conclusion of the report is that all electrofusion couplings using the installation techniques described above (i.e., 1-in. diameter holes in containment pipe and preparing the pipe as described) "are suspect and could fail due to any number of factors including (but not limited to) pipe expansion/contraction and ground movement." The report indicates "no bonded areas" for the tested samples and "no scraping of the pipe surface." These results suggest that for at least the tested samples, the grinding/grit paper preparation procedure used in the field was inadequate. The report also provides a rationale as to why the pipe initially passed pressure tests and subsequently leaked. "The main concern for these joints is the long term quality of the joints since the pipe was not scraped. Since the pipe was not scraped, there was no joining of polyethylene materials between the couplings and the pipe. Basically only a compression joint, not a fusion joint, exists between the pipe and fittings. Even though the joints passed an initial pressure test, the long term performance of the joints is questionable. Over time, with seasonal changes and changes in the ground temperature, the pipe will expand and contract. This expansion and contraction of the polyethylene pipe will cause the joints to weaken and probably leak."

- The electrofusion couplings for original construction were heated using equipment supplied by the coupling supplier, Central Plastics Company. The equipment was apparently programmed to a standard setting for melt time.

Central Plastics Company apparently makes no adjustment to the melt time for pipe SDR. For SDR 26 pipe, the melt time used may result in polyethylene softening through the entire pipe wall thickness. This may create a waviness to the inside of the pipe in the fusion zone. The potential impacts of this overheating, if any, have not been definitively established. Potential impacts could include reduced pressure during fusing, pipe wall thinning, or increased residual pipe stress. GeoSyntec does not believe these potential impacts will by themselves adversely affect pipe performance.

- Based on conversations with representatives from Central Plastics Company and Friatec, Inc., the impact of using a melt time longer than prescribed appears to be minimal. The representative of Central Plastics Company stated that there was no apparent evidence of overheating in the couplings he examined. The representative of Friatec Inc. stated that the probable effect of overheating is a flow of plastic and thinning of the pipe which has not been observed in the joints removed as part of repair activities.

- Initial electrofusion coupling installation procedures relied on the electrofusion control box to provide a diagnostic message alerting the operator of a problem with the fusion conditions. These diagnostic messages were primarily related to conditions indicated by voltage and amperage in the coupling heating elements. Several (number unknown) couplings were replaced or repaired by the construction contractor during the initial installation as a result of diagnostic messages indicating a problem in the fusion process. However, based on the findings of this investigation, the control box diagnostics are not sufficiently sensitive to indicate all fusion problems. For future construction, additional installation and CQC/CQA procedures should be implemented to address this limitation of the control box diagnostics. The additional procedures are given in Section 9 of this report.

- Recent (i.e., January to March 1999) investigations of the LTS have revealed three areas where pipe electrofusion couplings leaked. These areas are labeled on Figure 4-1.

  - A leak occurred at an electrofusion coupling on the carrier pipe south of a clean-out at approximately Sta. 12+00 The leak was found in February 1999 by CCT video survey of carrier pipe with the containment pipe full of

water. A small gap (less than 0.1 in.) was observed between the end of the pipe and coupling. Observation of the pipe after removal indicated that the pipe had not been fully seated in the coupling (short stabbing) and only a narrow area had been fused. Apparently, there was just enough fusion between the pipe and coupling to pass pressure testing. Subsequent thermal expansion/contraction and/or external physical stress caused the bond to fail. Visual observations also revealed a distinct lack of adequate pipe surface preparation at this location. The amount of grinding/grit papering at this location appeared inadequate to have removed surface contamination and oxidized surface material.

- A leak occurred at an electrofusion coupling on the carrier pipe at approximate Sta. 12+10. The leak was found in February 1999. The coupling appeared to be vertically misaligned.

- A leak occurred at an electrofusion coupling on the containment pipe at the south side of a cleanout near Sta. 16+00. The leak was located in February 1999 by filling the containment pipe with water. The coupling was cut out and subject to x-ray examination. The x-ray clearly indicated an area of incomplete fusion. It appears that this coupling failed due to a combination of the issues related to pipe preparation and weld pressure described in Section 7.

- Based on the information in this report, it is GeoSyntec's opinion that the electrofusion couplings installed on the LTS (except couplings installed as a part of current repair activities) may be of substandard installation quality due to a combination of one or more of the following factors: (i) inadequate pipe surface preparation; (ii) short-stabbing or inadequate alignment of pipe in the coupling; (iii) insufficient fusion pressure for containment pipe with 1-in. diameter alignment holes; (iv) excessive fusion heating time; and (v) moisture within the fusion zone at the time of heating.

- Due to the foregoing conclusion, installed electrofusion couplings may not achieve the design service life of the LTS system. The potential exists for future leaks at the couplings.

8.4 LTS Current Status

Post-repair pressure testing of the containment and carrier pipes is incomplete as of the date of this report. It should be noted that there are currently five excavations along the LTS as shown in Figure 4-1. The status of pressure test activities as of 18 March 1999 (i.e., the date upon which field investigation and repair activities were suspended pending the findings of this report, findings of the FDF internal investigation report, and additional planning activities by FDF and DOE) is as follows:

- Carrier pipe (MH-1 to MH-3): a hydrostatic pressure test was performed on 14 March 1999. During the test, the pressure in the pipe dropped from 54 to 42 psi in 1.5 hours. A CCT video survey of the carrier pipe with the containment pipe filled with yellow-dyed water was not conclusive, but evidence suggests a small leak located near the cleanout north of manhole MH-2. This leak should be further investigated prior to placing the existing permanent gravity line back into service.

- Containment pipe (MH-1 to MH-3): post-repair pressure testing of this section of pipe has not yet been performed.

- Carrier pipe (MH-3 to Excavation No. 1):

  - (MH-3 to Excavation No. 3): a hydrostatic pressure test was performed on 18 March 1999. Test results showed no loss of pressure during the test.
  - (Excavation No. 3 to Excavation No. 1): post repair testing of this section of pipe has not yet been performed because identified leaks in Excavation No. 3 and Excavation No. 1 have not been repaired.

- Containment pipe (MH-3 to Excavation No. 1):

  - (MH-3 to Excavation No. 3): a hydrostatic pressure test was performed on 18 March 1999. Test results showed no loss of pressure during the test.
  - (Excavation No. 3 to Excavation No. 1): post repair testing of this section of pipe has not yet been performed because identified leaks in Excavation No. 3 and Excavation No. 1 have not been repaired.

- Carrier pipe (Excavation No. 1 to PLS): a hydrostatic pressure test was performed on 16 March 1999. During the test the pressure in the pipe dropped from 55 psi to 41.5 psi in two hours.

- Containment pipe (Excavation No. 1 to PLS): post-repair testing of this section of pipe has not yet been performed because the carrier pipe has not yet passed post repair testing.

8.5 Coupling Adjacent to Cells

An electrofusion coupling exists where the containment pipe component of LCS and LDS pipes joins up to the liner penetration boxes beneath the western edge of Cell No. 1 and Cell No. 2. The locations of these electrofusion couplings are shown on Figure 3-3. In all, six electrofusion couplings were installed on the containment pipes between a stub-out pipe section on the factory-fabricated boxes and the main section of pipe that slopes westward to the LTS manhole structures. Only butt-fusion joints exist on the carrier pipe; electrofusion couplings were not needed to install the carrier pipe. These couplings were made on SDR 11 HDPE pipe and by a different construction contractor than the construction contractor that installed the SDR 26 pipe. These couplings were installed using the moveable installation procedure (as opposed to the fixed procedure) without any holes drilled in to the containment pipe. Other attributes of this component of the system are described in Section 3.9 of the report. Recent monitoring of the drainage ports for all six of these containment pipes has not revealed any indication of leakage. Based on all of the available information, GeoSyntec believes these electrofusion couplings are more reliable than those used on SDR 26 pipe. GeoSyntec can recommend these couplings for continued use in their current application.

126

9. RECOMMENDATIONS

9.1 Continued Use of LTS

One of the main objectives of this report was to evaluate the suitability of the LTS for continued use. With respect to this objective, GeoSyntec offers the following recommendations:

- If the remaining suspect conditions in the containment pipe and carrier pipe are successfully repaired and the pipes pass post-repair pressure tests, both the TGL and permanent line can be placed back into operation and operated for the upcoming construction season. While some probability exists of additional coupling leakage this year, GeoSyntec believes the probability is low and that response actions (e.g., tanker trucking to the PLS) are available should the leakage occur.

- When placed back into service, the LTS should be operated in strict accordance with the OSDF Systems Plan and with the additional leak detection monitoring activities described in Section 9.2 of this report. In the case of a leak, the LTS will need to be taken out of service, repaired, and pressure tested. During this period, alternate provisions (e.g., tanker trucking to the PLS) will be needed.

- All electrofusion couplings existing on the SDR 26 permanent gravity line between LCS manholes MH-1 and MH-3 and between the LDS/LCS manholes and the SDR 11 pipe leading to the OSDF cells that were installed using the procedures identified as potentially substandard in this report should be replaced or rehabilitated to provide a permanent gravity line system with the desired design service life. This recommendation does not preclude continued use of the existing permanent gravity line for the upcoming construction season (or for longer, if necessary). Future extension of the permanent gravity line should be performed in accordance with recommendations provided subsequently in this section of the report. GeoSyntec has identified the following rehabilitation or replacement options for the permanent gravity line:

  - slip line SDR 26 carrier pipe and backweld all suspect electrofusion couplings on SDR 26 containment pipe;

- replace all suspect electrofusion couplings on SDR 26 carrier and containment pipe; or

- replace all SDR 26 pipe with new, lower SDR pipe and new joints prepared in accordance with the recommendations and guidance given subsequently.

- It may be possible to continue to operate the TGL for its remaining service life with only a small probability for additional leakage during that time period (i.e., several years). One advantage of continuing to operate the TGL through 1999 is that it allows data to be obtained to better assess the probability of future leakage from the TGL electrofusion couplings.

- If a very high level of confidence is needed that the TGL will not leak during its remaining service life, then it will be necessary to rehabilitate or replace the pipe. GeoSyntec has identified the following rehabilitation options for the TGL:

  - Slip line the TGL carrier pipe with polyethylene pipe;

  - install new spool-fed SDR 17 pipe through the existing carrier pipe; a 3-in. diameter SDR-17 pipe can fit within the deflected TGL carrier pipe;

  - replace all electrofusion couplings on the SDR 26 containment and carrier pipe (or at least replace all coupling at areas where a concentration of several couplings exist as reflected in the as-built drawings); or

  - replace current TGL with new above-ground TGL starting at LCS manhole MH-3 and terminating at the PLS.

Each of the TGL rehabilitation options identified above has advantages and disadvantages. GeoSyntec understands that FDF is undertaking an evaluation of TGL rehabilitation options on a parallel track with GeoSyntec's preparation of this report.

9.2 Operations and Monitoring of Existing System

The LTS should be operated in strict accordance with the OSDF System Plan, Rev. 0, dated May 1997, as updated by the specific recommendations in this section. The following specific operating requirements are highlighted as essential to the proper operation of the system.

- Monitor the LTS containment pipe (and the LCS and LDS containment pipes from landfill cells) for any indications of leakage at least weekly and after storm events resulting in more than 0.25 in. of precipitation in a 24-hour period. The source of any observed leakage from the containment pipe should be immediately identified and corrective actions taken.

- Keep the LTS containment pipe (and the LCS and LDS containment pipes from landfill cells) drained. Drain ports at the PLS and the manholes should remain open except during maintenance activities.

- All containment pipe drain ports should be retrofitted with containment pipe leakage detection devises that can be monitored without the need for confined space entry. Any accumulated liquids in containment pipe leakage collection devices should be promptly drained as necessary for the devices to continue to be useful in revealing ongoing leakage.

- Any accumulated liquid in LDS manhole secondary containment vessels should be removed prior to overflow from the primary containment vessel into the secondary containment manhole. Overflow has apparently occurred on occasion in LDS manhole MH-1.

- LCS and LDS manhole containment structures should be maintained in a drained condition so that any leakage (or flow into the manhole from a source other than leakage) can be quickly identified and corrective measures taken. The manholes are designed to function as dry wells. Operational records seem to indicate the periodic accumulation of liquids in some structures.

- If liquid is observed in any LTS manhole, establish the elevation of the liquid and compare it to the trigger elevation for the alarm. If the measured elevation exceeds the trigger elevation, implement a complete system check.

Possible modifications for the manholes and PLS to facilitate monitoring of the LTS containment pipes are presented in Figures 9-1 through 9-3.

9.3 Design Loads

The allowable dead and live (traffic) loads that can be applied to the LTS are dependent on the pipe SDR utilized. For SDR 26 pipe, the allowable design loads are obtained from the calculation package contained in Appendix F and summarized in Section 5 of this document. Based on the calculation results, the following dead and live load restrictions are applied:

- Dead Loads: overburden stresses on the LTS containment pipe should not exceed 3,100 psf; for a soil unit weight conservatively estimated at 125 pcf this equates to a soil thickness of 25 ft over the crown of the containment pipe.

- Live Loads: the minimum depth overburden to support a 40,000 lb wheel load is 3 ft. This wheel load is conservative based on the list of equipment provided by FDF and shown in Table 5-1. If the construction contractor uses any equipment with a potentially heavier wheel load than that due to the equipment identified in Table 5-1, the required depth of cover should be increased based on recommendations from the design engineer.

9.4 Pipe Materials for Future Construction

Experience observing installation and welding of SDR 26 HDPE pipe suggests that pipe of greater wall thickness will better maintain roundness during installation and will be easier to join, using butt-fusion methods, electrofusion couplings, or extrusion welded sleeves. Thicker pipe is also less affected by construction impact, extended melt time during electrofusion joining, and inadvertent pressure application. For these reasons, GeoSyntec recommends that future LTS construction utilize HDPE pipe with a maximum 17 for both the containment pipe and carrier pipe.

9.5 Procedures for Joining Pipe

The preferred method of joining pipe is the butt fusion method. The method requires that the pipe end be capable of being physically brought together using a butt fusion welding machine (i.e., the two sections of pipe are not fixed). In the situation when containment pipe ends cannot be brought together an alternate joining procedure is required. The recommended alternate joining procedure for the carrier pipe is by installing an electrofusion coupling. The recommended alternative joining procedure for the containment pipe is an extrusion welded sleeve for fixed conditions as defined in Section 3 of this report. For moveable conditions, electrofusion couplings may be preferred.

Recommended procedures for joining pipe using electrofusion coupling methods and extrusion-welded sleeves are presented in Appendix I of this report. These procedures are more detailed than those called out in Section 02605 of the technical specifications and reflect lessons learned as described in this report. As noted above, the butt fusion method is the preferred procedure and work should be sequenced to minimize the number of electrofusion couplings used to the extent possible.

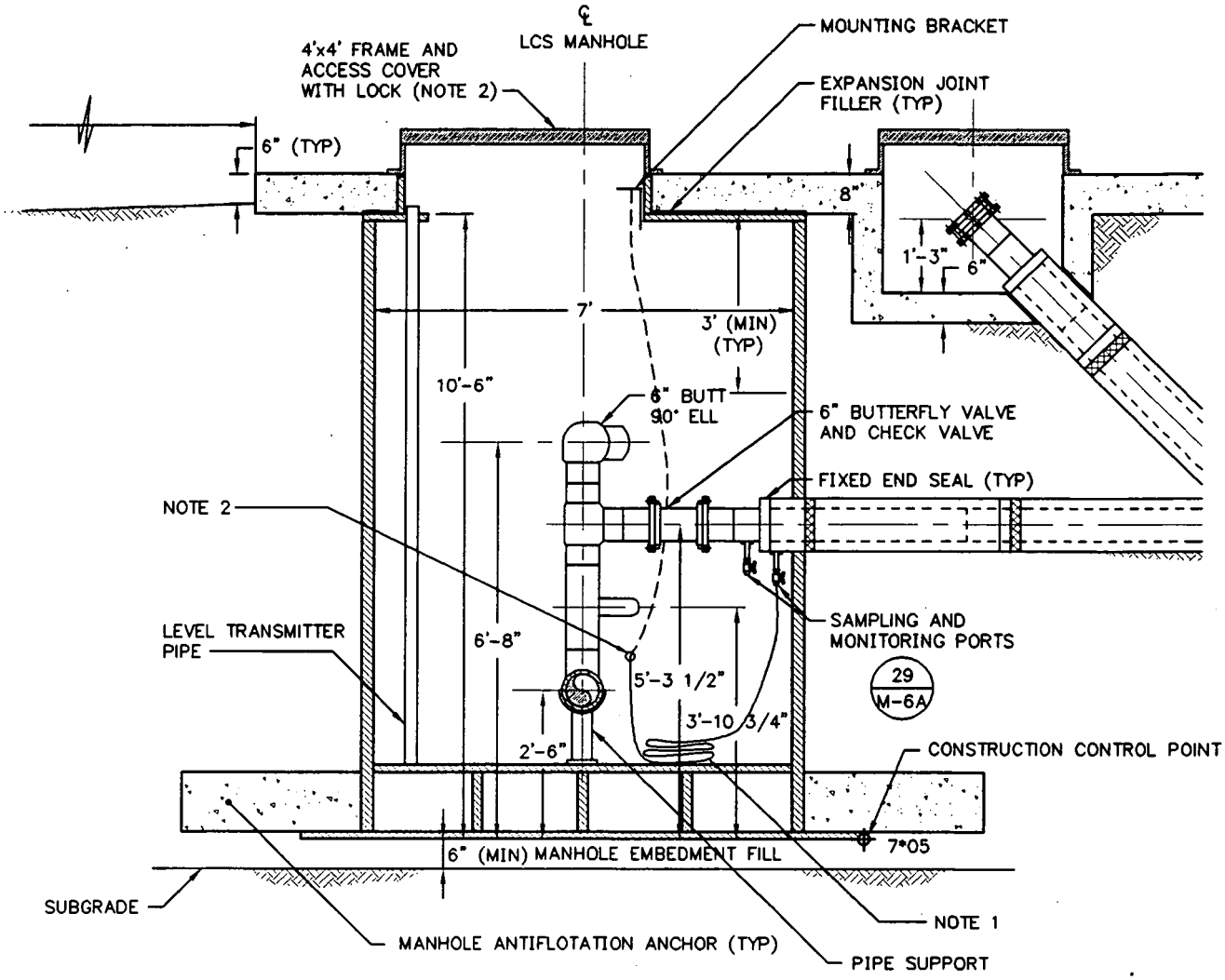
9.6 Procedures for Pressure Testing

Recommended procedures for pressure testing LTS containment pipe and carrier pipe are presented in Appendix J of this report. These procedures are more detailed than those called out in Section 02605 of the technical specifications and reflect lessons learned as described in this report.

9.7 Procedures for Construction Quality Control/Quality Assurance

Recommended procedures for CQC/CQA of LTS pipe pressure testing, installation, and joining are contained in Appendix K of this report. These procedures are more detailed than those contained in the OSDF CQA Plan and reflect lessons learned as described in this report.

MONITORING LCS CONTAINMENT PIPE AT MANHOLE



NOTES:

1. ATTACH TYGON TUBING TO MONITORING PORT OF LCS AND REDUNDANT LCS CONTAINMENT PIPE. INSTALL A SUFFICIENT LENGTH OF TYGON TUBING SO THAT THE FREE ENDS CAN BE RAISED TO 2 FEET ABOVE THE TOP OF THE ACCESS COVER. INSTALL A MOUNTING BRACKET JUST BELOW THE ACCESS COVER. ATTACH A LIGHTWEIGHT CHAIN TO THE FREE END OF THE TYGON TUBING. INSTALL A SUFFICIENT LENGTH OF CHAIN SUCH THAT IT CAN REACH THE MOUNTING BRACKET.

2. HANG EACH TYGON TUBING SUCH THAT THE FREE ENDS ARE AT AN ELEVATION ABOVE THE TRIGGER ELEVATION FOR THE ALARM AND BELOW THE ELEVATION OF THE LCS CONTAINMENT PIPE AND LCS REDUNDANT PIPE. IF LIQUID IS OBSERVED IN THE MANHOLE, RAISE EACH LENGTH OF TUBING SEPARATELY AND EVACUATE WITH A PERISTALTIC PUMP TO DETERMINE WHICH LINE IS THE SOURCE OF LEAKAGE.

132

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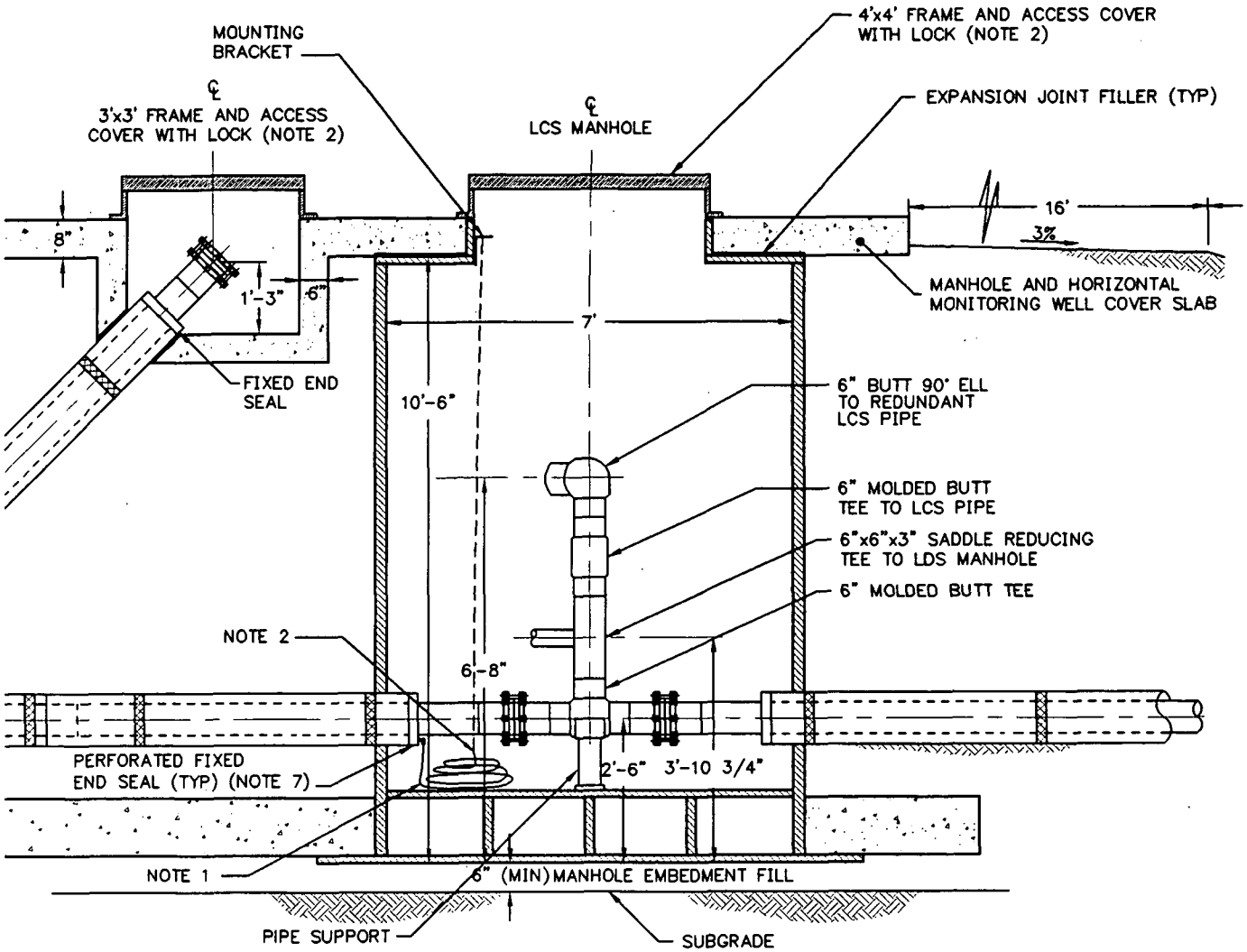
FIGURE NO.	9-1
PROJECT NO.	GQ0573-03.1
DOCUMENT NO.	F9930006
FILE NO.	0573F001

MONITORING LTS CONTAINMENT PIPE AT MANHOLE



NOTES:

1. ATTACH TYGON TUBING TO FITTING ON LTS CONTAINMENT PIPE. INSTALL A SUFFICIENT LENGTH OF TYGON TUBING SO THAT ITS FREE END CAN BE RAISED TO 2 FEET ABOVE THE TOP OF THE ACCESS COVER. INSTALL A MOUNTING BRACKET JUST BELOW THE ACCESS COVER. ATTACH A LIGHTWEIGHT CHAIN TO THE FREE END OF THE TYGON TUBING. INSTALL A SUFFICIENT LENGTH OF CHAIN SUCH THAT IT CAN REACH THE MOUNTING BRACKET.

2. HANG THE TYGON TUBING SUCH THAT THE FREE END IS AT AN ELEVATION ABOVE THE TRIGGER ELEVATION FOR THE ALARM AND BELOW THE ELEVATION OF THE LTS CONTAINMENT PIPE. IF LIQUID IS OBSERVED IN THE MANHOLE, RAISE THE TUBING AND EVACUATE WITH A PERISTALTIC PUMP TO DETERMINE THE AMOUNT OF LEAKAGE.

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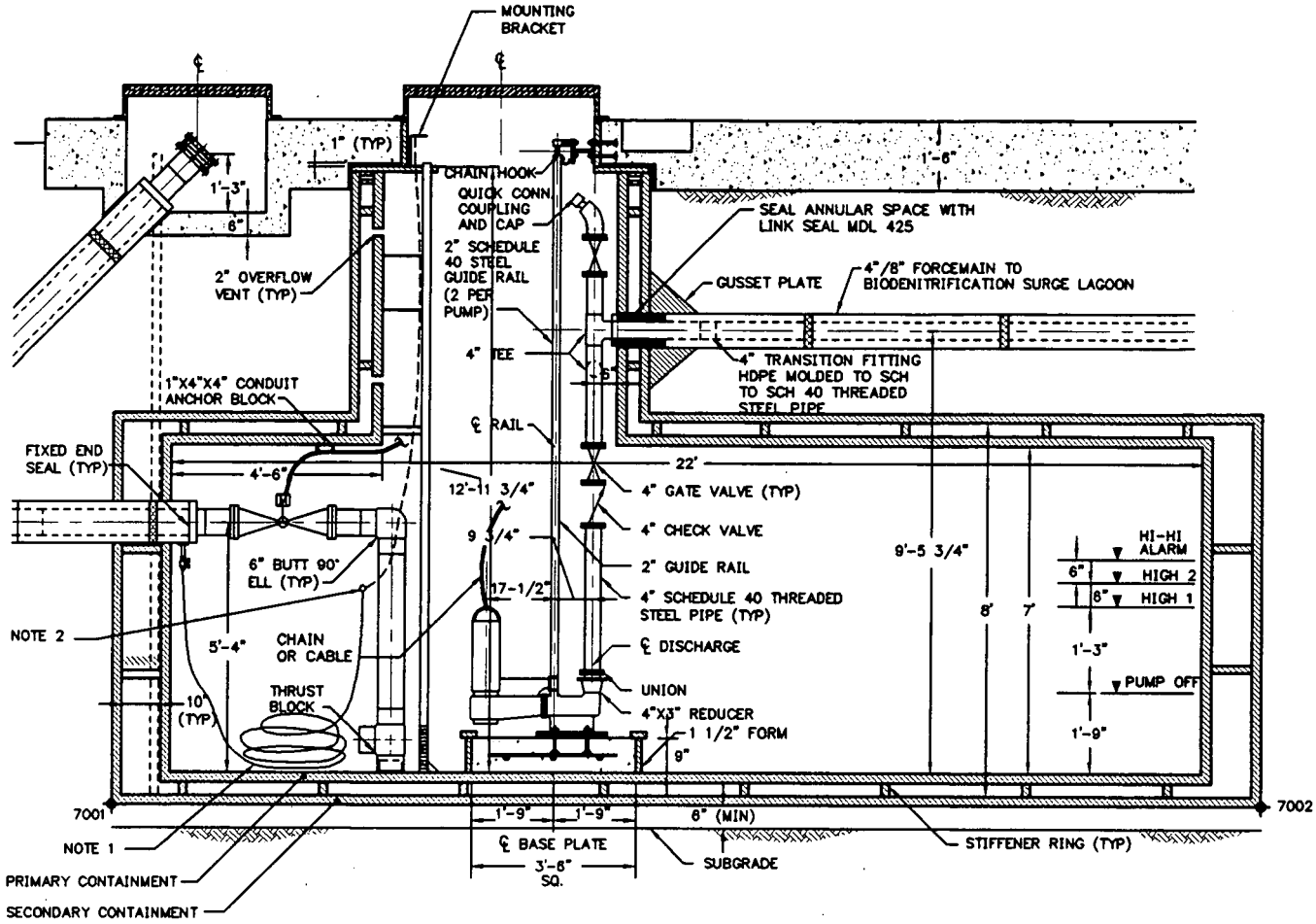
FIGURE NO.	9-2
PROJECT NO.	GQ0573-03.1
DOCUMENT NO.	F9930006
FILE NO.	0573F002

MONITORING LTS CONTAINMENT PIPE AT PERMANENT LIFT STATION



NOTES:

1. ATTACH TYGON TUBING TO FITTING ON LTS CONTAINMENT PIPE. INSTALL A SUFFICIENT LENGTH OF TYGON TUBING SO THAT ITS FREE END CAN BE RAISED TO 2 FEET ABOVE THE TOP OF THE ACCESS COVER. INSTALL A MOUNTING BRACKET JUST BELOW THE ACCESS COVER. ATTACH A LIGHTWEIGHT CHAIN TO THE FREE END OF THE TYGON TUBING. INSTALL A SUFFICIENT LENGTH OF CHAIN SUCH THAT IT CAN REACH THE MOUNTING BRACKET.

2. HANG THE TYGON TUBING SUCH THAT THE FREE END IS AT AN ELEVATION ABOVE THE TRIGGER ELEVATION FOR THE HIGH 2 ALARM AND BELOW THE ELEVATION OF THE LTS CONTAINMENT PIPE. RAISE THE TUBING AND EVACUATE WITH A PERISTALTIC PUMP TO DETERMINE IF LIQUID IS PRESENT IN THE LTS CONTAINMENT PIPE.

134

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FIGURE NO.	9-3
PROJECT NO.	GQ0573-03.1
DOCUMENT NO.	F9930006
FILE NO.	0573F003

2

135

APPENDIX A
SELECT LTS PLANS AND TECHNICAL SPECIFICATIONS

Leachate Conveyance System
Drawings Related to LTS

Pages 138 thru
151 are not in original
Document.

SYMBOLS LEGEND

EXISTING		PROPOSED
	FENCE	
	SECURITY FENCE	
	FENCE GATE	
	PAVED ROAD, SIDEWALK, OR PARKING LOT	
	UNPAVED ROAD, SIDEWALK, OR PARKING LOT	
	CENTERLINE OR BASELINE	
	LEACHATE TRANSMISSION SYSTEM GRAVITY LINE	
	LEACHATE TRANSMISSION SYSTEM TEMPORARY GRAVITY LINE	
	WATER TABLE OR PIEZOMETRIC SURFACE	
	VEGETATION	
	DECIDUOUS TREE	
	CONIFEROUS TREE	
	TRAILER OR BUILDING	
	POST	
	SLOPE INDICATOR	CREST / TOE
	CONSTRUCTION CONTROL POINT	
	CULVERT	
	POWER POLE	
	PIPELINE MARKER SIGN	
	CLEANOUT	
	LEACHATE TRANSMISSION SYSTEM MANHOLES (LDS AND LCS) AND HORIZONTAL MONITORING WELL COVER SLAB	

ABBREVIATIONS

ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BOP	BOTTOM OF PIPE
℄	CENTERLINE
CMP	CORRUGATED METAL PIPE
DIA	DIAMETER
DOE	DEPARTMENT OF ENERGY
DOT	DEPARTMENT OF TRANSPORTATION
EL	ELEVATION
HDPE	HIGH DENSITY POLYETHYLENE
ID	INSIDE DIAMETER
IPS	IRON PIPE SIZE
LCS	LEACHATE COLLECTION SYSTEM
LCS-M*	LEACHATE COLLECTION SYSTEM MANHOLE DESIGNATION
LDS	LEAK DETECTION SYSTEM
LDS-M*	LEAK DETECTION SYSTEM MANHOLE DESIGNATION
LIC	LEVEL INDICATOR CONTROLLER
LT	LEVEL TRANSMITTER
LTS	LEACHATE TRANSMISSION SYSTEM
mA	MILLIAMP
(MAX)	MAXIMUM
(MIN)	MINIMUM
NAD	NORTH AMERICAN DATUM
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NO.	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OSDF	ON-SITE DISPOSAL FACILITY
P	PANEL
PVC	POLY VINYL CHLORIDE
RGS	RIGID GALVANIZED STEEL
(TYP)	TYPICAL
WAC	WASTE ACCEPTANCE CRITERIA
WWF	WELDED WIRE FABRIC
VAC	VOLTS ALTERNATING CURRENT
VDC	VOLTS DIRECT CURRENT
Y	RELAY

CONTOUR LEGEND

EXISTING		PROPOSED
590	EXISTING GROUND ELEVATION (FEET)	
	FINISHED GRADE ELEVATION (FEET)	590

UTILITY LEGEND

EXISTING		PROPOSED
UE	ELECTRICAL DUCT	
	TELEPHONE	
FG	FUEL GAS	
FT	FILTRATE OR EFFLUENT	
OHE	OVERHEAD ELECTRIC	
UG	UNDERGROUND UTILITY	
CE	UNDERGROUND CONCRETE DUCT BANK OR DIRECT BURIAL CABLE	
DW	DRINKING WATER	
SN	SANITARY	

DETAIL AND SECTION IDENTIFICATION LEGEND

SEQUENTIAL DETAIL NUMBER — 29 / M-6A — SHEET ON WHICH ABOVE DETAIL IS PRESENTED

SEQUENTIAL DETAIL NUMBER — 29 / M-5A — SHEET ON WHICH ABOVE DETAIL IS REFERENCED

DETAIL
SAMPLING AND MONITORING PORTS
SCALE: 1" = 2'
F96H-002

EXAMPLE: DETAIL NUMBER 29, WHICH IS PRESENTED ON SHEET M-6A, WAS REFERENCED ON SHEET M-5A.

C / M-5A — SHEET ON WHICH ABOVE SECTION IS PRESENTED

C / M-5A — SECTION LETTER

SECTION LETTER — C / M-5A — SHEET ON WHICH ABOVE SECTION IS REFERENCED

SECTION
LCS MANHOLE AT CELLS 2 AND 3
SCALE: 1" = 2'
F96H-002

EXAMPLE: SECTION LETTER "C", WHICH IS PRESENTED ON SHEET M-5A, WAS REFERENCED ON SHEET M-5A.

GENERAL NOTES

NOTES:

1. TOPOGRAPHIC MAP BASED ON 1992 SITE FLYOVER.
2. ELEVATIONS ARE IN FEET ABOVE SEA LEVEL DATUM. (NOTE: "SEA LEVEL DATUM" REFERS TO THE NATIONAL GEODETIC VERTICAL DATUM [NGVD].)
3. GRID COORDINATE SYSTEM CORRESPONDS TO STATE PLANAR NORTH AMERICAN DATUM (NAD) 1983 OHIO SOUTH.
4. DETAILS ARE SHOWN TO SCALE AS NOTED EXCEPT FOR THE GEOSYNTHETICS, WHICH ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.
5. SURVEY COORDINATES AND DIMENSIONS SHOWN SHALL BE USED FOR CONSTRUCTION. DRAWING SHALL NOT BE SCALED TO OBTAIN LOCATIONS AND DIMENSIONS.
6. THE TERM "IMPACTED MATERIAL" REFERS TO THAT MATERIAL MEETING OSDF WASTE ACCEPTANCE CRITERIA (WAC) DESTINED FOR OSDF DISPOSAL.
7. THE TERM "SUBCONTRACTOR" REFERS TO THE PARTY SUBCONTRACTED BY FERMCO TO CONSTRUCT THE LEACHATE CONVEYANCE SYSTEM FOR THE OSDF.
8. THIS LEGEND AND SYMBOLS DRAWING APPLIES TO THE FOLLOWING DRAWINGS: G-8A; G-8B; G-8C; E-4A; E-7A; M-2A; M-4A; M-5A; M-6A; M-6B; M-9A; S-1A; S-3A; AND S-5B.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	LA	JRM	BJ	KWC	RB

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERMCO Environmental Restoration Management Corporation — FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT: LEACHATE CONVEYANCE SYSTEM - 2194

TITLE: LEGEND AND SYMBOLS

138

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Rudolph Bonaparte
SIGNATURE

8 Oct 1996
DATE

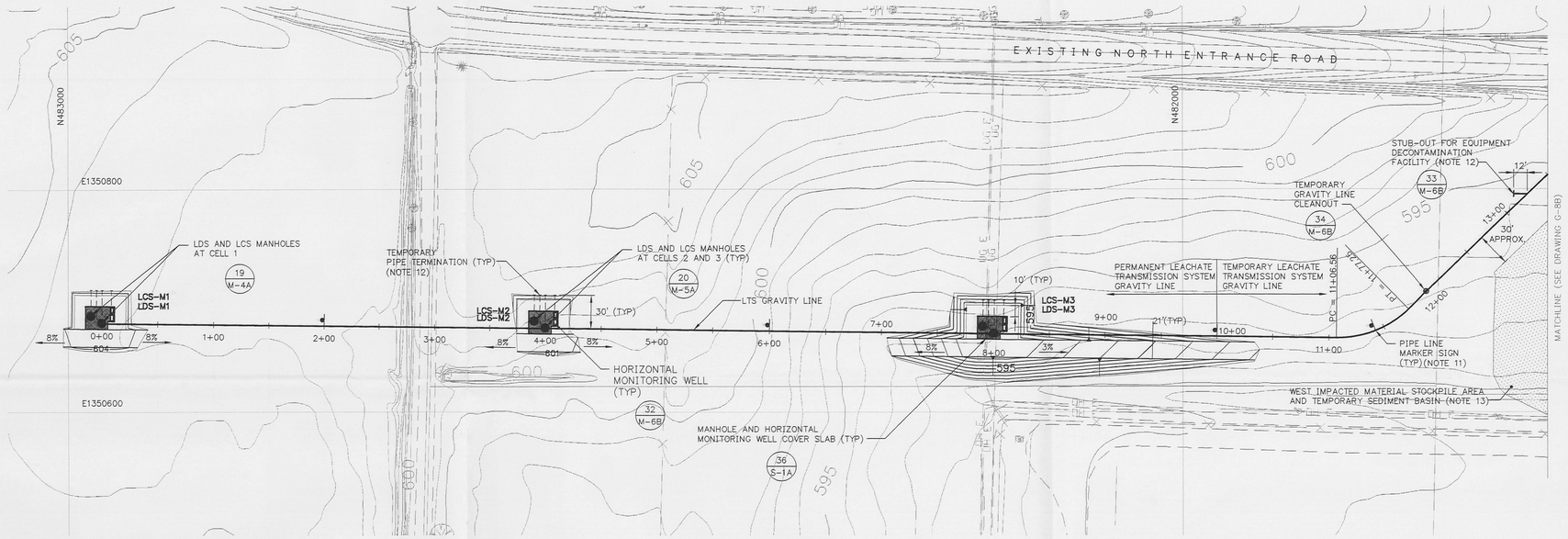
STATE OF OHIO — RUDOLPH BONAPARTE — E-56679 — REGISTERED PROFESSIONAL ENGINEER
SEAL

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-X-00056
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2017
SHEET NO.:	X-2A
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

M:\GAGADD2\GE3900.22\F96-2017 Mon Oct 07 13:13:04 1996 URSULAM



1 PLAN
LEACHATE TRANSMISSION SYSTEM
SCALE: 1" = 50'

LEGEND

500	EXISTING GROUND ELEVATION (FEET)
600	FINISHED GROUND ELEVATION (FEET)
	POWER POLE
	PIPE LINE MARKER SIGN
	TEMPORARY GRAVITY LINE CLEANOUT
	LEACHATE TRANSMISSION SYSTEM MANHOLES (LDS AND LCS) AND HORIZONTAL MONITORING WELL COVER SLAB

CURVE REPORT – LTS GRAVITY LINE

Project: Fermco
Horizontal Alignment Station and Curve Report.
Alignment: LTS-line Desc: LEACHATE TRANSMISSION SYSTEM

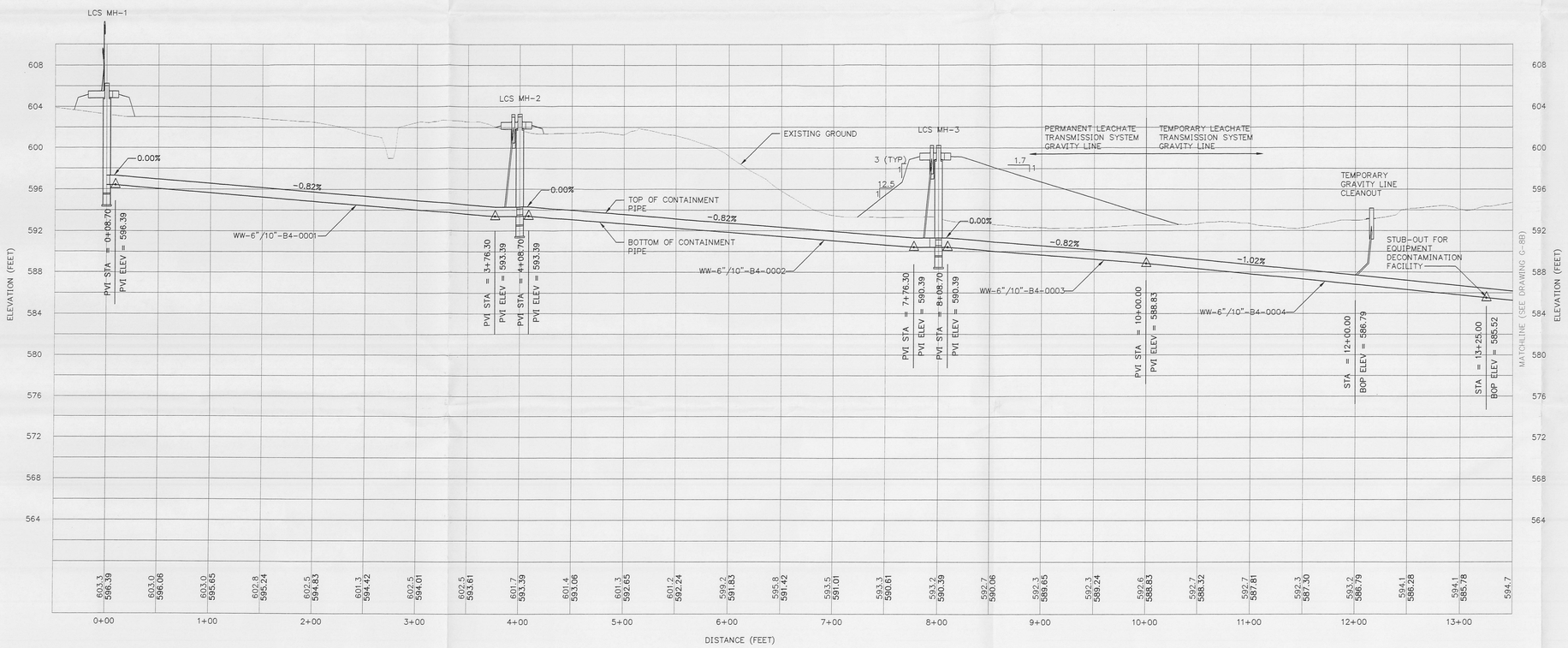
Desc.	Station	Spiral/Curve Data		Northing	Easting
PI	0+00			482969.33	1350680.21
	Length:	1143.84	Course:	S 00-42-01 W	
PI	11+43.84			481825.58	1350666.23
	Length:	286.98	Course:	S 44-17-59 E	
	Delta:	45-00-00			
		Tangent Data			
	0+00			482969.33	1350680.21
	11+06.56			481862.85	1350666.68
	Length:	1106.56	Course:	S 00-42-01 W	
		Circular Curve Data			
PC	11+06.56			481862.85	1350666.68
RP				481861.75	1350756.68
PT	11+77.25			481798.90	1350692.26
	Delta:	45-00	Type:	LEFT	
	Radius:	90.00	DOC:	63-40	
	Length:	70.69	Tangent:	37.28	
	Mid-Ord:	6.85	External:	7.42	
	Chord:	68.88	Course:	S 21-47-59 E	
	Ex:	7.42			
PI	14+26.95			481620.19	1350866.66
	Length:	1903.94	Course:	S 01-33-34 W	
	Delta:	45-51-33			

NOTES:

1. TOPOGRAPHIC MAP BASED ON 1992 SITE FLYOVER.
2. ELEVATIONS ARE IN FEET ABOVE SEA LEVEL DATUM. (NOTE: "SEA LEVEL DATUM" REFERS TO THE NATIONAL GEODETIC VERTICAL DATUM [NGVD]).
3. GRID COORDINATE SYSTEM CORRESPONDS TO STATE PLANAR NORTH AMERICAN DATUM (NAD) 1983 OHIO SOUTH.
4. LOCATION AND ELEVATION OF EXISTING ACTIVE AND ABANDONED UNDERGROUND UTILITIES SHOWN ON CONSTRUCTION DRAWINGS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE SUBCONTRACTOR PRIOR TO START OF CONSTRUCTION. SUBCONTRACTOR SHALL PROVIDE TEMPORARY BRACING AND SUPPORT AS REQUIRED TO MAINTAIN AND PROTECT EXISTING ACTIVE UTILITIES. VERIFY THAT UTILITIES IDENTIFIED BY THE CONSTRUCTION MANAGER AS ABANDONED ARE SUCH PRIOR TO EXCAVATION. REMOVE ABANDONED UTILITIES WITHIN LIMIT OF EXCAVATION.
5. SUBCONTRACTOR SHALL FIELD VERIFY EXISTING TOPOGRAPHY PRIOR TO START OF CONSTRUCTION.
6. LEACHATE TRANSMISSION SYSTEM TEMPORARY GRAVITY LINE SHALL HAVE A MINIMUM SOIL COVER OF 36 INCHES.
7. CONSTRUCTION CONTROL POINTS FOR MANHOLES ARE PROVIDED ON DRAWINGS M-4A AND M-5A.
8. CLEARING ZONE SHALL NOT EXCEED 15 FEET FROM LIMIT OF EXCAVATION WORK.
9. CONSTRUCTION CONTROL POINTS FOR HORIZONTAL MONITORING WELLS ARE PROVIDED ON DRAWING M-6B.
10. PIPING AND INSTRUMENTATION CODE INFORMATION ARE PROVIDED ON DRAWING M-2A.
11. SUBCONTRACTOR SHALL INSTALL PIPE LINE MARKER SIGNS AT THE LOCATIONS SHOWN ON CONSTRUCTION DRAWINGS. PIPE LINE MARKER SIGNS SHALL BE INSTALLED IN ACCORDANCE WITH DRAWING 92X-5900-G-00257.
12. SUBCONTRACTOR SHALL SURVEY AND RECORD LOCATION OF TEMPORARY END OF PIPE AND PROVIDE ABOVE GROUND MARKER FOR FUTURE REFERENCE IN ACCORDANCE WITH SECTION 02100 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS. SUBCONTRACTOR SHALL PROTECT TEMPORARY END OF PIPE TO PREVENT LIQUID, SOIL OR DEBRIS FROM ENTERING PIPE AT ALL TIMES DURING INSTALLATION AND SUBSEQUENT EXCAVATION FOR FUTURE EXTENSION OF PIPE.

ARE PART OF A SEPARATE DESIGN PACKAGE. THE APPROXIMATE AREA OF THESE STRUCTURES IS SHOWN FOR CLARITY. SEE REFERENCE DRAWING 75X-5500-G-00441.

14. REMOVE ABANDONED UTILITIES WITHIN LIMIT OF EXCAVATION.



2 PROFILE
LEACHATE TRANSMISSION SYSTEM
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

CERTIFIED FOR CONSTRUCTION

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	LA	JRM	BJ	KWC	RB

SCALE IN FEET: 5 2.5 0 5 10 — 50 25 0 50 100

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:

FERMCO — FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE: LEACHATE TRANSMISSION SYSTEM
PLAN AND PROFILE DATA I 139

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

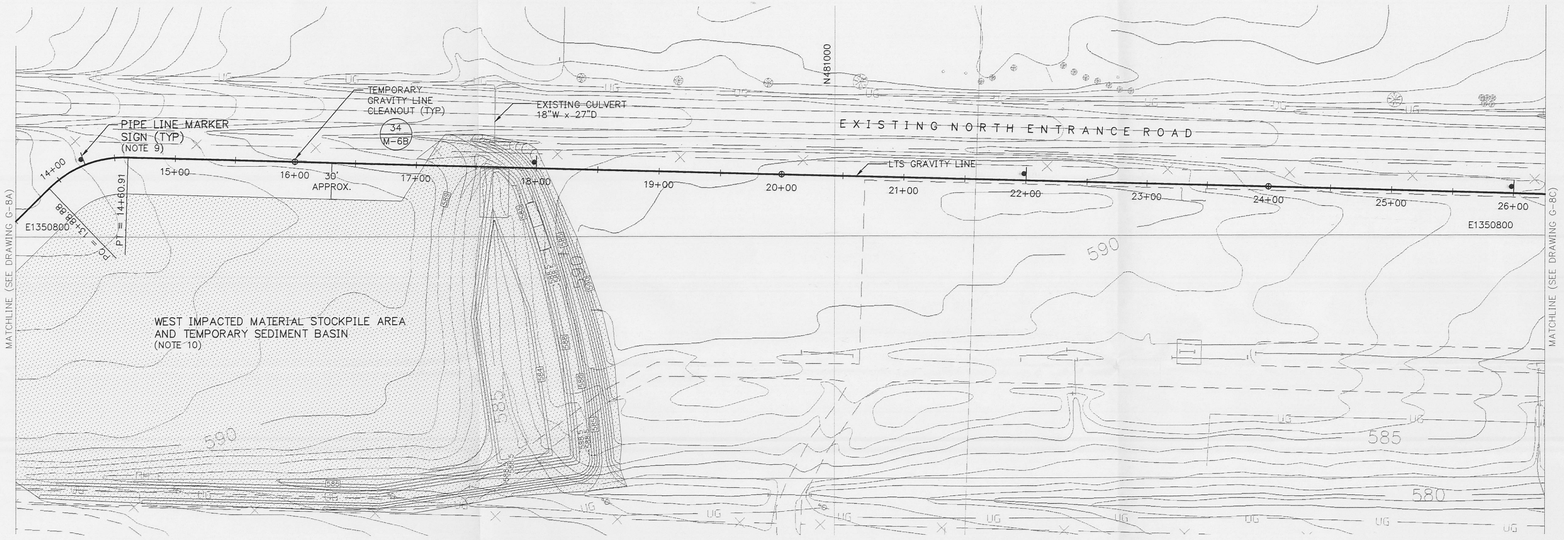
Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO — RUDOLPH BONAPARTE — E-56679 — REGISTERED PROFESSIONAL ENGINEER

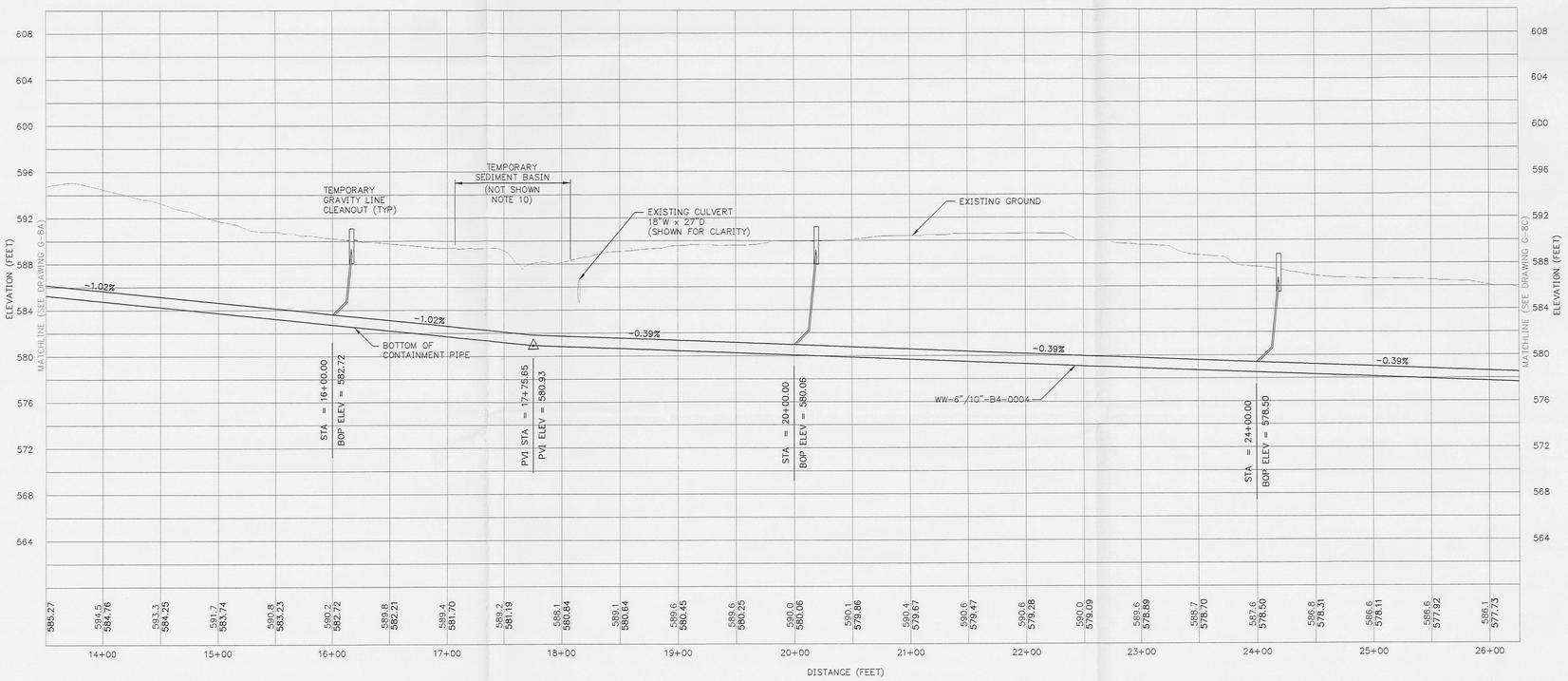
GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-G-00057
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2009
SHEET NO.:	G-8A
REVISION NO.:	0

M:\GAGAUDO2\GE3900.22\F96-2009 Mon Oct 07 12:18:07 1996 FERMCO/DUNN



3 / - PLAN
LEACHATE TRANSMISSION SYSTEM
SCALE: 1" = 50'



4 / - PROFILE
LEACHATE TRANSMISSION SYSTEM
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

LEGEND

600	EXISTING GROUND ELEVATION (FEET)
600	FINISHED GROUND ELEVATION (FEET)
	POWER POLE
	PIPE LINE MARKER SIGN
	TEMPORARY GRAVITY LINE CLEANOUT

CURVE REPORT – LTS GRAVITY LINE

Project: Fermco
Horizontal Alignment Station and Curve Report.
Alignment: LTS-line Desc: LEACHATE TRANSMISSION SYSTEM

Desc.	Station	Spiral/Curve Data		Northing	Easting
PI	14+26.95			481620.19	1350866.66
	Length:	1903.94	Course:	S 01-33-34 W	
	Delta:	45-51-33			
		Tangent Data			
	11+77.25			481798.90	1350692.26
	13+88.88			481647.44	1350840.07
	Length:	211.63	Course:	S 44-17-59 E	
		Circular Curve Data			
PC	13+88.88			481647.44	1350840.07
RP				481584.58	1350775.65
PT	14+60.91			481582.13	1350865.62
	Delta:	45-52	Type:	RIGHT	
	Radius:	90.00	DOC:	63-40	
	Length:	72.04	Tangent:	38.07	
	Mid-Ord:	7.11	External:	7.72	
	Chord:	70.13	Course:	S 21-22-13 E	
	Es:	7.72			
PI	33+26.78			479716.95	1350814.85
	Length:	281.61	Course:	S 45-42-01 W	
	Delta:	44-08-27			
		Tangent Data			
	14+60.91			481582.13	1350865.62
	32+90.29			479753.43	1350815.84

NOTES:

1. TOPOGRAPHIC MAP BASED ON 1992 SITE FLYOVER.
2. ELEVATIONS ARE IN FEET ABOVE SEA LEVEL DATUM. (NOTE: "SEA LEVEL DATUM" REFERS TO THE NATIONAL GEODETIC VERTICAL DATUM [NGVD]).
3. GRID COORDINATE SYSTEM CORRESPONDS TO STATE PLANAR NORTH AMERICAN DATUM (NAD) 1983 OHIO SOUTH.
4. LOCATION AND ELEVATION OF EXISTING ACTIVE AND ABANDONED UNDERGROUND UTILITIES SHOWN ON CONSTRUCTION DRAWINGS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE SUBCONTRACTOR PRIOR TO START OF CONSTRUCTION. SUBCONTRACTOR SHALL PROVIDE TEMPORARY BRACING AND SUPPORT AS REQUIRED TO MAINTAIN AND PROTECT EXISTING ACTIVE UTILITIES. VERIFY THAT UTILITIES IDENTIFIED BY THE CONSTRUCTION MANAGER AS ABANDONED ARE SUCH PRIOR TO EXCAVATION. REMOVE ABANDONED UTILITIES WITHIN LIMIT OF EXCAVATION.
5. SUBCONTRACTOR SHALL FIELD VERIFY EXISTING TOPOGRAPHY PRIOR TO START OF CONSTRUCTION.
6. LEACHATE TRANSMISSION SYSTEM TEMPORARY GRAVITY LINE SHALL HAVE A MINIMUM SOIL COVER OF 36 INCHES.
7. CLEARING ZONE SHALL NOT EXCEED 15 FEET FROM LIMIT OF EXCAVATION WORK.
8. PIPING AND INSTRUMENTATION CODE INFORMATION ARE PROVIDED ON DRAWING M-2A.
9. SUBCONTRACTOR SHALL INSTALL PIPE LINE MARKER SIGNS AT THE LOCATIONS SHOWN ON CONSTRUCTION DRAWINGS. PIPE LINE MARKER SIGNS SHALL BE INSTALLED IN ACCORDANCE WITH DRAWING 92X-5900-G-00257.
10. CONSTRUCTION OF WEST IMPACTED MATERIAL STOCKPILE AND TEMPORARY SEDIMENT BASIN ARE PART OF A SEPARATE DESIGN PACKAGE. THE APPROXIMATE AREA OF THESE STRUCTURES IS SHOWN FOR CLARITY. SEE REFERENCE DRAWING 75X-5500-G-00441.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	LA	JRM	BJ	KWC	RB

SCALE IN FEET (5 2.5 0 5 10)
SCALE IN FEET (50 25 0 50 100)

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE: LEACHATE TRANSMISSION SYSTEM
PLAN AND PROFILE DATA II 148

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-G-00058
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2009
SHEET NO.:	G-8B
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

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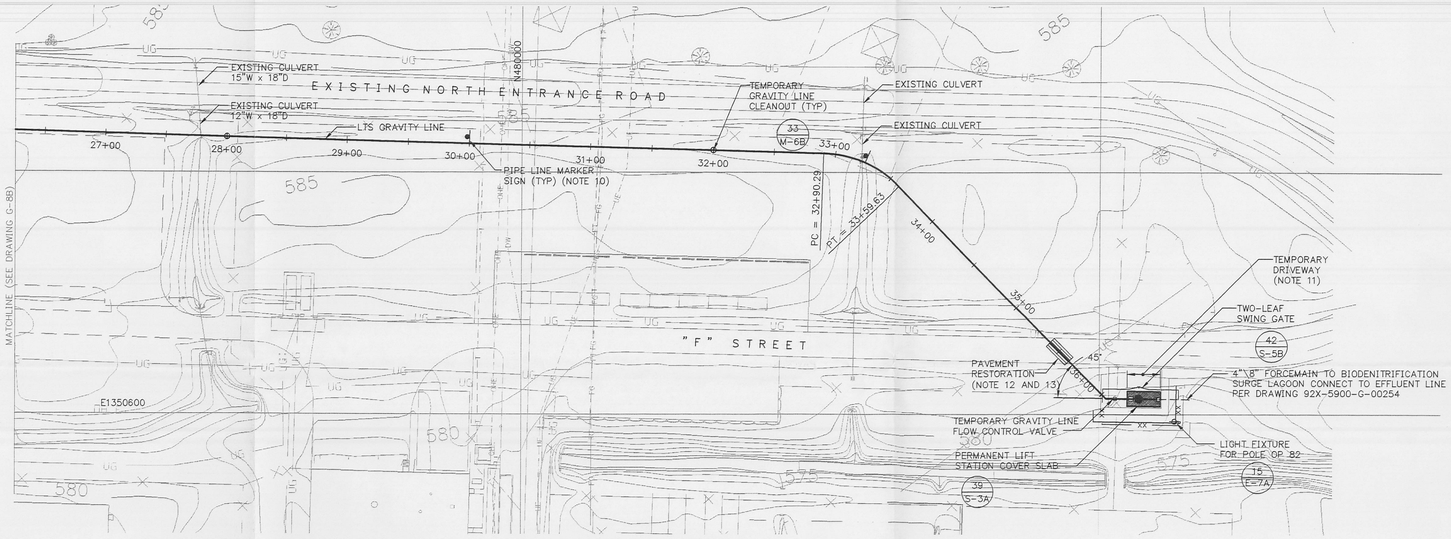
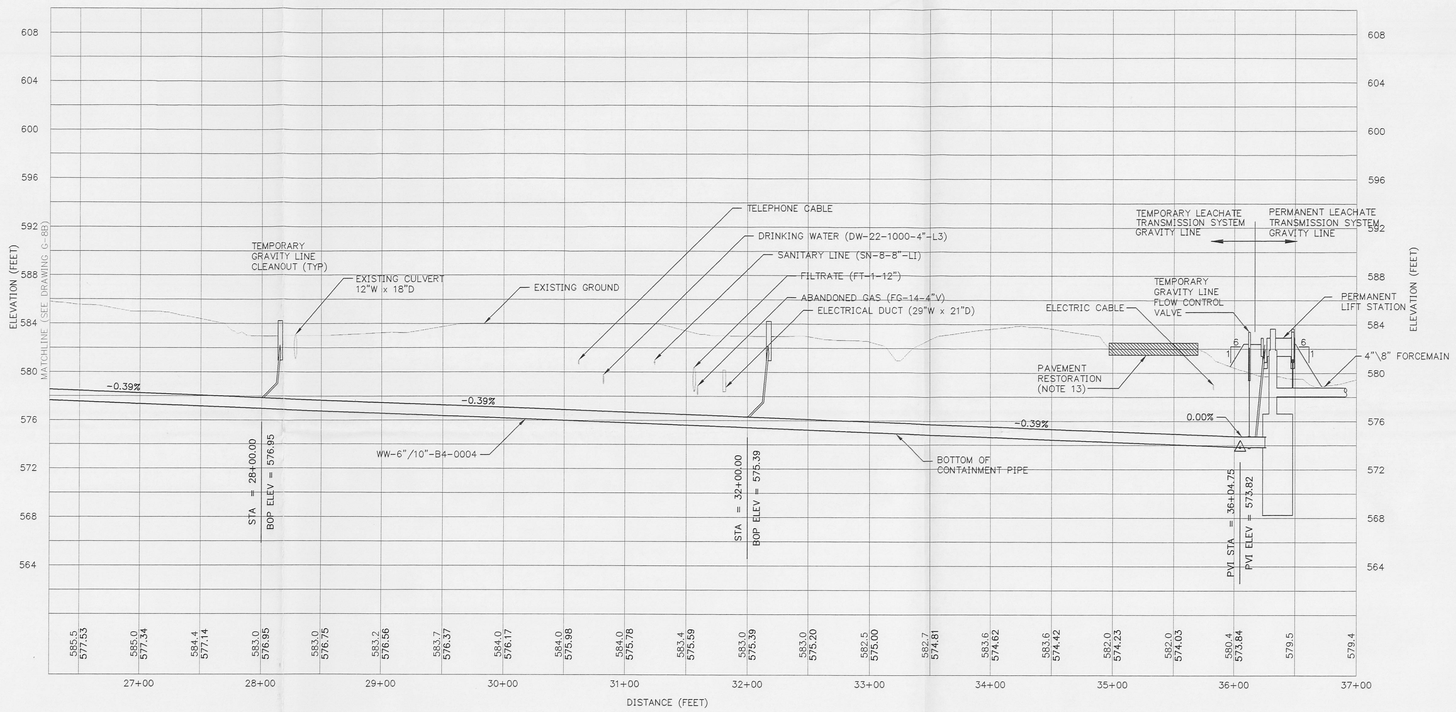


5 / - PLAN
LEACHATE TRANSMISSION SYSTEM
SCALE: 1" = 50'



6 / - PROFILE
LEACHATE TRANSMISSION SYSTEM
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

LEGEND

600	EXISTING GROUND ELEVATION (FEET)
600	FINISHED GROUND ELEVATION (FEET)
	POWER POLE
	PIPE LINE MARKER SIGN
	TEMPORARY GRAVITY LINE CLEANOUT
xx xx xx	SECURITY FENCE
	PERMAMENT LIFT STATION COVER SLAB

CURVE REPORT – LTS GRAVITY LINE

Project: Fermco
Horizontal Alignment Station and Curve Report.
Alignment: LTS-line Desc: LEACHATE TRANSMISSION SYSTEM

Desc.	Station	Spiral/Curve Data		Northing	Easting
PI	33+26.78			479716.95	1350814.85
	Length:	281.61	Course:	S 45-42-01 W	
	Delta:	44-08-27			
		Tangent Data			
	14+60.91			481582.13	1350865.62
	32+90.29			479753.43	1350815.84

Desc.	Station	Spiral/Curve Data		Northing	Easting
	Length:	1829.38	Course:	S 01-33-34 W	
		Circular Curve Data			
PC	32+90.29			479753.43	1350815.84
RP				479755.88	1350725.87
PT	33+59.63			479691.46	1350788.73
	Delta:	44-08	Type:	RIGHT	
	Radius:	90.00	DOC:	63-40	
	Length:	69.34	Tangent:	36.49	
	Mid-Ord:	6.59	External:	7.12	
	Chord:	67.63	Course:	S 23-37-47 W	
	Es:	7.12			
PI	36+04.75			479520.27	1350613.30
	Length:	21.51	Course:	S 00-42-01 W	
	Delta:	45-00-00			
		Tangent Data			
	33+59.63			479691.46	1350788.73
	36+04.75			479520.27	1350613.30
	Length:	245.12	Course:	S 45-42-01 W	
PI	36+26.26			479498.76	1350613.04
		Tangent Data			
	36+04.75			479520.27	1350613.30
	36+26.26			479498.76	1350613.04
	Length:	21.51	Course:	S 00-42-01 W	

NOTES:

1. TOPOGRAPHIC MAP BASED ON 1992 SITE FLYOVER.
2. ELEVATIONS ARE IN FEET ABOVE SEA LEVEL DATUM. (NOTE: "SEA LEVEL DATUM" REFERS TO THE NATIONAL GEODETIC VERTICAL DATUM [NGVD]).
3. GRID COORDINATE SYSTEM CORRESPONDS TO STATE PLANAR NORTH AMERICAN DATUM (NAD) 1983 OHIO SOUTH.
4. LOCATION AND ELEVATION OF EXISTING ACTIVE AND ABANDONED UNDERGROUND UTILITIES SHOWN ON CONSTRUCTION DRAWINGS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE SUBCONTRACTOR PRIOR TO START OF CONSTRUCTION. SUBCONTRACTOR SHALL PROVIDE TEMPORARY BRACING AND SUPPORT AS REQUIRED TO MAINTAIN AND PROTECT EXISTING ACTIVE UTILITIES. VERIFY THAT UTILITIES IDENTIFIED BY THE CONSTRUCTION MANAGER AS ABANDONED ARE SUCH PRIOR TO EXCAVATION. REMOVE ABANDONED UTILITIES WITHIN LIMIT OF EXCAVATION.
5. SUBCONTRACTOR SHALL FIELD VERIFY EXISTING TOPOGRAPHY PRIOR TO START OF CONSTRUCTION.
6. LEACHATE TRANSMISSION SYSTEM TEMPORARY GRAVITY LINE SHALL HAVE A MINIMUM SOIL COVER OF 36 INCHES.
7. CONSTRUCTION CONTROL POINTS FOR PERMANENT LIFT STATION ARE PROVIDED ON DRAWING M-9A.
8. CLEARING ZONE SHALL NOT EXCEED 15 FEET FROM LIMIT OF EXCAVATION WORK.
9. PIPING AND INSTRUMENTATION CODE INFORMATION ARE PROVIDED ON DRAWING M-2A.
10. SUBCONTRACTOR SHALL INSTALL PIPE LINE MARKER SIGNS AT THE LOCATIONS SHOWN ON CONSTRUCTION DRAWINGS. PIPE LINE MARKER SIGNS SHALL BE INSTALLED IN ACCORDANCE WITH DRAWING 92X-5900-G-00257.
11. TEMPORARY DRIVEWAY SHALL EXTEND FROM PERMANENT LIFT STATION COVER SLAB TO EDGE OF "F" STREET. SEE DRAWING M-9A FOR TEMPORARY DRIVEWAY CONSTRUCTION REQUIREMENTS.
12. SUBCONTRACTOR SHALL NOT DISRUPT OR BLOCK TRAFFIC FLOW ON "F" STREET EXCEPT DURING TIMES APPROVED BY CONSTRUCTION MANAGER.
13. SUBCONTRACTOR SHALL RESTORE DISTURBED AREA OF "F" STREET AFTER INSTALLATION OF LTS TEMPORARY GRAVITY LINE IN ACCORDANCE WITH DETAIL SHOWN ON DRAWING 92X-5900-G-00257.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	LA	JRM	BJ	KWC	RB

SCALE IN FEET (5 2.5 0 5 10) SCALE IN FEET (50 25 0 50 100)

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERMCO Restoration Management Corporation — FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE: LEACHATE TRANSMISSION SYSTEM
PLAN AND PROFILE DATA III 141

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

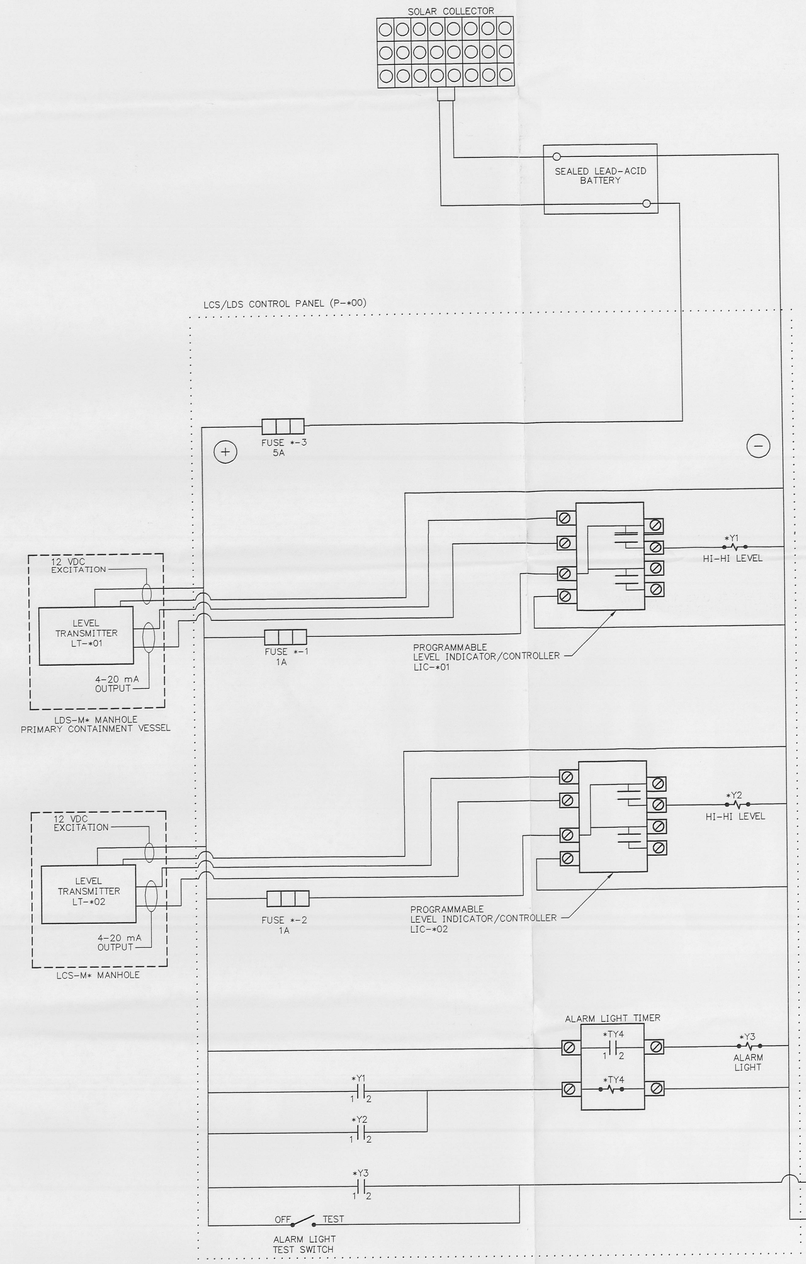
STATE OF OHIO — RUDOLPH BONAPARTE — E-56679 — REGISTERED PROFESSIONAL ENGINEER
SEAL

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

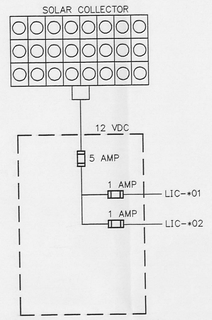
FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	92X-5900-G-00059
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2009
SHEET NO.:	G-8C
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

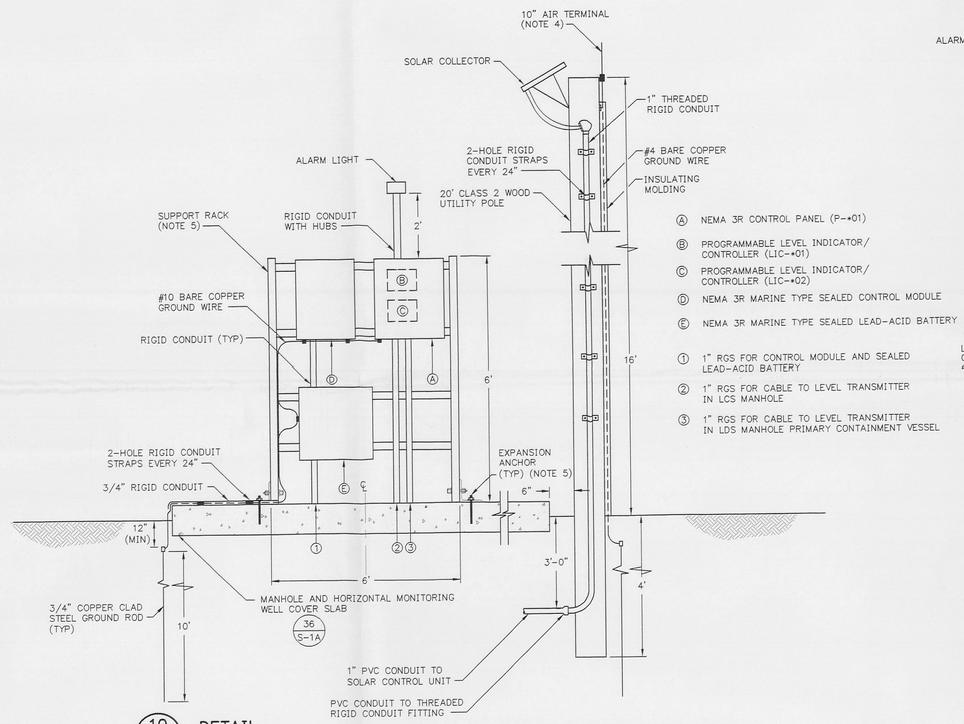
M:\GAUDIO\GE3900.22\F96-2009 Mon Oct 07 12:52:12 1996 FERMCO/DUNN



7 — DETAIL
LDS AND LCS MANHOLES CONTROL SCHEMATIC
SCALE: NTS



8 — DETAIL
LDS AND LCS MANHOLE SINGLE LINE DIAGRAM
SCALE: NTS



Ⓐ NEMA 3R CONTROL PANEL (P-*01)
Ⓑ PROGRAMMABLE LEVEL INDICATOR/ CONTROLLER (LIC-*01)
Ⓒ PROGRAMMABLE LEVEL INDICATOR/ CONTROLLER (LIC-*02)
Ⓓ NEMA 3R MARINE TYPE SEALED CONTROL MODULE
Ⓔ NEMA 3R MARINE TYPE SEALED LEAD-ACID BATTERY
① 1" RGS FOR CONTROL MODULE AND SEALED LEAD-ACID BATTERY
② 1" RGS FOR CABLE TO LEVEL TRANSMITTER IN LCS MANHOLE
③ 1" RGS FOR CABLE TO LEVEL TRANSMITTER IN LDS MANHOLE PRIMARY CONTAINMENT VESSEL

10 S-1A — DETAIL
LDS AND LCS MANHOLES ELECTRIC SERVICE PANEL AND POLE
(NOTE 3)
SCALE: NTS
XREF F96H2013

RELAY NUMBER - *Y1 : LDS-M* HI-HI LEVEL

COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ENERGIZE (*TY4) ALARM LIGHT TIMER

NOTES:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

RELAY NUMBER - *Y2 : LCS-M* HI-HI LEVEL

COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ENERGIZE (*TY4) ALARM LIGHT TIMER

NOTES:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

RELAY NUMBER - *Y3 : LDS-M*, LCS-M* ALARM LIGHT ENERGIZED

COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ALARM LIGHT (LA-*01) ON

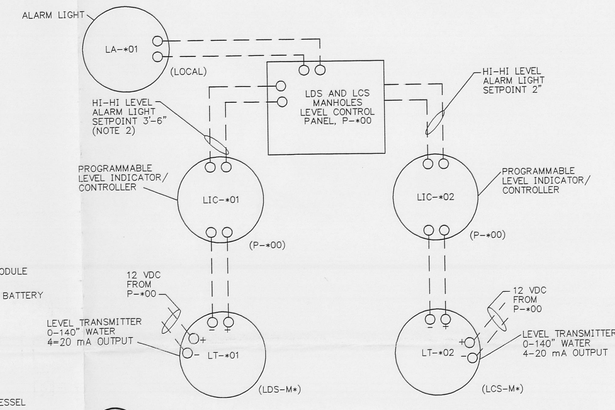
NOTES:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

RELAY NUMBER - *TY4 : LDS-M*, LCS-M* ALARM LIGHT TIMER

COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ACTIVATE ALARM LIGHT TIMER ENERGIZE (*Y3) ALARM LIGHT

NOTES:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

9 — DETAIL
LDS AND LCS MANHOLE CONTROL RELAY CONTACT CONFIGURATION
SCALE: NTS



11 — DETAIL
LDS AND LCS MANHOLES LEVEL INSTRUMENTATION LOOP DIAGRAM
SCALE: NTS
XREF F96H1012

NOTES:

1. THE "*" SYMBOL REPRESENTS THE APPROPRIATE MANHOLE NUMBER FOR EACH CELL.
2. SETPOINT SHALL BE ADJUSTED IN ACCORDANCE WITH THE SYSTEMS PLAN.
3. MECHANICAL AND ELECTRICAL CONSTRUCTION SHALL BE IN ACCORDANCE WITH DIVISIONS 15 AND 16 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
4. AIR TERMINAL SHALL BE IN ACCORDANCE WITH SECTION 16370 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
5. SUPPORT RACK SHALL BE IN ACCORDANCE WITH SECTION 16050 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	LF	AHF	BJ	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERMCO Fernald Environmental Restoration Management Corporation

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE: LEACHATE TRANSMISSION SYSTEM ELECTRICAL DETAILS I

142

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95P5005028
FERMCO DRAWING NO.:	90X-6000-E-00060
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2004
SHEET NO.:	E-4A
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

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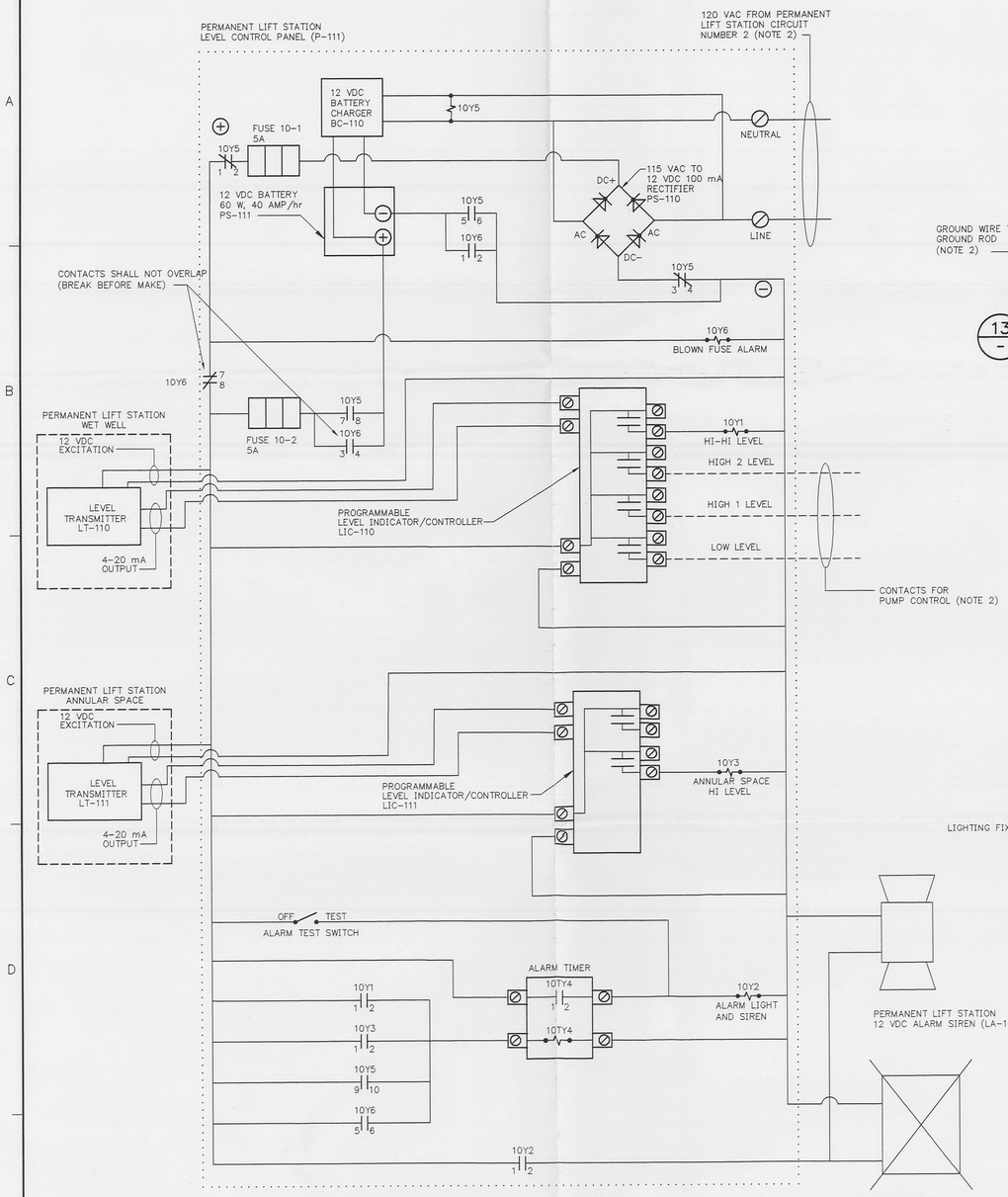
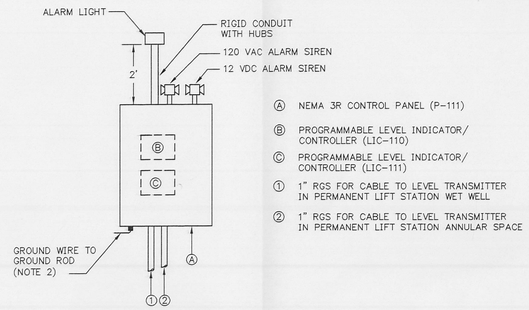




13 DETAIL
PERMANENT LIFT STATION CONTROL PANEL
(NOTE 1)
SCALE: NTS

RELAY NUMBER - 10Y1 : PERMANENT LIFT STATION HI-HI LEVEL			
COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ENERGIZE (10TY4) ALARM TIMER
3 - 4		X	MOTOR OPERATED VALVE (V-001) CLOSE

NOTE:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

RELAY NUMBER - 10Y2 : PERMANENT LIFT STATION ALARMS ON			
COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ALARM LIGHT (LA-110) AND 12 VDC ALARM SIREN (LA-111B) ON
3 - 4	X		120 VAC ALARM SIREN (LA-111A) ON

NOTE:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

RELAY NUMBER - 10Y3 : PERMANENT LIFT STATION ANNULAR SPACE HI-LEVEL			
COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ENERGIZE (10TY4) ALARM TIMER
3 - 4		X	MOTOR OPERATED VALVE (V-001) CLOSE

NOTE:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

RELAY NUMBER - 10TY4: PERMANENT LIFT STATION ALARM TIMER			
COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		ENERGIZE (10Y2) ALARM LIGHT AND SIREN

NOTE:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

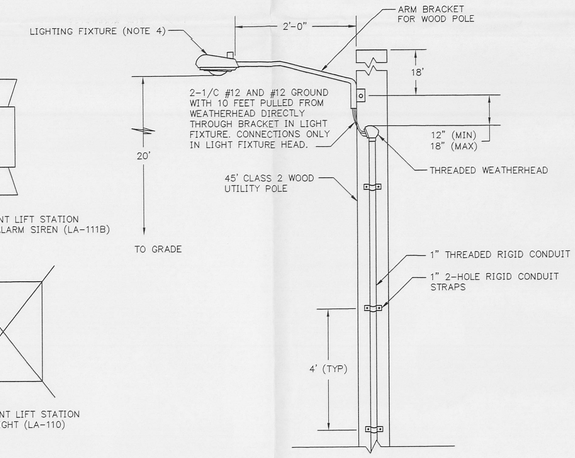
RELAY NUMBER - 10Y5: PERMANENT LIFT STATION LOSS OF 120 VAC POWER			
COIL L 120 VAC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2	X		NORMAL 12 VDC HOT LEG
3 - 4	X		NORMAL 12 VDC COMMON
5 - 6		X	BATTERY 12 VDC COMMON
7 - 8		X	BATTERY 12 VDC HOT LEG
9 - 10		X	ENERGIZE (10TY4) ALARM TIMER

NOTE:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

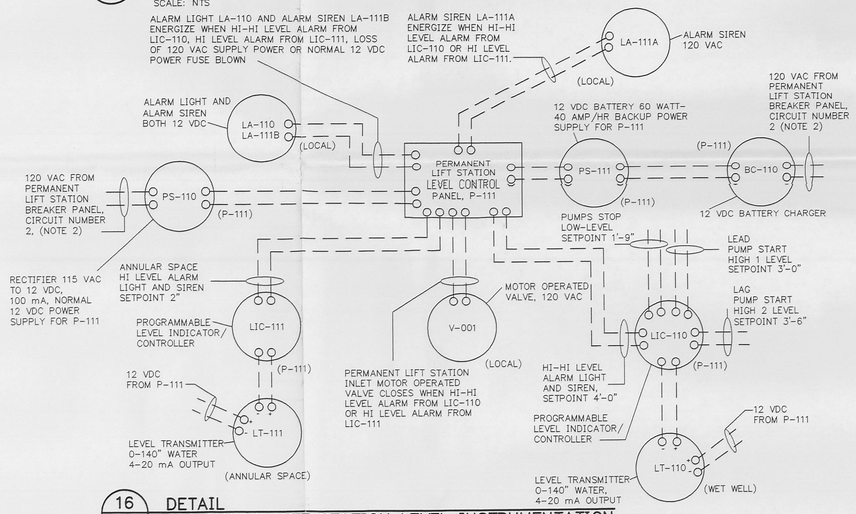
RELAY NUMBER - 10Y6: PERMANENT LIFT STATION NORMAL 12 VDC POWER FUSE BLOWN			
COIL L 12 VDC N	NORMALLY OPEN	NORMALLY CLOSED	CONTACT FUNCTION
CONTACTS #	NO	NC	
1 - 2		X	BATTERY 12 VDC COMMON
3 - 4		X	BATTERY 12 VDC HOT LEG
5 - 6		X	ENERGIZE (10TY4) ALARM TIMER
7 - 8	X		BLOWN FUSE LATCH

NOTE:
1. RELAY SHOWN IN DE-ENERGIZED SHELF STATE

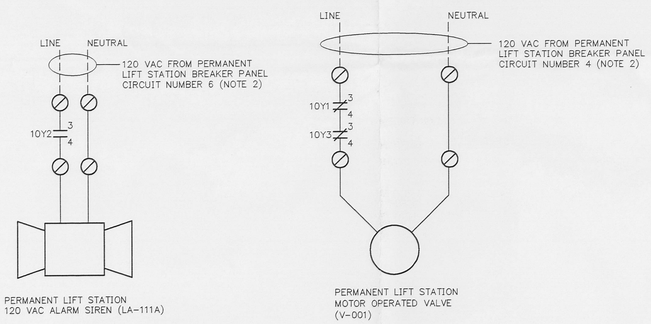
14 DETAIL
PERMANENT LIFT STATION CONTROL RELAY CONTACT CONFIGURATION
SCALE: NTS



15 DETAIL
LIGHT FIXTURE FOR POLE OP 82
(NOTE 3)
SCALE: NTS



16 DETAIL
PERMANENT LIFT STATION LEVEL INSTRUMENTATION LOOP DIAGRAM FOR LOOP L-110
SCALE: NTS



12 DETAIL
PERMANENT LIFT STATION CONTROL SCHEMATIC
SCALE: NTS

NOTES:

1. REFER TO DRAWING E-00325 FOR PANEL LOCATION ON EQUIPMENT RACK.
2. REFER TO DRAWING E-00324 FOR DISTRIBUTION PANEL DETAILS.
3. REFER TO DRAWINGS E-00500 AND E-00501 FOR POLE LOCATION AND ELECTRIC POWER DETAILS.
4. FURNISH OUTDOOR AREA DIE CAST ALUMINUM LIGHTING FIXTURE WITH 70-WATT HIGH PRESSURE SODIUM LAMP. BALLAST WIRED FOR 110 VAC, PHOTOCELL CONTROL FOR DUSK TO DAWN OPERATION, GLASS REFRACTOR LENS, POLE-MOUNTED ON 2 FOOT ALUMINUM ARM. FURNISH COMPLETE WITH FIXTURE, LAMP, ARM, HOOK-UP WIRE, PHOTO CONTROL AND MOUNTING HARDWARE.

CERTIFIED FOR CONSTRUCTION

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	LF	AHF	BJ	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERMCO Fernald Environmental Restoration Management Corporation

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE: LEACHATE TRANSMISSION SYSTEM ELECTRICAL DETAILS IV 143

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

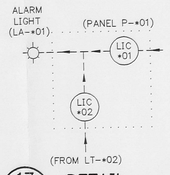
Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER

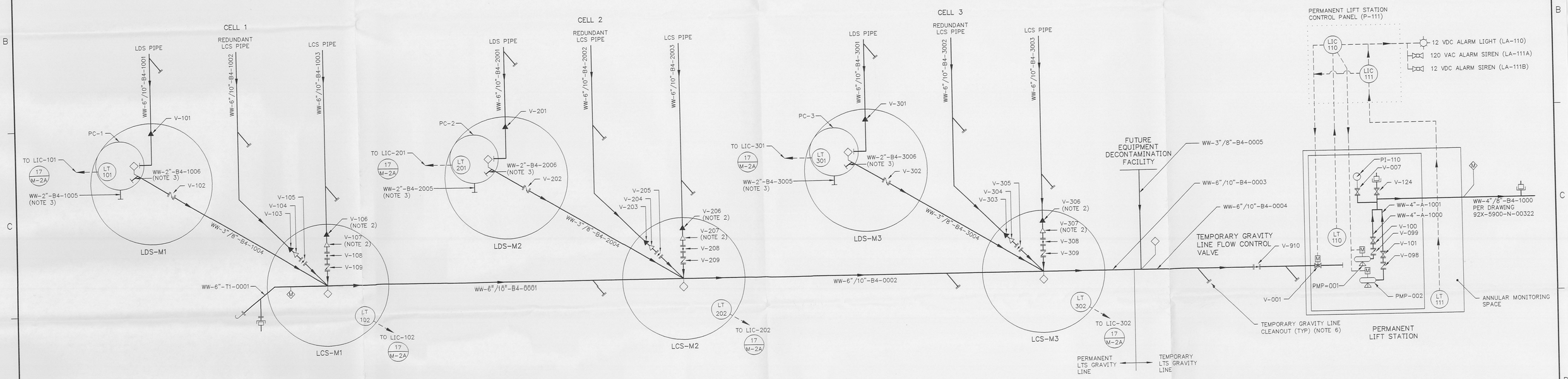
GeoSyntec Consultants
1150 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-E-00061
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2005
SHEET NO.:	E-7A
REVISION NO.:	0

M:\CACADD2\GE3900.22\F96-2005 Mon Oct 07 11:36:18 1996 John C.



17 / M-2A DETAIL
LCS AND LDS MANHOLE ALARM CONTROL PANEL
(NOTE 4)
SCALE: NTS



18 / – DETAIL
PIPING AND INSTRUMENTATION DIAGRAM
(NOTE 1 AND 5)
SCALE: NTS

SYMBOLS

- BALL VALVE
- BLIND FLANGE
- BUTTERFLY VALVE (CLOSED POSITION)
- BUTTERFLY VALVE (OPEN POSITION)
- GATE VALVE
- CHECK VALVE
- ELECTRICAL CONTROL PANEL
- ELECTRICAL SIGNAL
- FLOW DIRECTION
- LOCAL MOUNTED INSTRUMENT
- MATERIAL CODE BREAK
- MONITORING PORT (WITH VALVE) (NOTE 2)
- MOTOR OPERATOR
- OPEN PIPE END
- PIPE SIZE BREAK
- QUICK CONNECT
- SAMPLING PORT (WITH VALVE) (NOTE 2)
- SUBMERSIBLE PUMP
- VENT WITH SCREEN
- PRESSURE INDICATOR

PIPING CODES

MC - PS - MT - LN

MC = FLOW MEDIUM CODE
PS = NOMINAL PIPE SIZE (CARRIER/CONTAINMENT)
MT = PIPE MATERIAL STANDARD ABBREVIATION
LN = PIPELINE NUMBER

EXAMPLE: WW-6"/10"-B4-0006

WW = WASTEWATER
6"/10" = 6"/10" NOMINAL PIPE SIZE (CARRIER/CONTAINMENT)
B4 = HDPE
0006 = PIPELINE NUMBER 0006

INSTRUMENT CODES

AAA - BCC

AAA = EQUIPMENT ABBREVIATION
B = CELL NUMBER
CC = INSTRUMENT NUMBER

EXAMPLE: V-304

V = VALVE
3 = CELL 3
04 = INSTRUMENT NUMBER 04

STANDARD ABBREVIATIONS

A	A53, GR. A, SEAMLESS STEEL PIPE
B4	HIGH DENSITY POLYETHYLENE
T1	TYPE 316L, STAINLESS STEEL PIPE
WW	WASTEWATER

EQUIPMENT ABBREVIATIONS

FM	FORCEMAIN
LA	ALARM LIGHT
LIC	PROGRAMMABLE LEVEL INDICATOR/CONTROLLER
LT	LEVEL TRANSMITTER
P	CONTROL PANEL
PC	PRIMARY CONTAINMENT VESSEL
PI	PRESSURE INDICATOR
PMP	SUBMERSIBLE PUMP
QC	QUICK CONNECT
V	VALVE

NOTES:

1. SUBCONTRACTOR SHALL PROVIDE OPERATION MANUALS AND PERFORM START-UP OF THE LEACHATE TRANSMISSION SYSTEM IN ACCORDANCE WITH SECTIONS 02605 AND 15000 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
2. MONITORING PORT IS LOCATED ON 10-INCH CONTAINMENT PIPE. SAMPLING PORT IS LOCATED ON 6-INCH CARRIER PIPE.
3. PUMP SUCTION AND DISCHARGE CONNECTIONS SHALL BE USED TO CONVEY LIQUID FROM THE PRIMARY CONTAINMENT VESSEL TO THE LEACHATE TRANSMISSION SYSTEM PIPE:
   LINE NUMBERS WW-2"-B4-*005: SUCTION
   LINE NUMBERS WW-2"-B4-*006: DISCHARGE
4. THE "*" SYMBOL REPRESENTS THE APPROPRIATE MANHOLE NUMBER FOR EACH CELL.
5. EACH VALVE SHALL BE IDENTIFIED WITH ITS UNIQUE VALVE NUMBER. LABEL SIZE SHALL BE MINIMUM 1/2-INCH LETTERS. LABELS SHALL BE CONSTRUCTED USING NON-REFLECTIVE MATERIALS. BLACK CHARACTERS ON A WHITE BACKGROUND OR VICE-VERSA OFFER THE BEST CONTRAST AND LEGIBILITY. IF WHITE-ON-BLACK ENGRAVED LABELS ARE USED, A CLEAR OVERCOATING SHALL BE APPLIED TO PREVENT DIRT FROM OBSCURING THE WHITE-ENGRAVED CHARACTERS. LABELS AND ATTACHMENTS SHALL BE CORROSION RESISTANT, AND SHALL BE COMPATIBLE WITH THE MATERIAL AND ENVIRONMENT WHERE THEY ARE USED.
6. SEVEN CLEANOUTS SHALL BE INSTALLED ALONG TEMPORARY GRAVITY LINE AS SHOWN ON DRAWINGS G-8A, G-8B, AND G-8C.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	BJ	JRM	LA	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:

FERMCO FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE: LEACHATE TRANSMISSION SYSTEM PIPING AND INSTRUMENTATION DIAGRAM 144

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER

Rudolph Bonaparte
SIGNATURE

8 Oct 1996
DATE

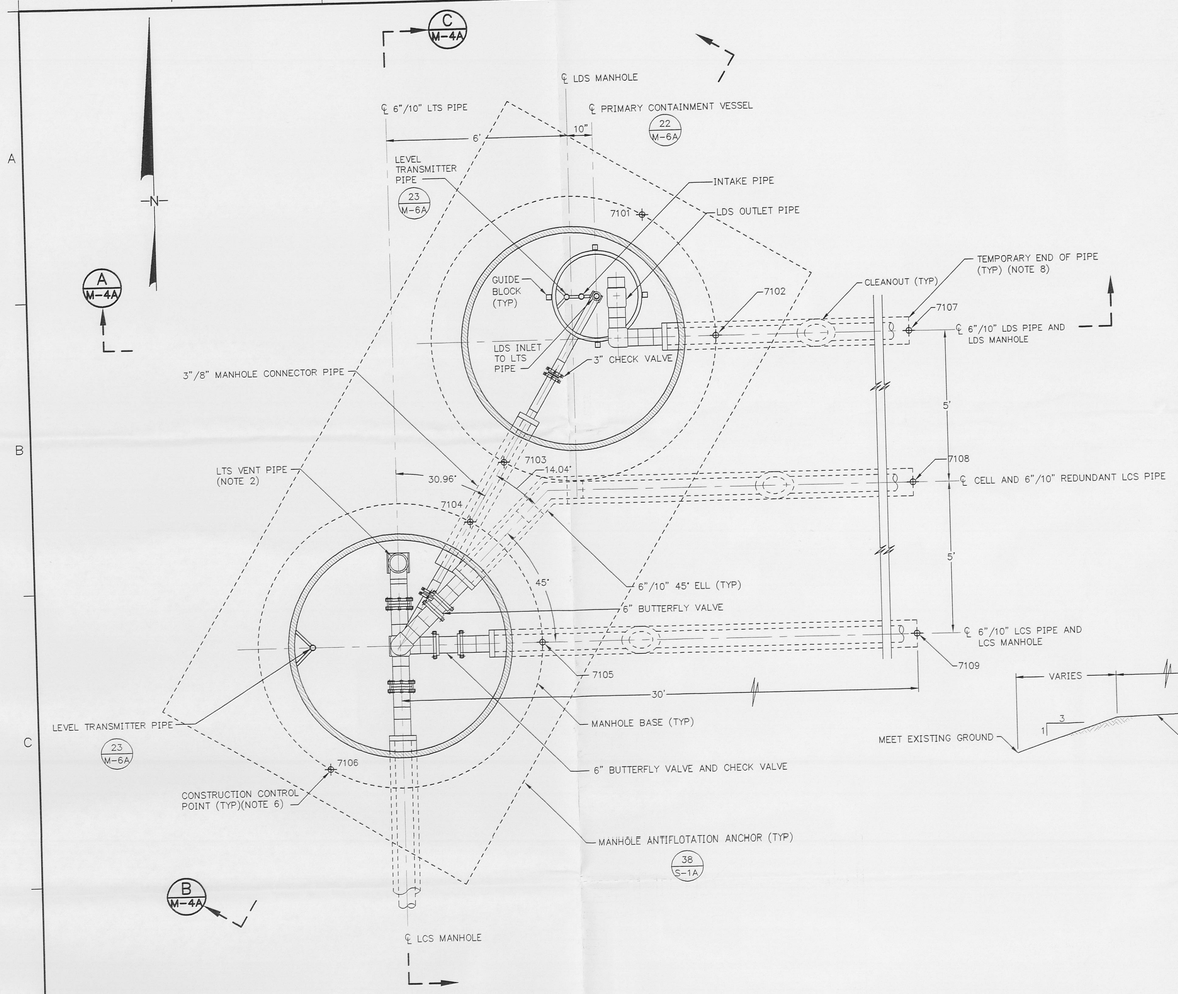
SEAL

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

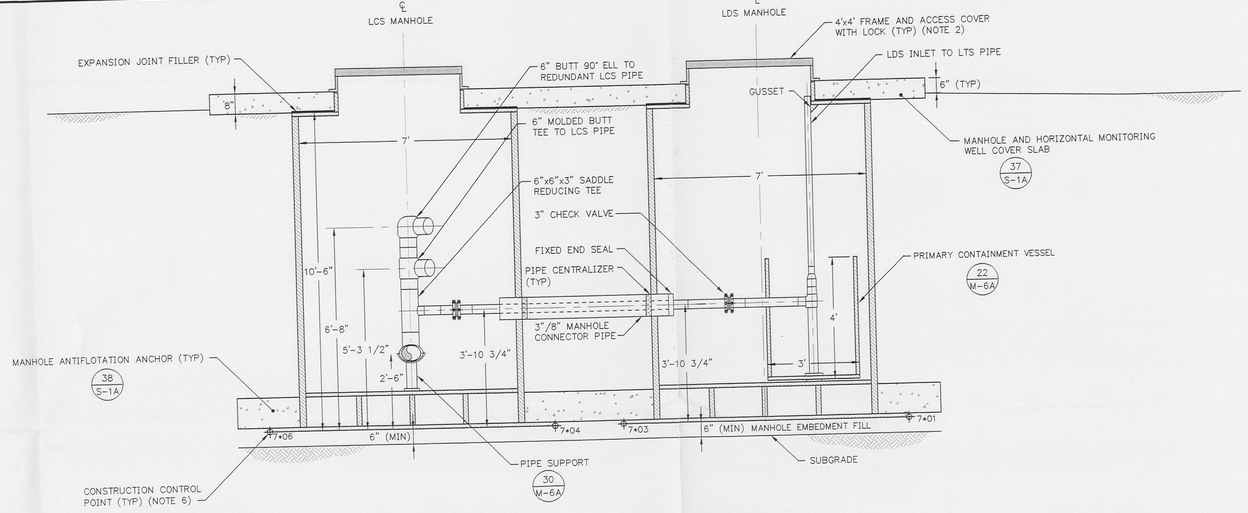
FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-M-00062
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2003
SHEET NO.:	M-2A
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

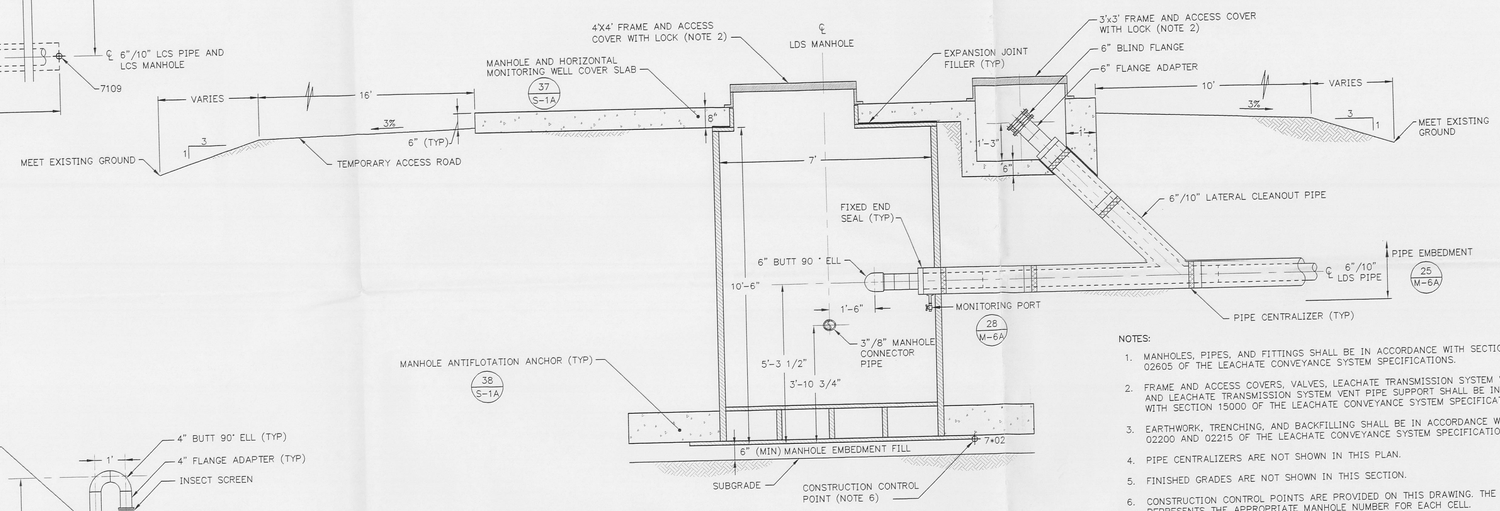
J:\AUTO2\GE3900\22\F96-2003 Mon Oct 07 12:22:32 1996 John C.



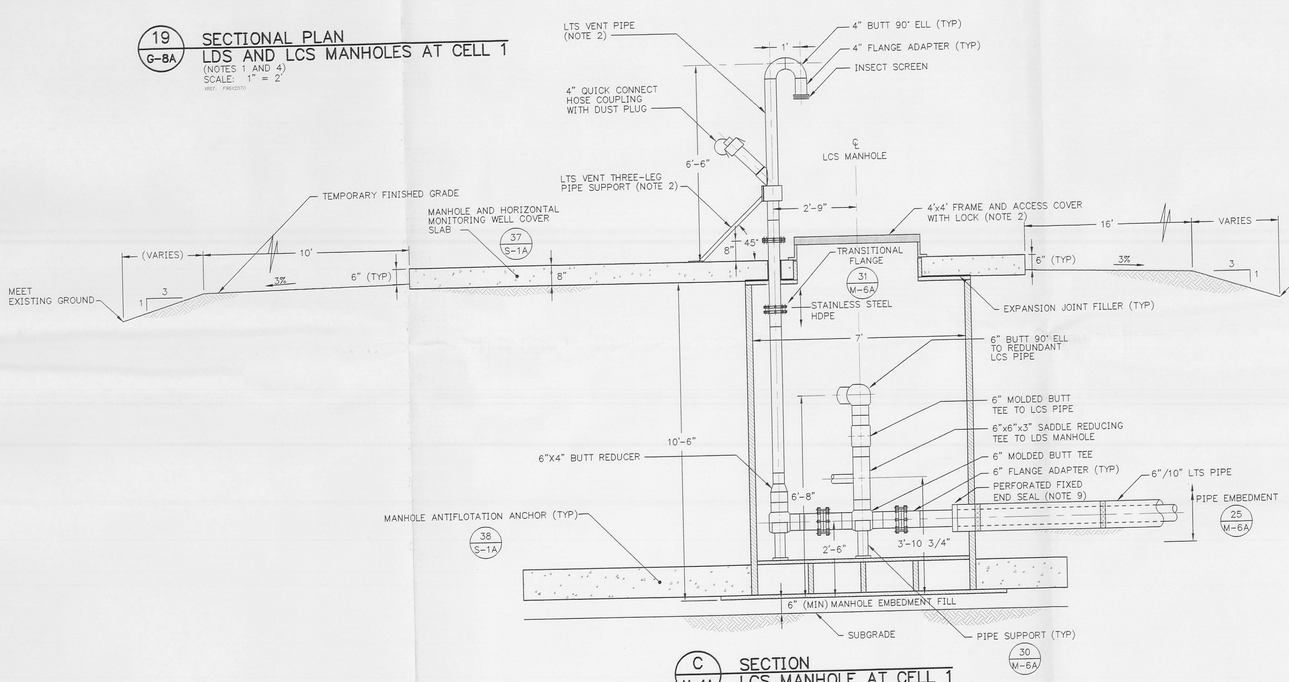
19 G-8A **SECTIONAL PLAN**
LDS AND LCS MANHOLES AT CELL 1
(NOTES 1 AND 4)
SCALE: 1" = 2'
XREF: F96X2070



B M-4A **SECTION (TYPICAL)**
LCS AND LDS MANHOLES AT CELLS 1 THROUGH 3
(NOTES 3 AND 5)
SCALE: 1" = 2'
XREF: F96X2071



A M-4A **SECTION (TYPICAL)**
LDS MANHOLE AT CELLS 1 THROUGH 3
(NOTES 3 AND 7)
SCALE: 1" = 2' (NOTE 4)
XREF: F96X2069



C M-4A **SECTION**
LCS MANHOLE AT CELL 1
(NOTE 3)
SCALE: 1" = 2'
XREF: F96X2072

NOTES:

1. MANHOLES, PIPES, AND FITTINGS SHALL BE IN ACCORDANCE WITH SECTION 02605 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
2. FRAME AND ACCESS COVERS, VALVES, LEACHATE TRANSMISSION SYSTEM VENT PIPE, AND LEACHATE TRANSMISSION SYSTEM VENT PIPE SUPPORT SHALL BE IN ACCORDANCE WITH SECTION 15000 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
3. EARTHWORK, TRENCHING, AND BACKFILLING SHALL BE IN ACCORDANCE WITH SECTIONS 02200 AND 02215 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
4. PIPE CENTRALIZERS ARE NOT SHOWN IN THIS PLAN.
5. FINISHED GRADES ARE NOT SHOWN IN THIS SECTION.
6. CONSTRUCTION CONTROL POINTS ARE PROVIDED ON THIS DRAWING. THE "+" SYMBOL REPRESENTS THE APPROPRIATE MANHOLE NUMBER FOR EACH CELL.
7. PRIMARY CONTAINMENT VESSEL IS NOT SHOWN IN THIS SECTION.
8. SUBCONTRACTOR SHALL SURVEY AND RECORD LOCATION OF TEMPORARY END OF PIPE AND PROVIDE ABOVE GROUND MARKER FOR FUTURE REFERENCE IN ACCORDANCE WITH SECTION 02100 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS. SUBCONTRACTOR SHALL PROTECT TEMPORARY END OF PIPE TO PREVENT LIQUID, SOIL OR DEBRIS FROM ENTERING PIPE AT ALL TIMES DURING INSTALLATION AND SUBSEQUENT EXCAVATION FOR FUTURE EXTENSION OF PIPE.
9. FIXED END SEAL ON LTS PIPE SHALL BE PERFORATED WITH 6-5/8-INCH DIAMETER HOLES EVENLY SPACED AT 60 DEGREES APART.

LDS AND LCS MANHOLES
CONSTRUCTION CONTROL POINTS

CELL 1 CONTROL POINTS

POINT NO.	NORTHING	EASTING	ELEVATION
7101	482983.26	1350688.79	594.34
7102	482979.20	1350691.03	594.34
7103	482975.26	1350683.86	594.34
7104	482973.33	1350682.67	594.34
7105	482969.28	1350684.91	594.34
7106	482965.33	1350677.74	594.34
7107	482978.97	1350710.33	599.19
7108	482973.97	1350710.26	600.58
7109	482968.97	1350710.20	599.19

CELL 2 CONTROL POINTS

POINT NO.	NORTHING	EASTING	ELEVATION
7201	482583.29	1350683.91	591.34
7202	482579.23	1350686.14	591.34
7203	482575.29	1350678.97	591.34
7204	482573.36	1350677.78	591.34
7205	482569.31	1350680.02	591.34
7206	482565.36	1350672.85	591.34
7207	482579.00	1350705.44	596.19
7208	482574.00	1350705.38	597.58
7209	482569.00	1350705.31	596.19

CELL 3 CONTROL POINTS

POINT NO.	NORTHING	EASTING	ELEVATION
7301	482183.32	1350679.02	588.34
7302	482179.26	1350681.25	588.34
7303	482175.32	1350674.08	588.34
7304	482173.39	1350672.90	588.34
7305	482169.34	1350675.13	588.34
7306	482165.39	1350667.96	588.34
7307	482179.03	1350700.55	593.19
7308	482174.03	1350700.49	594.58
7309	482169.03	1350700.43	593.19

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	BJ	JRM	LA/DS	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERMCO Fernald Environmental Restoration Management Corporation
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT:
LEACHATE CONVEYANCE SYSTEM 2194

TITLE:
LEACHATE TRANSMISSION SYSTEM GRAVITY LINE AND MANHOLE MECHANICAL DETAILS I 145

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Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER
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GEO SYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-5000-M-00063
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2007
SHEET NO.:	M-4A
REVISION NO.:	0

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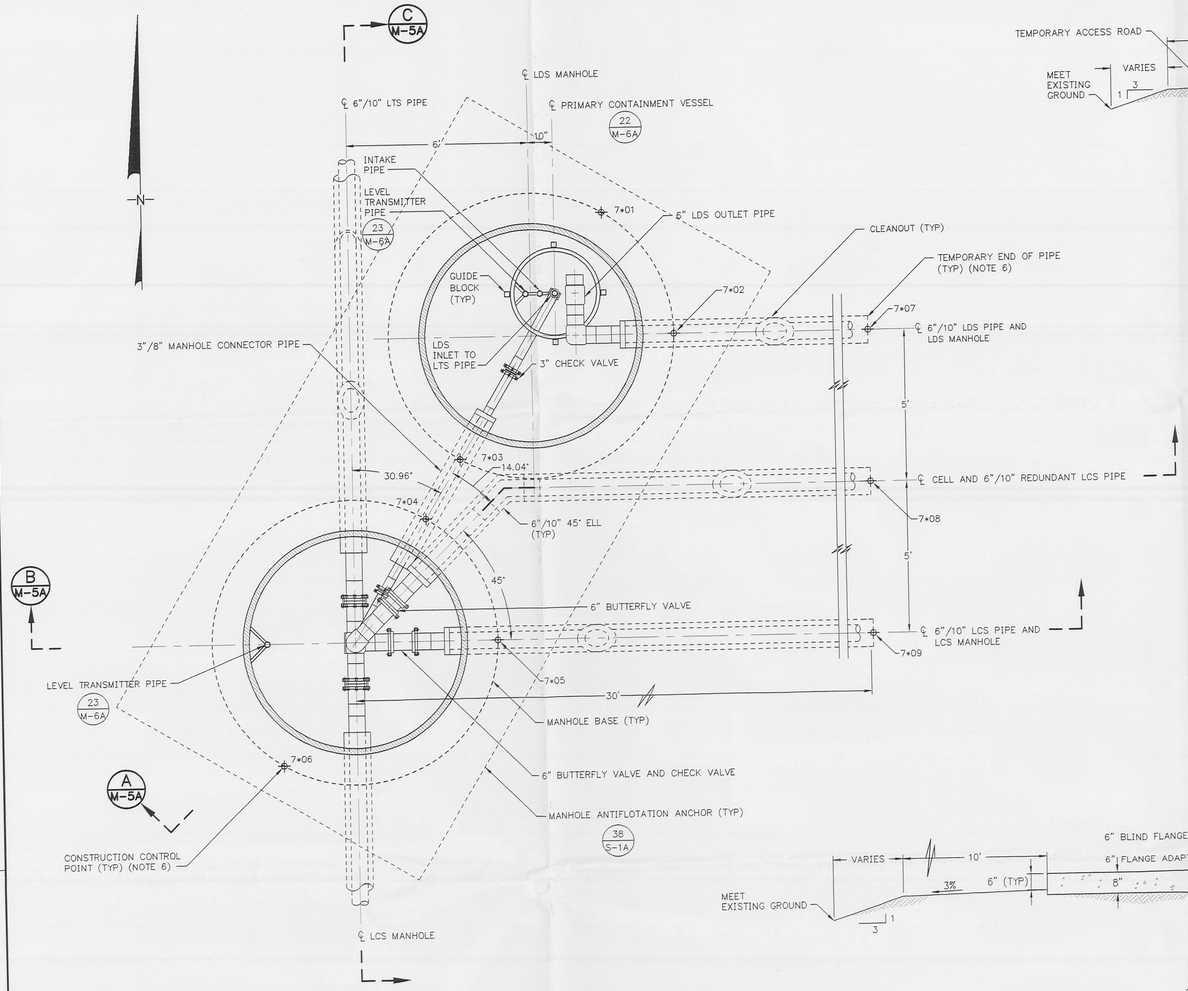
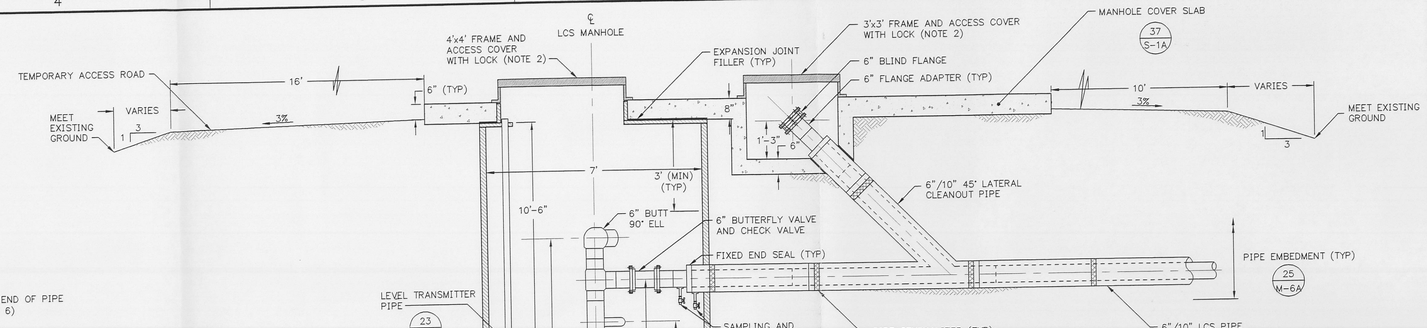
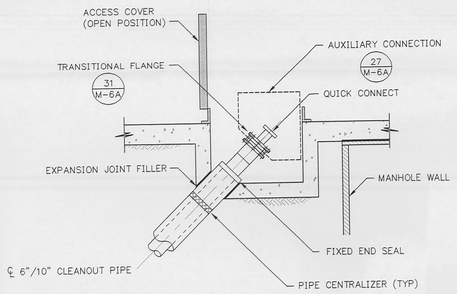
007 Mon Oct 07 11:57:10 1996 J MILLER



20 / G-8A SECTIONAL PLAN
LDS AND LCS MANHOLES AT CELLS 2 AND 3
(NOTES 1 AND 4)
SCALE: 1" = 2'
XREF: F96X2067

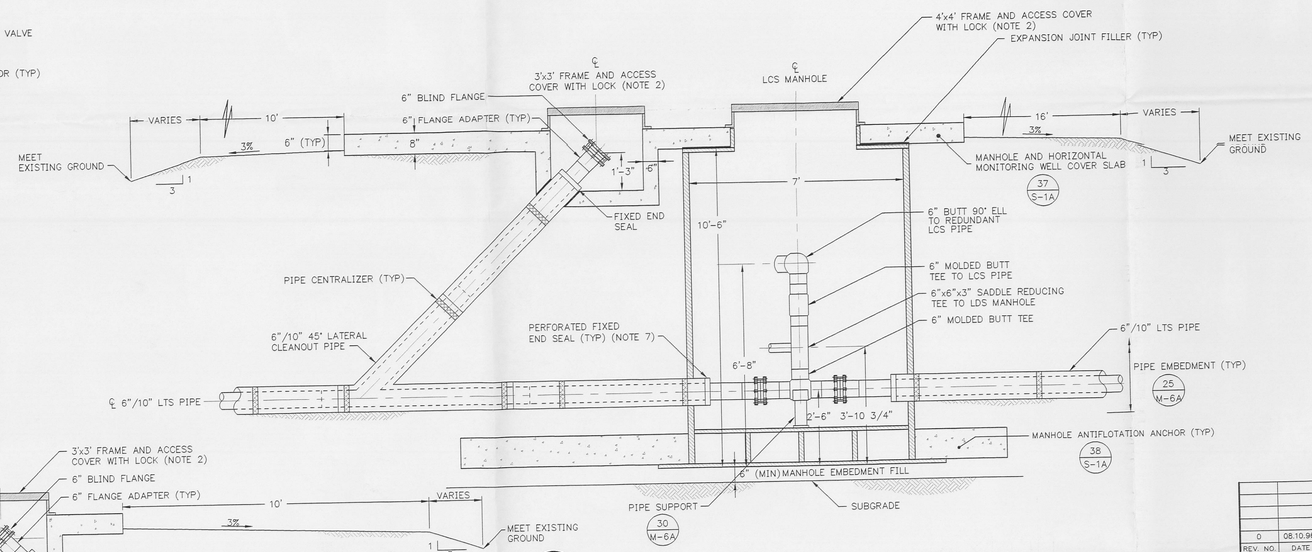


B / M-5 SECTION (TYPICAL)
LCS MANHOLE AT CELLS 1 THROUGH 3
(NOTE 3)
SCALE: 1" = 2'
XREF: F96X2066

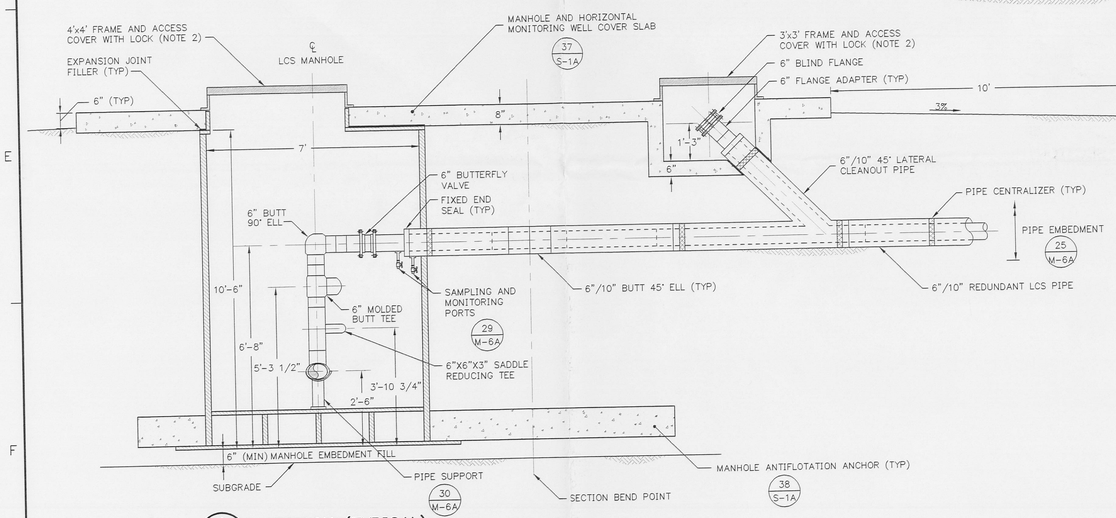


21 / - DETAIL
CLEANOUT AND AUXILIARY CONNECTION
(NOTE 2)
SCALE: 1" = 2'
XREF: F96X2068

LDS AND LCS MANHOLES CONSTRUCTION CONTROL POINTS			
CELL 1 CONTROL POINTS			
POINT NO.	NORTHING	EASTING	ELEVATION
7101	482983.26	1350688.79	594.34
7102	482979.20	1350691.03	594.34
7103	482975.26	1350683.86	594.34
7104	482973.33	1350682.67	594.34
7105	482969.28	1350684.91	594.34
7106	482965.33	1350677.74	594.34
7107	482978.97	1350710.33	599.19
7108	482973.97	1350710.26	600.58
7109	482968.97	1350710.20	599.19
CELL 2 CONTROL POINTS			
POINT NO.	NORTHING	EASTING	ELEVATION
7201	482583.29	1350683.91	591.34
7202	482579.23	1350686.14	591.34
7203	482575.29	1350678.97	591.34
7204	482573.36	1350677.78	591.34
7205	482569.31	1350680.02	591.34
7206	482565.36	1350672.85	591.34
7207	482579.00	1350705.44	596.19
7208	482574.00	1350705.38	597.58
7209	482569.00	1350705.31	596.19
CELL 3 CONTROL POINTS			
POINT NO.	NORTHING	EASTING	ELEVATION
7301	482183.32	1350679.02	588.34
7302	482179.26	1350681.25	588.34
7303	482175.32	1350674.08	588.34
7304	482173.39	1350672.90	588.34
7305	482169.34	1350675.13	588.34
7306	482165.39	1350667.96	588.34
7307	482179.03	1350700.55	593.19
7308	482174.03	1350700.49	594.58
7309	482169.03	1350700.43	593.19



C / M-5A SECTION
LCS MANHOLE AT CELLS 2 AND 3
(NOTE 3)
SCALE: 1" = 2'
XREF: F96X2064



A / M-5A SECTION (TYPICAL)
LCS MANHOLE AT CELLS 1 THROUGH 3
(NOTE 3)
SCALE: 1" = 2'
XREF: F96X2065

NOTES:

1. MANHOLES, PIPES, AND FITTINGS SHALL BE IN ACCORDANCE WITH SECTION 02605 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
2. FRAME AND ACCESS COVERS, VALVES, AND AUXILIARY CONNECTION TO CLEANOUT SHALL BE IN ACCORDANCE WITH SECTION 15000 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS. AUXILIARY CONNECTION TO CLEANOUT PIPE SHALL BE INSTALLED IN ACCORDANCE WITH THE SYSTEMS PLAN OR AT THE DIRECTION OF THE CONSTRUCTION MANAGER.
3. EARTHWORK, TRENCHING, AND BACKFILLING SHALL BE IN ACCORDANCE WITH SECTIONS 02200 AND 02215 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
4. PIPE CENTRALIZERS ARE NOT SHOWN IN THIS PLAN.
5. CONSTRUCTION CONTROL POINTS ARE PROVIDED ON THIS DRAWINGS. THE "*" SYMBOL REPRESENTS THE APPROPRIATE MANHOLE NUMBER FOR EACH CELL.
6. SUBCONTRACTOR SHALL SURVEY AND RECORD LOCATION OF TEMPORARY END OF PIPE AND PROVIDE ABOVE GROUND MARKER FOR FUTURE REFERENCE IN ACCORDANCE WITH SECTION 02100 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS. SUBCONTRACTOR SHALL PROTECT TEMPORARY END OF PIPE TO PREVENT LIQUID, SOIL OR DEBRIS FROM ENTERING PIPE AT ALL TIMES DURING INSTALLATION AND SUBSEQUENT EXCAVATION FOR FUTURE EXTENSION OF PIPE.
7. FIXED END SEAL ON LTS PIPE SHALL BE PERFORATED WITH 6-5/8-INCH DIAMETER HOLES EVENLY SPACED AT 60° APART.

CERTIFIED FOR CONSTRUCTION

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	BJ	JRM	LA/DS	RWC	RB

SCALE AS SHOWN

OWNER/FACILITY: UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT: FERMCO Fernald Environmental Restoration Management Corporation — FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE: LEACHATE TRANSMISSION SYSTEM GRAVITY LINE AND MANHOLE MECHANICAL DETAILS II 146

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Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO — RUDOLPH BONAPARTE — E-56679 — REGISTERED PROFESSIONAL ENGINEER

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-M-00064
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2008
SHEET NO.:	M-5A
REVISION NO.:	0

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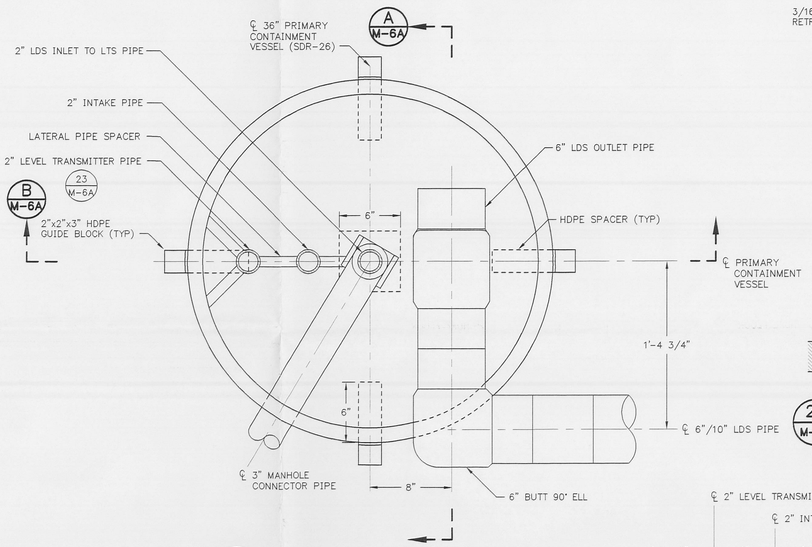
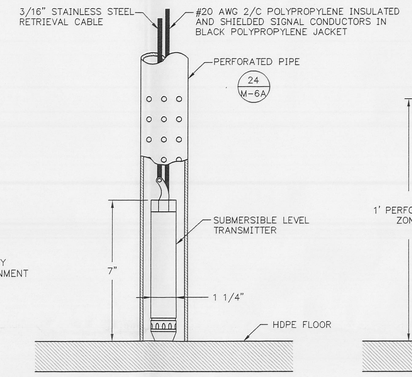
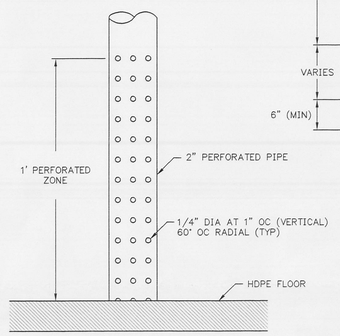


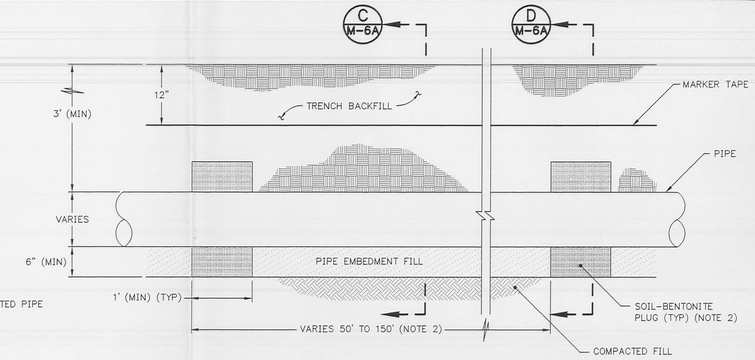
22 M-4A SECTIONAL PLAN
PRIMARY CONTAINMENT VESSEL
(NOTE 1)
SCALE: 1" = 6"
XREF: F96K2050



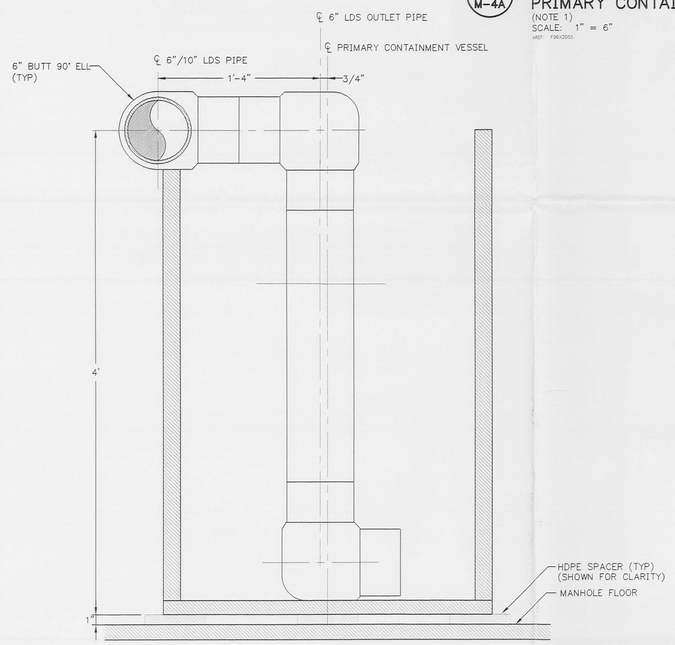
23 M-4A DETAIL
LEVEL TRANSMITTER PIPE
SCALE: NTS
XREF: F96K2056



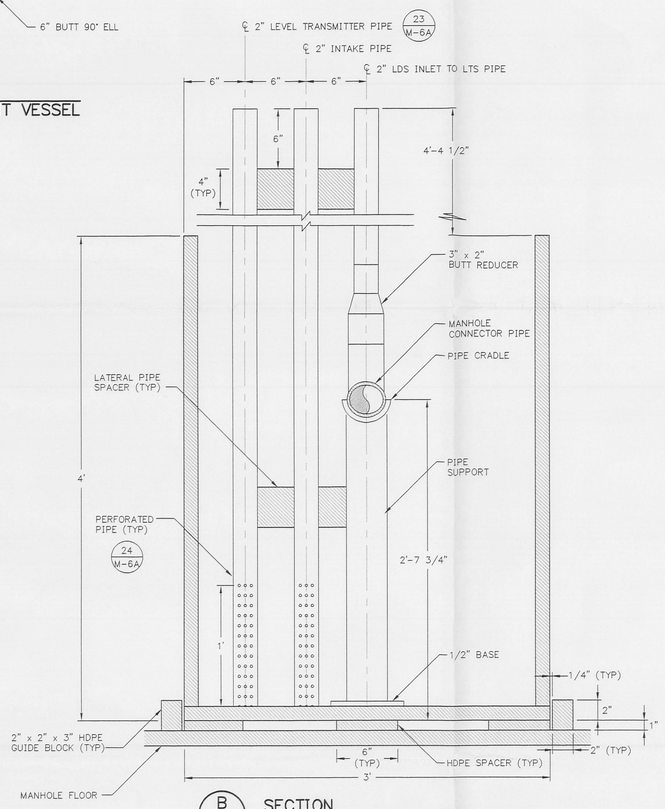
24 M-6A DETAIL
PERFORATED PIPE
SCALE: 1" = 3"
XREF: F96K2056



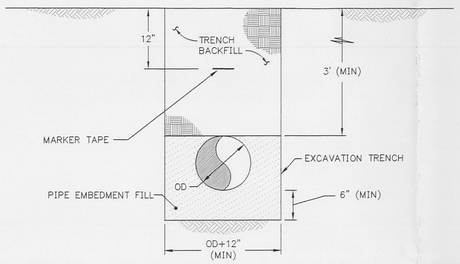
25 M-4A DETAIL
PIPE EMBEDMENT
(NOTE 3)
SCALE: 1" = 1'
XREF: F96K2057



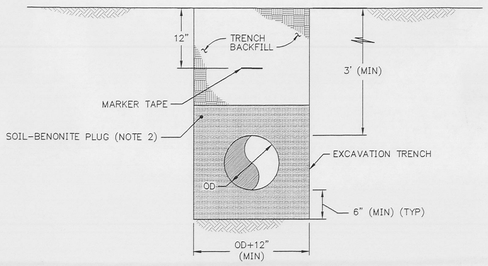
A M-6A SECTION
LDS OUTLET PIPE
SCALE: 1" = 6"
XREF: F96K2055



B M-6A SECTION
PRIMARY CONTAINMENT VESSEL
(NOTE 4)
SCALE: 1" = 6"
XREF: F96K2055



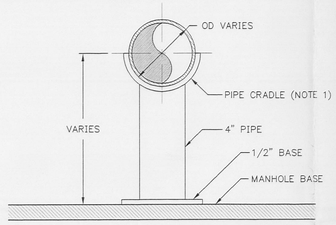
C M-6A SECTION (TYP)
PIPE EMBEDMENT AT EMBEDMENT FILL
(NOTE 3)
SCALE: 1" = 1'
XREF: F96K2058



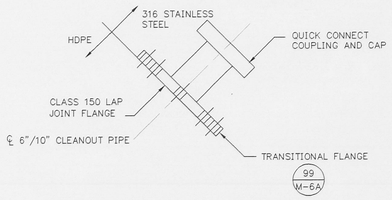
D M-6A SECTION (TYP)
PIPE EMBEDMENT AT SOIL-BENTONITE PLUG
(NOTE 3)
SCALE: 1" = 1'
XREF: F96K2058

NOTES:

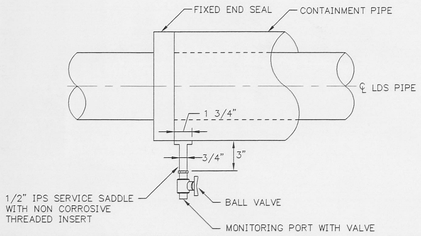
1. PIPES, PIPE SUPPORTS, AND FITTINGS SHALL BE IN ACCORDANCE WITH SECTION 02605 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS. PIPE CRADLE SHALL NOT BE WELDED TO PIPE WHICH IT SUPPORTS. PIPE SUPPORT SHALL BE WELDED TO MANHOLE BASE.
2. SOIL-BENTONITE PLUGS SHALL BE CONSTRUCTED IN ALL PIPE-CARRYING TRENCHES CONNECTED TO THE MANHOLE EMBEDMENT FILL, AT MAXIMUM DISTANCE OF 50 FEET FROM LCS OR LDS MANHOLE IN ADDITION, SOIL-BENTONITE PLUGS SHALL BE INSTALLED AT 150-FOOT INTERVALS ALONG PERMANENT AND TEMPORARY LTS GRAVITY LINES.
3. EARTHWORK, TRENCHING AND BACKFILLING SHALL BE IN ACCORDANCE WITH SECTIONS 02200 AND 02215 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
4. LEACHATE DETECTION SYSTEM OUTLET PIPE IS NOT SHOWN IN THIS SECTION.



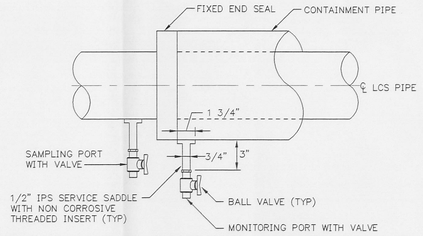
30 M-4A DETAIL
PIPE SUPPORT
SCALE: 1" = 6"
XREF: F96K2059



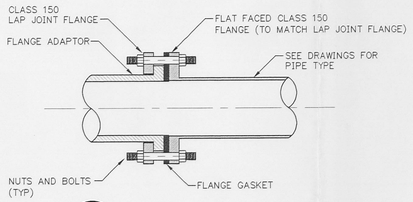
27 M-5A DETAIL
AUXILIARY CONNECTION
SCALE: 1" = 6"
XREF: F96K2062



28 M-4A DETAIL
MONITORING PORT
SCALE: 1" = 6"
XREF: F96K2061



29 M-5A DETAIL
SAMPLING AND MONITORING PORTS
SCALE: 1" = 6"
XREF: F96K2061



31 M-4A DETAIL
TRANSITIONAL FLANGE
SCALE: 1" = 6"
XREF: F96K2060

CERTIFIED FOR CONSTRUCTION

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	BJ	JRM	LA/DS	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT:
LEACHATE CONVEYANCE SYSTEM 2194

TITLE:
LEACHATE TRANSMISSION SYSTEM GRAVITY LINE AND MANHOLE MECHANICAL DETAILS III 147

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER
SEAL

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
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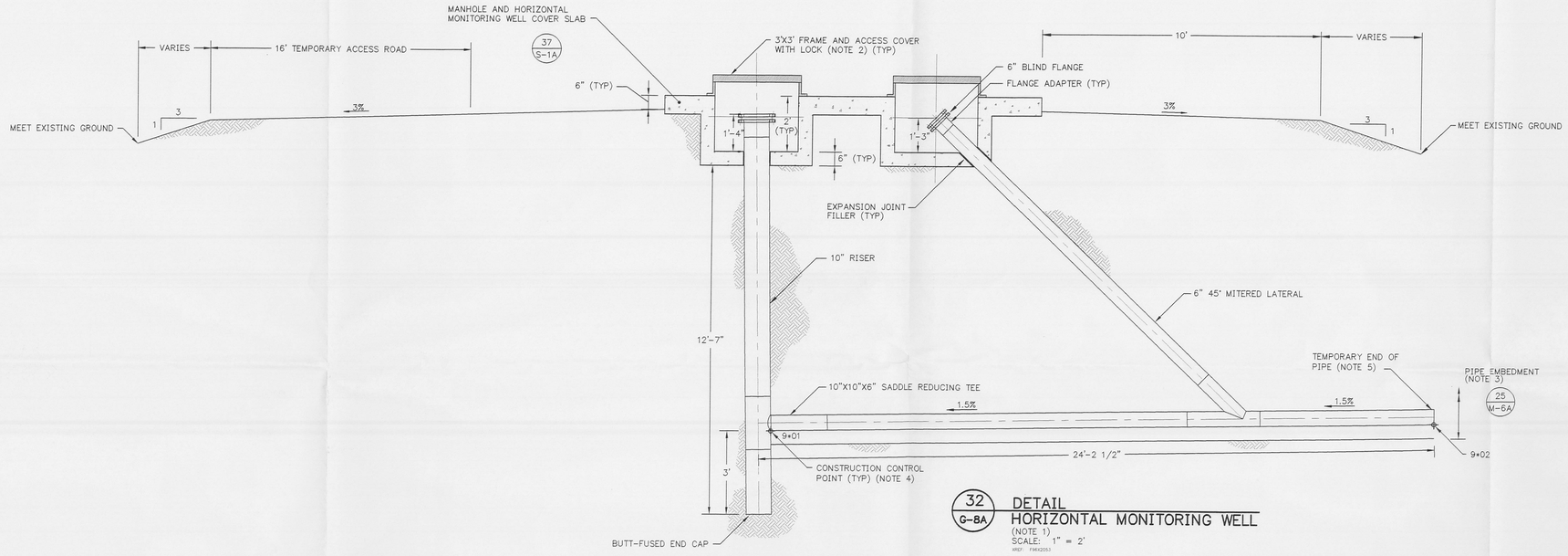
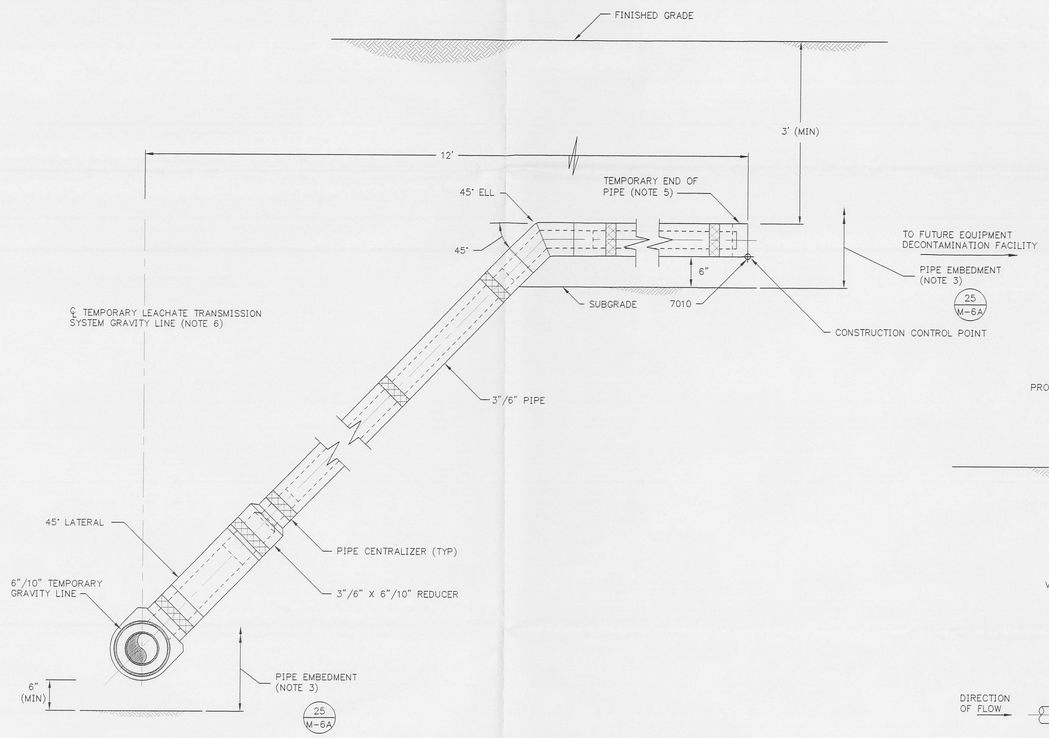
FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95P5005028
FERMCO DRAWING NO.:	90-X-6000-M-00065
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2016
SHEET NO.:	M-6A
REVISION NO.:	0

L:\F96-2016 Mon Oct 07 12:31:29 1996 J.MILLER

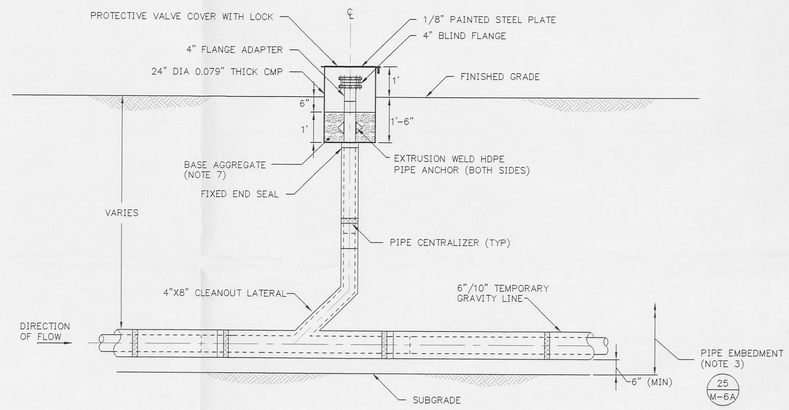


32 G-8A **DETAIL**
HORIZONTAL MONITORING WELL
(NOTE 1)
SCALE: 1" = 2'
XREF: F96H2053

CONSTRUCTION CONTROL POINTS			
HORIZONTAL MONITORING WELLS			
POINT NO.	NORTHING	EASTING	ELEVATION
9101	482960.27	1350685.30	592.97
9102	482959.85	1350720.09	593.49
9201	482560.30	1350680.42	589.97
9202	482559.88	1350715.20	590.49
9301	482160.33	1350675.53	586.97
9302	482159.90	1350710.32	587.49
STUB-OUT FOR EQUIPMENT DECONTAMINATION FACIITIY			
POINT NO.	NORTHING	EASTING	ELEVATION
7010	481701.53	1350804.04	593.75



33 G-8A **DETAIL**
STUB-OUT FOR EQUIPMENT DECONTAMINATION FACILITY
(NOTE 1)
SCALE: 1" = 1'
XREF: F96C0048



34 G-8A **DETAIL**
TEMPORARY GRAVITY LINE CLEANOUT
(NOTE 1)
SCALE: 1" = 2'
XREF: F96C0047

NOTES:

1. PIPES AND FITTINGS SHALL BE IN ACCORDANCE WITH SECTION 02605 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
2. FRAME AND ACCESS COVER AT HORIZONTAL MONITORING WELL SHALL BE IN ACCORDANCE WITH SECTION 15000 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
3. EARTHWORK, TRENCHING, AND BACKFILLING SHALL BE IN ACCORDANCE WITH SECTIONS 02200 AND 02215 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
4. CONSTRUCTION CONTROL POINTS ARE PROVIDED ON THIS DRAWING. THE "+" SYMBOL REPRESENTS THE APPROPRIATE MANHOLE NUMBER FOR EACH CELL. CONSTRUCTION CONTROL POINTS REFER TO BOTTOM OF PIPE.
5. SUBCONTRACTOR SHALL SURVEY AND RECORD LOCATION OF TEMPORARY END OF PIPE AND PROVIDE ABOVE GROUND MARKER FOR FUTURE REFERENCE IN ACCORDANCE WITH SECTION 02100 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS. SUBCONTRACTOR SHALL PROTECT TEMPORARY END OF PIPE TO PREVENT LIQUID, SOIL OR DEBRIS FROM ENTERING PIPE AT ALL TIMES DURING INSTALLATION AND SUBSEQUENT EXCAVATION FOR FUTURE EXTENSION OF PIPE.
6. SEE DRAWING G-8A FOR TEMPORARY LEACHATE TRANSMISSION SYSTEM GRAVITY LINE CONSTRUCTION CONTROL POINTS.
7. BASE AGGREGATE SHALL MEET THE REQUIREMENTS OF ITEM 304.02 AND 703.04 OF THE OHIO DOT SPECIFICATIONS.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	BJ	JRM	LA/DS	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT:
LEACHATE CONVEYANCE SYSTEM 2194

TITLE:
LEACHATE TRANSMISSION SYSTEM GRAVITY LINE AND MANHOLE DETAILS IV 148

"THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED."

Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

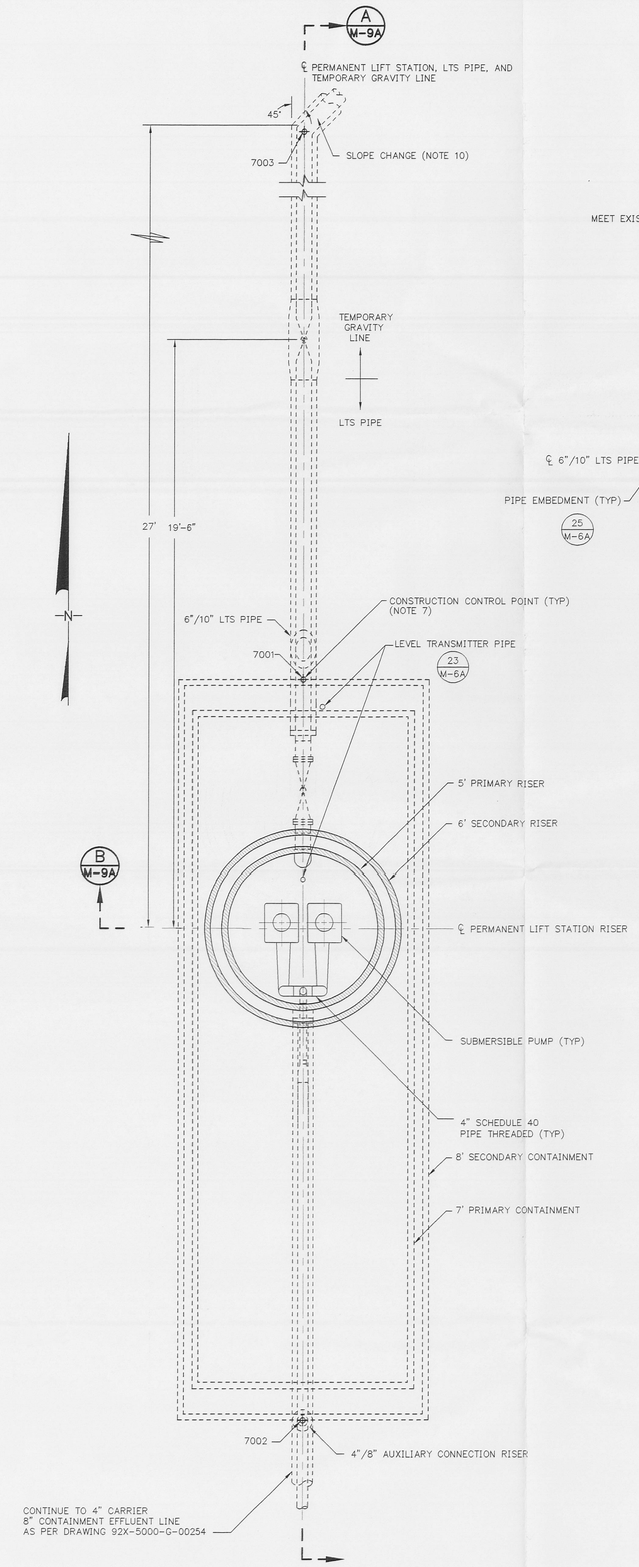
STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER
SEAL

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

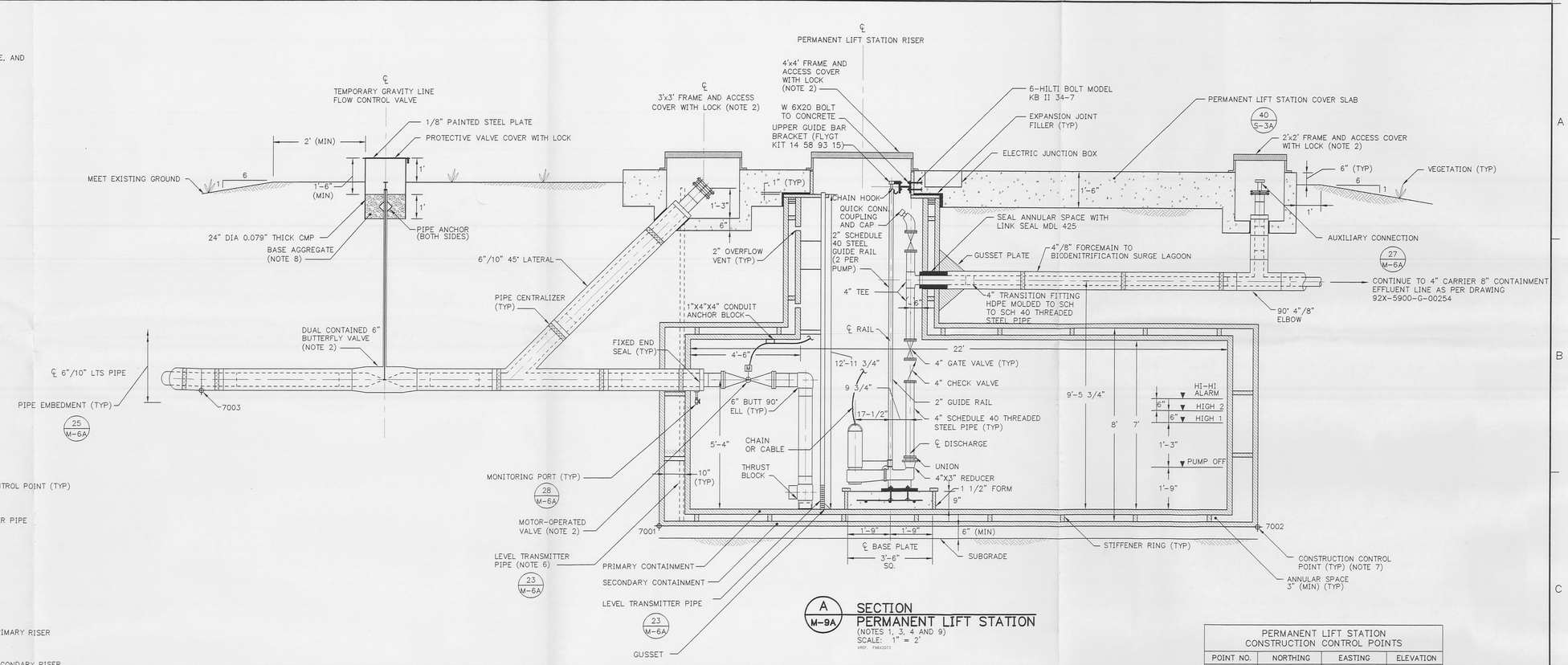
FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-M-00066
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2013
SHEET NO.:	M-6B
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

M:\ACAD\DGE3900 22\F96-2013 Mon Oct 07 12:22:58 1996 URSULAW

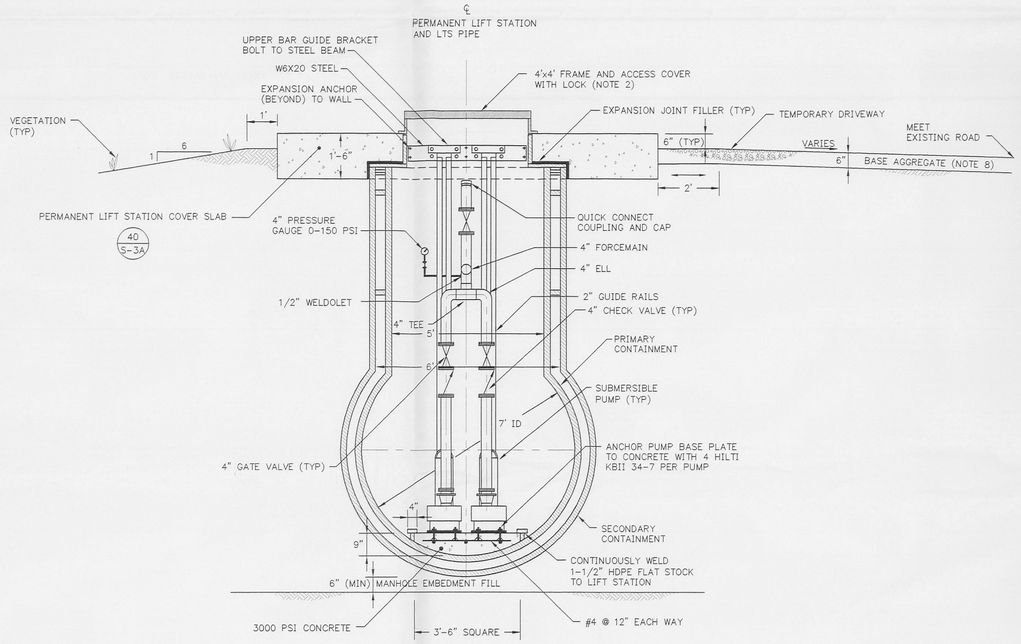


35 / - SECTIONAL PLAN
PERMANENT LIFT STATION
(NOTES 1 AND 5)
SCALE: 1" = 2'
REF: F96120146



A / M-9A SECTION
PERMANENT LIFT STATION
(NOTES 1, 3, 4 AND 9)
SCALE: 1" = 2'
REF: F9612073

PERMANENT LIFT STATION CONSTRUCTION CONTROL POINTS			
POINT NO.	NORTHING	EASTING	ELEVATION
7001	479503.10	1350605.84	568.08
7002	479475.60	1350613.30	568.08
7003	479520.27	1350613.30	573.82



B / M-9A SECTION
PERMANENT LIFT STATION
(NOTES 3, 4 AND 9)
SCALE: 1" = 2'
REF: F96120031

NOTES:

1. PRIMARY CONTAINMENT, SECONDARY CONTAINMENT, HDPE PIPES, AND FITTINGS SHALL BE IN ACCORDANCE WITH SECTION 02605 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
2. FRAME, ACCESS COVERS, MOTOR OPERATED VALVE, AND DUAL CONTAINED BUTTERFLY VALVE SHALL BE IN ACCORDANCE WITH SECTION 15000 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
3. EARTH WORK, TRENCHING, AND BACKFILLING SHALL BE IN ACCORDANCE WITH SECTIONS 02200 AND 02215 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
4. SUBMERSIBLE PUMPS AND QUICK DISCHARGE CONNECTOR FOR PUMP SHALL BE IN ACCORDANCE WITH SECTION 15160 OF THE LEACHATE CONVEYANCE SYSTEM SPECIFICATIONS.
5. PIPE CENTRALIZERS, ARE NOT SHOWN IN THIS PLAN.
6. LEVEL TRANSMITTER PIPE IS SHOWN IN THIS SECTION FOR CLARITY.
7. CONSTRUCTION CONTROL POINTS ARE PROVIDED ON THIS DRAWING.
8. BASE AGGREGATE SHALL MEET THE REQUIREMENTS OF ITEM 304.02 AND 703.04 OF THE OHIO DOT SPECIFICATIONS.
9. SEE DRAWING 92X-5900-G-00258 FOR PIPE, PAINT, AND DISCHARGE LINE VALVE REQUIREMENTS.
10. SEE DRAWING G-8C FOR LEACHATE TRANSMISSION SYSTEM GRAVITY LINE SLOPE REQUIREMENTS.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	08.10.96	CERTIFIED FOR CONSTRUCTION	BJ	AHF	LA/DS	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERMCO Fernald Environmental Restoration Management Corporation
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT: LEACHATE CONVEYANCE SYSTEM 2194

TITLE:
LEACHATE TRANSMISSION SYSTEM
LIFT STATION MECHANICAL DETAILS III

149

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Rudolph Bonaparte
SIGNATURE
8 Oct 1996
DATE

STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER
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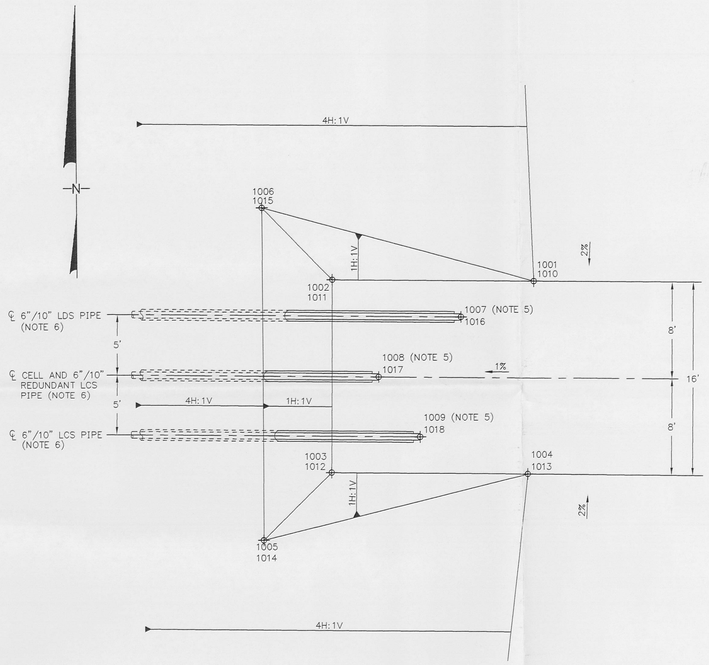
GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

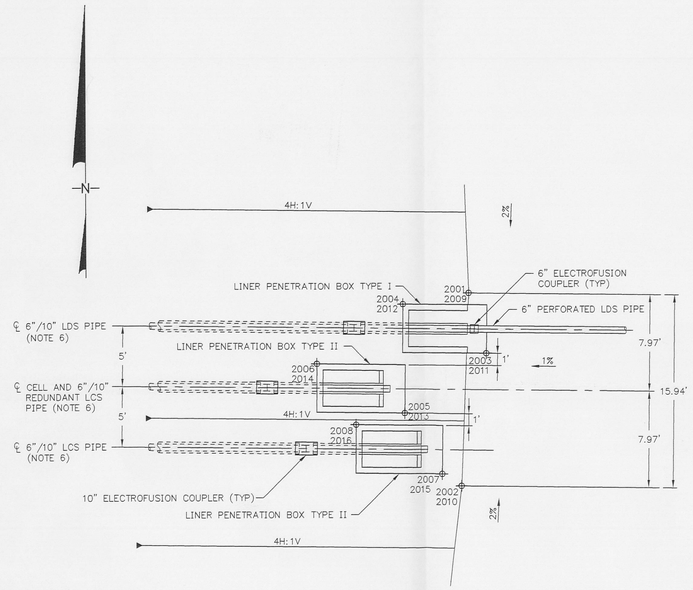
FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-M-00067
GEOSYNTEC PROJECT NO.:	GE3900-22.1
GEOSYNTEC DOCUMENT NO.:	F96-2012
SHEET NO.:	M-9A
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

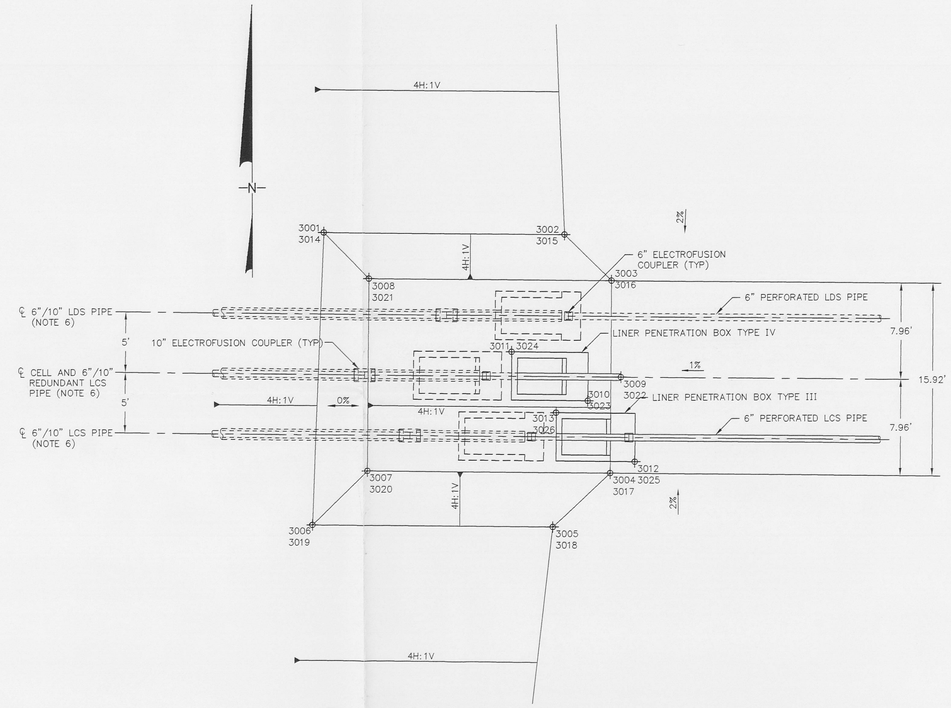
L:\F96-2012 Mon Oct 07 15:20:22 1996 J MILLER



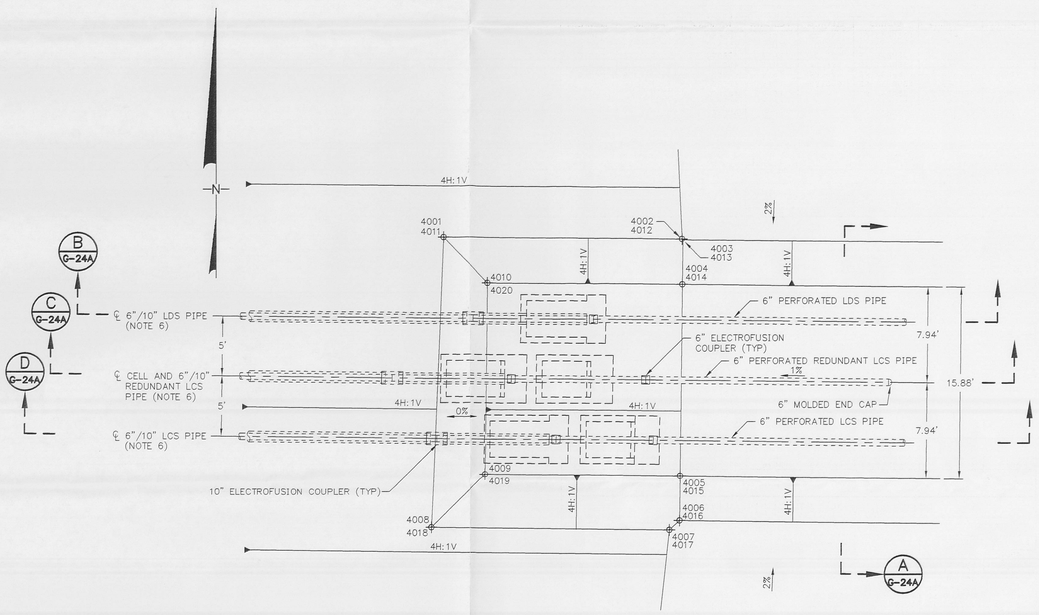
1 / G-5A PLAN (TYPICAL)
TOP OF SUBGRADE AT CELL OUTLET
SCALE: 1" = 5'
XREF: F96I3526



2 / - PLAN (TYPICAL)
TOP OF COMPACTED CLAY LINER AT CELL OUTLET
SCALE: 1" = 5'
XREF: F96I3527



3 / - PLAN (TYPICAL)
TOP OF LDS DRAINAGE LAYER AT CELL OUTLET
SCALE: 1" = 5'
XREF: F96I3528



4 / - PLAN (TYPICAL)
TOP OF LCS DRAINAGE LAYER AT CELL OUTLET
SCALE: 1" = 5'
XREF: F96I3529

CONSTRUCTION CONTROL POINTS

TOP OF SUBGRADE AT CELL OUTLET

CELL 1				CELL 2			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
1001	482980.20	1350855.06	598.22	1010	482580.23	1350850.17	595.22
1002	482980.40	1350838.33	598.06	1011	482580.43	1350833.44	595.06
1003	482964.40	1350838.14	598.06	1012	482564.43	1350833.25	595.06
1004	482964.20	1350854.40	598.22	1013	482564.23	1350849.52	595.22
1005	482958.83	1350832.48	603.64	1014	482558.86	1350827.60	600.64
1006	482986.39	1350832.55	603.92	1015	482586.42	1350827.66	600.92
1007	482977.27	1350848.90	–	1016	482577.30	1350844.02	–
1008	482972.36	1350842.10	–	1017	482572.38	1350837.22	–
1009	482967.31	1350845.45	–	1018	482567.34	1350840.56	–

TOP OF COMPACTED CLAY LINER AT CELL OUTLET

CELL 1				CELL 2			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
2001	482980.16	1350855.42	601.23	2009	482580.19	1350850.53	598.23
2002	482964.23	1350854.76	601.22	2010	482564.26	1350849.87	598.22
2003	482975.18	1350856.84	601.24	2011	482575.21	1350851.95	598.24
2004	482979.26	1350849.68	602.60	2012	482579.29	1350845.00	599.60
2005	482970.26	1350850.00	602.48	2013	482570.29	1350845.11	599.48
2006	482974.35	1350842.79	604.32	2014	482574.38	1350837.91	601.32
2007	482965.22	1350853.17	601.63	2015	482565.25	1350848.28	598.63
2008	482969.31	1350845.96	603.48	2016	482569.34	1350841.07	600.48

TOP OF LDS AT CELL OUTLET

CELL 1				CELL 2			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
3001	482984.17	1350835.55	607.27	3014	482584.20	1350830.66	604.27
3002	482983.92	1350855.40	602.30	3015	482583.95	1350850.51	599.30
3003	482980.11	1350859.27	602.27	3016	482580.14	1350854.38	599.27
3004	482964.19	1350859.08	602.27	3017	482564.22	1350854.19	599.27
3005	482959.75	1350854.35	602.31	3018	482559.78	1350849.46	599.31
3006	482959.99	1350834.53	607.27	3019	482560.02	1350829.64	604.27
3007	482964.43	1350839.08	607.27	3020	482564.46	1350834.19	604.27
3008	482980.35	1350839.27	607.27	3021	482580.38	1350834.38	604.27
3009	482972.14	1350860.01	602.27	3022	482572.17	1350855.12	599.27
3010	482970.17	1350857.27	602.74	3023	482570.20	1350852.38	599.74
3011	482974.25	1350851.03	604.31	3024	482574.28	1350846.14	601.31
3012	482965.12	1350861.11	602.29	3025	482565.15	1350856.22	599.29
3013	482969.20	1350854.66	603.39	3026	482569.23	1350849.77	600.39

TOP OF LCS AT CELL OUTLET

CELL 1				CELL 2			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
4001	482984.14	1350835.67	608.26	4011	482584.17	1350830.78	605.26
4002	482983.90	1350855.52	603.30	4012	482583.93	1350850.63	600.30
4003	482983.83	1350855.59	603.30	4013	482583.86	1350850.70	600.30
4004	482980.13	1350855.54	604.23	4014	482580.16	1350850.65	601.23
4005	482964.25	1350855.35	604.23	4015	482564.28	1350850.46	601.23
4006	482960.55	1350855.30	603.30	4016	482560.58	1350850.41	600.30
4007	482959.77	1350854.47	603.31	4017	482559.80	1350849.58	600.31
4008	482960.01	1350834.65	608.26	4018	482560.04	1350829.76	605.26
4009	482964.45	1350839.20	608.26	4019	482564.48	1350834.31	605.26
4010	482980.33	1350839.39	608.26	4020	482580.36	1350834.51	605.26

TIE-IN TO EXISTING LEACHATE CONVEYANCE SYSTEM (NOTE 6)

CELL 1				CELL 2			
PIPE ID	NORTHING	EASTING	ELEVATION	PIPE ID	NORTHING	EASTING	ELEVATION
LDS	482978.97	1350710.33	599.19	LDS	482579.00	1350705.44	596.19
LCS	482968.97	1350710.20	599.19	LCS	482569.00	1350705.31	596.19
LCS (RED)	482973.97	1350710.26	600.58	LCS (RED)	482574.00	1350705.38	597.58

LEGEND

2008 CONSTRUCTION CONTROL POINT

NOTES:

1. LCS AND LDS PIPES SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 02605.
2. SEE DRAWINGS G-24A AND G-25A FOR LINER PENETRATION BOX DETAILS.
3. TRENCH FOR LDS AND LCS PIPES IS NOT SHOWN ON THIS DRAWING FOR CLARITY. TRENCHING AND BACKFILLING FOR LDS AND LCS PIPES SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 02215.
4. HORIZONTAL MONITORING WELL IS NOT SHOWN ON THIS DRAWING FOR CLARITY, THEREFORE NO ELEVATIONS ARE PROVIDED. SEE DRAWING G-40A FOR HORIZONTAL MONITORING WELL DETAILS.
5. CONSTRUCTION CONTROL POINTS AT THESE LOCATIONS ARE SHOWN TO ILLUSTRATE THE HORIZONTAL LOCATION OF THE DRAINAGE CORRIDOR PIPE TERMINATIONS.
6. LDS PIPES, LCS PIPES, AND REDUNDANT LCS PIPES SHALL TIE INTO EXISTING PIPES PREVIOUSLY INSTALLED UNDER A SEPARATE CONTRACT. THE TIE-IN LOCATIONS ARE SHOWN IN THE CONSTRUCTION CONTROL POINT TABLE ON THIS SHEET. THE TIE-IN CONTROL POINTS REPRESENT THE OUTSIDE BOTTOM OF THE 10-INCH PIPE. SUBCONTRACTOR SHALL REMOVE PLUGS OR OTHER TEMPORARY PROTECTION MEASURES INSTALLED IN EXISTING PIPES PRIOR TO TIE-IN. AS-BUILT TIE-IN POINTS MAY VARY SLIGHTLY FROM THE CONTROL POINTS GIVEN ON THIS DRAWING.

REV. NO.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW	APPROVE
0	19.10.96	CERTIFIED FOR CONSTRUCTION	DLVL	UMW	KLO	KWC	RB

SCALE IN FEET (5 2.5 0 5 10)

2194

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FERMCO Fernald Environmental Restoration Management Corporation
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

PROJECT:
ON-SITE DISPOSAL FACILITY PHASE I CONSTRUCTION

TITLE:
CELL OUTLET GRADING PLANS

150

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Rudolph Bonaparte
SIGNATURE
19 Oct 1996
DATE

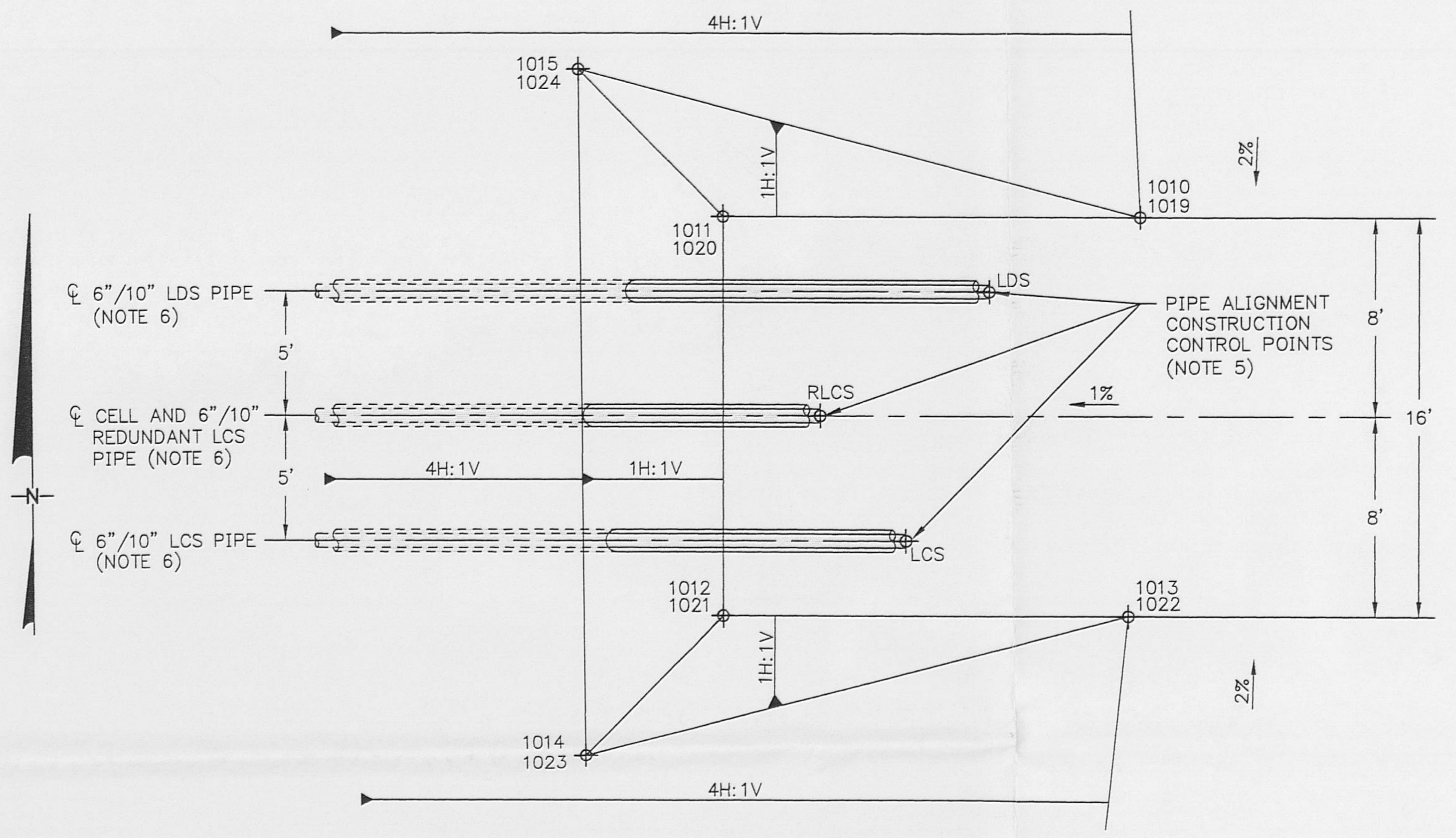
STATE OF OHIO
RUDOLPH BONAPARTE
E-56679
REGISTERED PROFESSIONAL ENGINEER

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

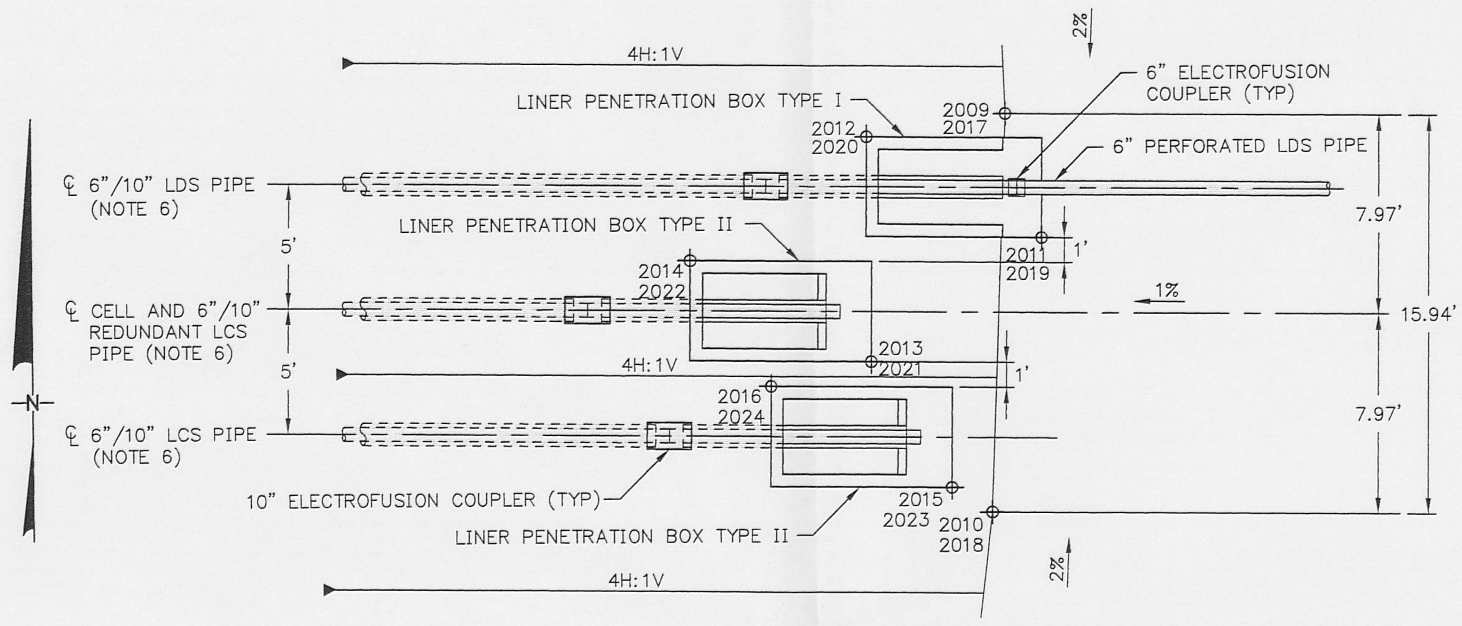
FERMCO PROJECT NO.:	20100
FERMCO SUBCONTRACT NO.:	95PS005028
FERMCO DRAWING NO.:	90X-6000-G-00076
GEOSYNTEC PROJECT NO.:	GE3900-21.1
GEOSYNTEC DOCUMENT NO.:	F96-3508
SHEET NO.:	G-9A
REVISION NO.:	0

CERTIFIED FOR CONSTRUCTION

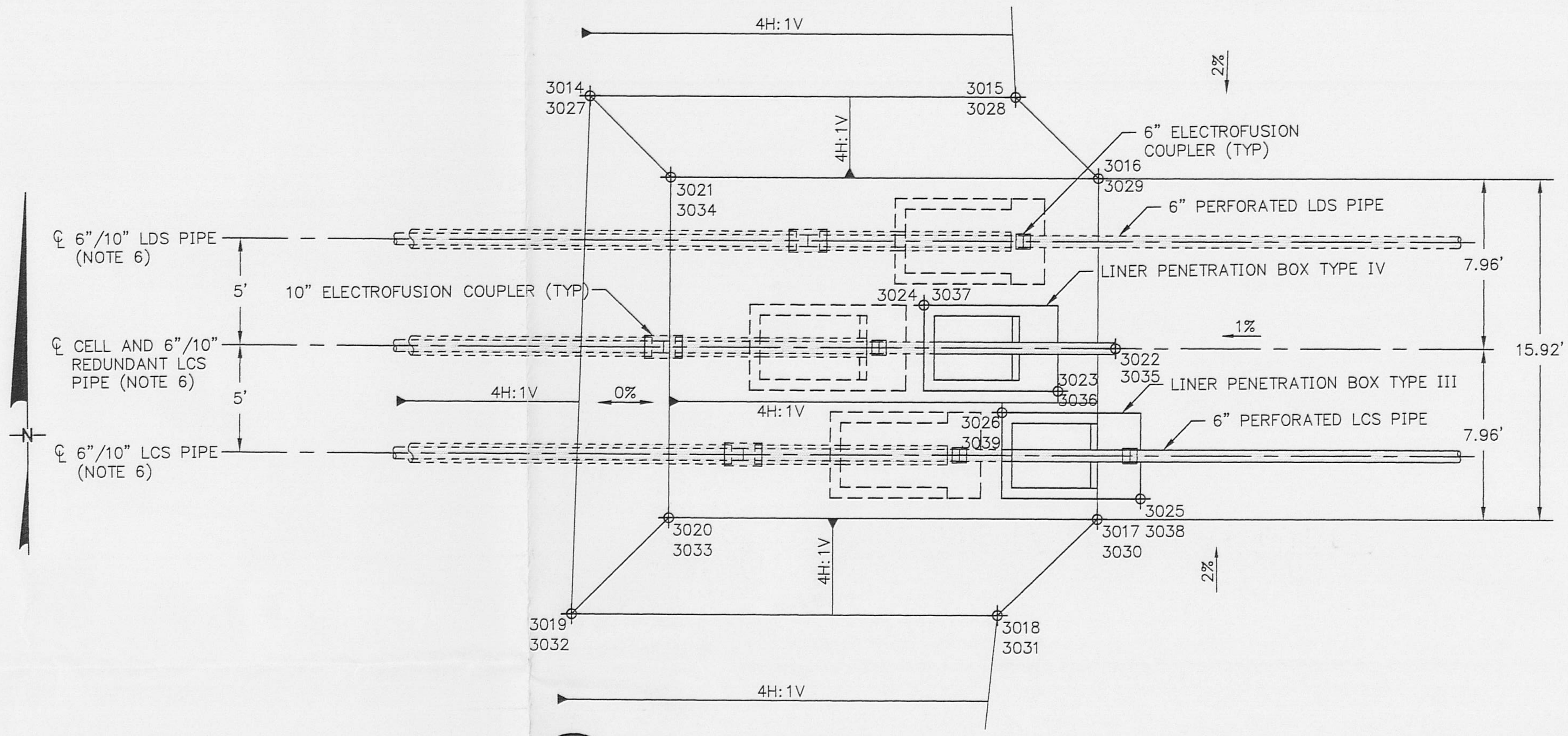
W:\CAD\ADD\GE3900 21\F96-3508 Thu Oct 17 12:45:42 1996 FERMCO/DUNN



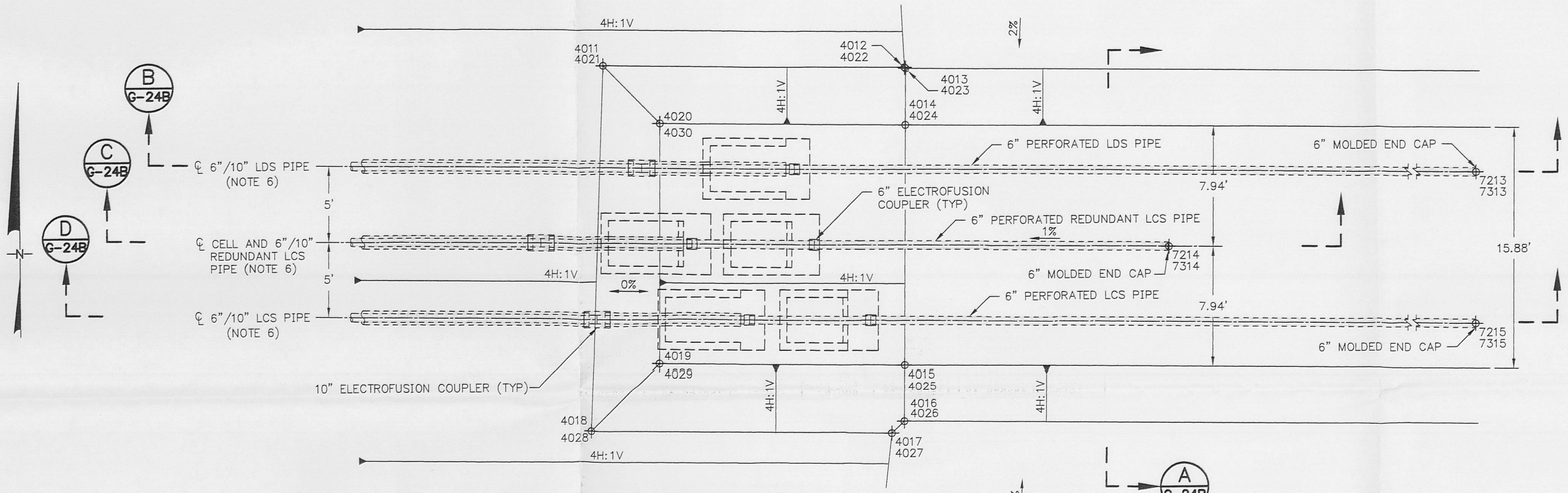
1 / G-5D **PLAN (TYPICAL)**
TOP OF SUBGRADE AT CELL OUTLET
SCALE: 1" = 5'
XREF: F97X0626



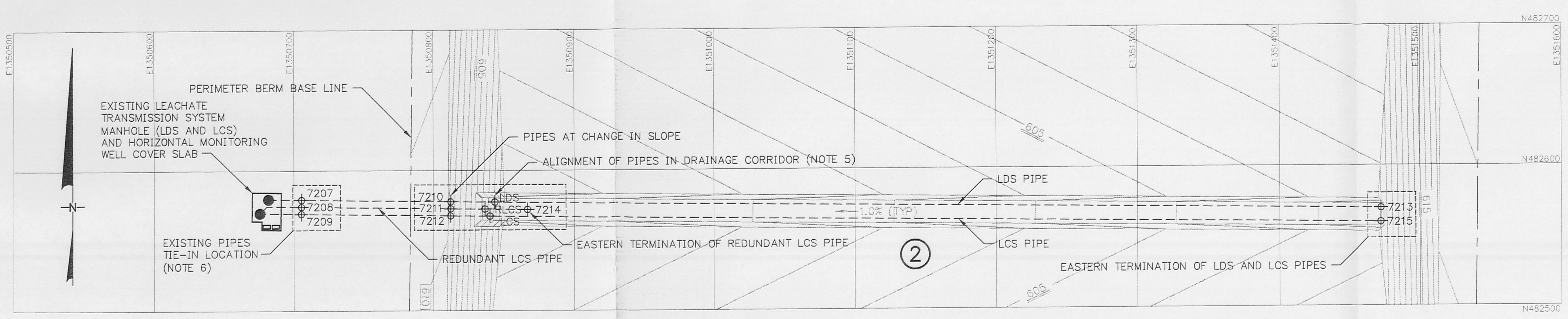
2 / G-6A **PLAN (TYPICAL)**
TOP OF COMPACTED CLAY LINER AT CELL OUTLET
SCALE: 1" = 5'
XREF: F97X0627



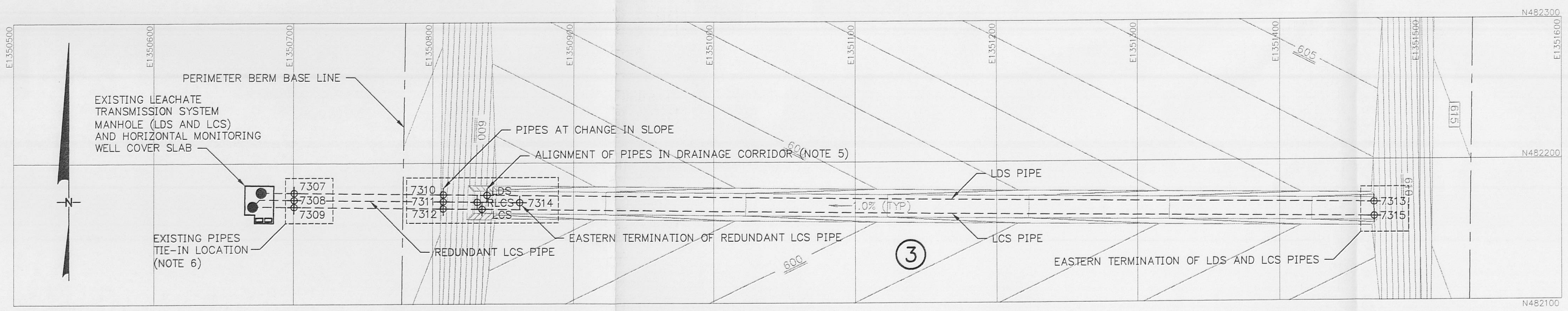
3 / - **PLAN (TYPICAL)**
TOP OF LDS DRAINAGE LAYER AT CELL OUTLET
SCALE: 1" = 5'
XREF: F97X0628



4 / - **PLAN (TYPICAL)**
TOP OF LCS DRAINAGE LAYER AT CELL OUTLET
SCALE: 1" = 5'
XREF: F97X0629



4A / - **PLAN**
CONSTRUCTION CONTROL POINT LOCATIONS FOR CELL 2 LCS, LDS, AND REDUNDANT LCS PIPES
(NOTE 4)
SCALE: 1" = 50'
XREF: F97X0718



4B / - **PLAN**
CONSTRUCTION CONTROL POINT LOCATIONS FOR CELL 3 LCS, LDS, AND REDUNDANT LCS PIPES
(NOTE 4)
SCALE: 1" = 50'
XREF: F97X0719

CONSTRUCTION CONTROL POINTS

TOP OF SUBGRADE AT CELL OUTLET

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
1010	482580.23	1350850.17	595.22	1019	482180.26	1350845.28	592.22
1011	482580.43	1350833.44	595.06	1020	482180.46	1350828.56	592.06
1012	482564.43	1350833.25	595.06	1021	482164.46	1350828.36	592.06
1013	482564.23	1350849.52	595.22	1022	482164.26	1350844.63	592.22
1014	482558.86	1350827.60	600.64	1023	482158.89	1350822.71	597.64
1015	482586.42	1350827.66	600.92	1024	482186.45	1350822.77	597.92

TOP OF COMPACTED CLAY LINER AT CELL OUTLET

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
2009	482580.19	1350850.53	598.23	2017	482180.22	1350845.64	595.23
2010	482564.26	1350849.87	598.22	2018	482164.29	1350844.99	595.22
2011	482575.21	1350851.95	598.24	2019	482175.24	1350847.06	595.24
2012	482579.29	1350845.00	599.60	2020	482179.32	1350840.11	596.60
2013	482570.29	1350845.11	599.48	2021	482170.32	1350840.23	596.48
2014	482574.38	1350837.91	601.32	2022	482174.41	1350833.02	598.32
2015	482565.25	1350848.28	598.63	2023	482165.28	1350843.39	595.63
2016	482569.34	1350841.07	600.48	2024	482169.37	1350836.18	597.48

TOP OF LDS AT CELL OUTLET

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
3014	482584.20	1350830.66	604.27	3027	482184.23	1350825.77	601.27
3015	482583.95	1350850.51	599.30	3028	482183.98	1350845.62	596.30
3016	482580.14	1350854.38	599.27	3029	482180.17	1350849.49	596.27
3017	482564.22	1350854.19	599.27	3030	482164.25	1350849.30	596.27
3018	482559.78	1350849.46	599.31	3031	482159.81	1350844.57	596.31
3019	482560.02	1350829.64	604.27	3032	482160.05	1350824.75	601.27
3020	482564.46	1350834.19	604.27	3033	482164.49	1350829.30	601.27
3021	482580.38	1350834.38	604.27	3034	482180.41	1350829.49	601.27
3022	482572.17	1350855.12	599.27	3035	482172.20	1350850.23	596.27
3023	482570.20	1350852.38	599.74	3036	482170.23	1350847.49	596.74
3024	482574.28	1350846.14	601.31	3037	482174.31	1350841.25	598.31
3025	482565.15	1350856.22	599.29	3038	482165.18	1350851.33	596.29
3026	482569.23	1350849.77	600.39	3039	482169.26	1350844.88	597.39

TOP OF LCS AT CELL OUTLET

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
4011	482584.17	1350830.78	605.26	4021	482184.20	1350825.89	602.26
4012	482583.93	1350850.63	600.30	4022	482183.96	1350845.74	597.30
4013	482583.86	1350850.70	600.30	4023	482183.89	1350845.81	597.30
4014	482580.16	1350850.65	601.23	4024	482180.19	1350845.76	598.23
4015	482564.28	1350850.46	601.23	4025	482164.31	1350845.57	598.23
4016	482560.58	1350850.41	600.30	4026	482160.61	1350845.53	597.30
4017	482559.80	1350849.58	600.31	4027	482159.83	1350844.69	597.31
4018	482560.04	1350829.76	605.26	4028	482160.07	1350824.87	602.26
4019	482564.48	1350834.31	605.26	4029	482164.51	1350829.42	602.26
4020	482580.36	1350834.51	605.26	4030	482180.39	1350829.62	602.26

EXISTING LDS, LCS, AND REDUNDANT LCS PIPES TIE-IN LOCATION (NOTE 6)

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
7207	482579.00	1350705.44	596.19	7307	482179.03	1350700.55	593.19
7208	482574.00	1350705.38	597.58	7308	482174.03	1350700.49	594.58
7209	482569.00	1350705.31	596.19	7309	482169.03	1350700.43	593.19

LDS, LCS, AND REDUNDANT LCS PIPES AT CHANGE IN SLOPE

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
7210	482577.69	1350812.63	597.67	7310	482177.72	1350807.75	594.67
7211	482572.69	1350812.57	599.67	7311	482172.72	1350807.69	596.67
7212	482567.69	1350812.51	598.67	7312	482167.72	1350807.63	595.67

LDS, LCS, AND REDUNDANT LCS PIPES ALIGNMENT IN DRAINAGE CORRIDOR (NOTE 5)

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
LDS	482577.30	1350844.02	NOTE 5	LDS	482177.33	1350839.13	NOTE 5
RLCS	482572.38	1350837.22	NOTE 5	RLCS	482172.41	1350832.33	NOTE 5
LCS	482567.34	1350840.56	NOTE 5	LCS	482167.37	1350835.68	NOTE 5

LDS, LCS, AND REDUNDANT LCS PIPES EASTERN TERMINATION

CELL 2				CELL 3			
POINT NO.	NORTHING	EASTING	ELEVATION	POINT NO.	NORTHING	EASTING	ELEVATION
7213	482569.62	1351472.26	604.44	7313	482169.65	1351467.37	601.44
7214	482572.02	1350866.95	600.39	7314	482172.05	1350862.07	597.39
7215	482259.62	1351472.19	605.45	7314	482159.65	1351467.56	602.45

LEGEND

2009 ⌖	CONSTRUCTION CONTROL POINT
610	COMPACTED CLAY LINER ELEVATION (FEET)
605	LEACHATE COLLECTION SYSTEM ELEVATION (FEET)
— — —	CENTERLINE OR PERIMETER BERM BASELINE
(symbol)	LEACHATE TRANSMISSION SYSTEM MANHOLES (LDS AND LCS) AND HORIZONTAL MONITORING WELL COVER SLAB
(3)	CELL DESIGNATION

NOTES:

1. LCS AND LDS PIPES SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 02605.
2. SEE DRAWING G-25B FOR LINER PENETRATION BOX DETAILS.
3. TRENCH FOR LDS AND LCS PIPES IS NOT SHOWN ON THIS DRAWING FOR CLARITY. TRENCHING AND BACKFILLING FOR LDS AND LCS PIPES SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 02215 AND 02225.
4. HORIZONTAL MONITORING WELL IS NOT SHOWN ON THIS DRAWING FOR CLARITY, THEREFORE NO ELEVATIONS ARE PROVIDED. SEE DRAWING G-40A FOR HORIZONTAL MONITORING WELL DETAILS.
5. CONSTRUCTION CONTROL POINTS AT THESE LOCATIONS ARE SHOWN TO ILLUSTRATE THE HORIZONTAL LOCATION OF THE DRAINAGE CORRIDOR PIPE TERMINATIONS. PIPE LENGTH MAY REQUIRE ADJUSTMENT TO MATCH LINER PENETRATION BOX PIPE END.
6. LDS PIPES, LCS PIPES, AND REDUNDANT LCS PIPES SHALL TIE INTO EXISTING PIPES INSTALLED AS PART OF PREVIOUS LEACHATE CONVEYANCE SYSTEM CONSTRUCTION. TIE-IN LOCATIONS ARE SHOWN IN CONSTRUCTION CONTROL POINT TABLE PRESENTED ON THIS DRAWING. TIE-IN CONSTRUCTION CONTROL POINTS REPRESENT THE OUTSIDE BOTTOM OF THE 10-INCH PIPE. CONTRACTOR SHALL REMOVE PLUGS OR OTHER TEMPORARY PROTECTION INSTALLED IN EXISTING PIPE PRIOR TO TIE-IN. AS-BUILT TIE-IN LOCATION MAY VARY SLIGHTLY FROM THE CONSTRUCTION CONTROL POINTS GIVEN ON THIS DRAWING.

REV. NO.	DATE	DESCRIPTION	DES. BY	DR. BY	CHK. BY	RVW. BY	APP. BY
0	97.11.10	CERTIFIED-FOR-CONSTRUCTION	DLVL	SLB	CFW	KWC	RB
A	97.10.06	90 PERCENT SUBMITTAL TO DOE	DLVL	UMW	CFW	KWC	RB

SCALE AS SHOWN

OWNER/FACILITY:
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

CLIENT:
FLUOR DANIEL FERNALD — FLUOR DANIEL FERNALD

2194

PROJECT: ON-SITE DISPOSAL FACILITY - PHASE II

TITLE: CELL OUTLET GRADING PLANS

151

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

STATE OF OHIO — RUDOLPH BONAPARTE — E-56679 — REGISTERED PROFESSIONAL ENGINEER — SEAL

GEOSYNTEC CONSULTANTS
1100 LAKE HEARN DRIVE
ATLANTA, GEORGIA 30342 USA

FDF PROJECT NO.:	20100
FDF SUBCONTRACT NO.:	95PS005028
FDF DRAWING NO.:	90X-6000-G-00206
GEOSYNTEC PROJECT NO.:	GQ0166-07
GEOSYNTEC DOCUMENT NO.:	F97-0608
SHEET NO.:	G-9B
REVISION NO.:	0

CERTIFIED-FOR-CONSTRUCTION

R:\GQ0166-.07\DWGS\F97-0608 Wed Nov 12 10:27:13 1997 FERMC02

Leachate Conveyance System
Technical Specifications Related to LTS

NON-CONTROLLED DOCUMENT

SPECIFICATION COVER SHEET

SPECIFICATION SECTION: 02215 . **TITLE:** TRENCHING AND BACKFILLING

Specifications By: (Cognizant Engineer)
Signature Dennis L. Vander Linde — Date 20 August 1996
Printed Name and Title DENNIS L. VANDER LINDE, PROJECT ENGINEER

Scope and Format Checked By: (Checker)
Signature Brian D. Jacobson — Date 20 Aug 1996
Printed Name and Title BRIAN D JACOBSON, SENIOR STAFF ENGINEER

Detailed Requirements Checked by: (Checker)
Signature J.F. Beerli — Date 20 Aug 96
Printed Name and Title J.F. BEERLI, PRINCIPAL

Overall Review By: (PDP)
Signature J.F. Beerli — Date 20 Aug 96
Printed Name and Title J.F. BEERLI, PRINCIPAL

Approved by: (DTL)
Signature [illegible] — Date 20 Aug 96
Printed Name and Title Kenneth W Cargill, Associate

Record of Revision (Number and initial all revisions)

Rev. No.	Reason	Date	By	Checked	Approval
A	Issued to FERMCO for Review	21.08.96	DLVL	[illegible]	[illegible]
B	Issued to DOE for Review	09.09.96	DLVL	[illegible]	[illegible] 7 Sept 96
0	Certified for Construction	7 Oct 96	—	—	[illegible]

SECTION 02215

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SCOPE

A. This Section includes trenching, bedding, and backfilling materials and placement.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 - Surveying

B. Section 02110 - Clearing, Grubbing, and Stripping

C. Section 02200 - Earthwork

D. Section 02270 - Erosion and Sediment Control

E. Section 02300 - Boring and Jacking

F. Section 02605 - High Density Polyethylene (HDPE) Manholes, Pipes, and Fittings

G. Section 02930 - Vegetation

H. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest version of American Society for Testing and Materials (ASTM) Standards:
   1. ASTM C 136. Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D 698. Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixture using a 5.5 Pound Rammer and a 12-inch Drop.
   3. ASTM D 2487. Standard Test Method for Classification of Soils for Engineering Purposes.

4. ASTM E 946. Standard Test Method for Water Absorption of Bentonite by the Porous Plate Method.

B. Latest version of Ohio Department of Transportation Construction and Material Specifications (Ohio DOT Specifications).

C. Latest version of Occupational Safety and Health Administration (OSHA) Construction Standards.

D. Reference Reports addressing OSDF site subsurface conditions:
   1. "*Geotechnical Investigation Report, On-Site Disposal Facility*" [Parsons, 1995]. This report contains geotechnical data for the subsurface soils in the OSDF area.
   2. "*Disposal Facility Pre-Design Geotechnical Investigation, Soil Investigation Data Report, CERCLA/RCRA Unit 2*" [Science Applications International, 1995]. This report presents geotechnical data for the subsurface soils in the OSDF area.
   3. "*Geotechnical Data and Evaluation Report for East and South Field Borrow Areas*" [Parsons, 1996a]. This report contains geotechnical data for the subsurface soils in the East Field borrow area.
   4. "*Off-Site Borrow Materials Evaluation*" [Parsons, 1996b]. This report presents geotechnical data for potential off-site borrow sources for OSDF construction materials, including fine and coarse concrete aggregates, pea gravel, and riprap.

1.04 SUBMITTALS

A. Submit the following to the Construction Manager for review within 45 calendar days from Notice to Proceed:
   1. a list of equipment for trenching and backfilling;
   2. for each source of manhole and embedment fill material, submit:
      a. the source of the embedment fill;
      b. the results of tests conducted on each of three embedment fill samples (taken from three different locations within the material stockpile such that the material is fully represented) in accordance with ASTM C 136 and ASTM D 2487.
      c. a 50-pound representative sample of the embedment fill;
      d. written certification that the embedment fill meets the material requirements of this section; and
   3. a specification sheet for the proposed bentonite powder or granules and a 5-pound representative sample of the material.

1.05 EXISTING CONDITIONS

A. Existing site surface and subsurface conditions, based on available site data, are indicated on the Construction Drawings and in the Reference Reports identified in the "References" Article of this Part.

B. In advance of trenching in an area, verify the accuracy of existing conditions shown on the Construction Drawings. Immediately notify the Construction Manager in writing of deviations from the existing conditions indicated on the Construction Drawings.

C. The approximate locations of all known underground and above ground utilities and structures are shown on the Construction Drawings and/or Reference Drawings. Immediately stop work and notify the Construction Manager if other utility lines or structures, not shown on the Construction Drawings and/or Reference Drawings, are encountered during the verification of existing conditions and execution of work.

D. Ground-water levels in the brown and gray till layers at the site vary during the year and may be higher than those shown on the Reference Drawings. Levels may approach ground surface during extended periods of heavy precipitation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Furnish embedment fill material consisting of homogeneous crushed or angular soil, relatively free of metal, roots, trees, stumps, concrete, construction debris, organic matter, or other deleterious material.

B. Furnish manhole embedment fill material classifying as GW, GP, SW, or SP in accordance with the Unified Soil Classification System (per ASTM D 2487), not gap graded, and having a gradation (per ASTM C 136) meeting the requirements for AASHTO No. 89 coarse aggregate presented in Section 703 of the Ohio DOT Specifications.

C. Furnish pipe embedment fill material for HDPE pipes meeting the requirements of Section 703.06 of the Ohio DOT Specifications.

D. Furnish granular filter material at the locations shown on the Construction Drawings meeting the requirements of Section 703.06 of the Ohio DOT Specifications.

E. Furnish trench backfill material for HDPE pipes and manholes that meets the material requirements for compacted fill as specified in Section 02200.

F. Furnish bentonite powder or granules consisting of Wyoming-grade bentonite containing at least 85 percent sodium montmorillonite, and a water adsorption of at least 500 percent when tested in accordance with ASTM E 946.

G. Furnish a minimum 4-inch wide plastic underground warning tape with suitable warning legend and with integral magnetic locator wire to mark all HDPE and PVC pipes, electrical conduits, control cables, and any other underground utilities as shown on the Construction Drawings.

H. Furnish pipe line marker signs at the intervals shown on the Construction Drawings.

2.02 EQUIPMENT

A. Furnish, operate, and maintain all equipment necessary to perform the work of this Section.

PART 3 EXECUTION

3.01 GENERAL

A. Review Existing Site Utility Drawings and identify and stake existing utilities to locate existing utilities in vicinity of trench lines.

B. In areas of trenching and backfilling, maintain and protect existing above and below ground utilities.

C. Do not damage or disturb survey benchmarks, finished construction, and existing structures.

D. Do not damage or disturb above and below grade utilities that are to remain.

E. Dust control measures for all trenching and backfilling shall be in accordance with Part 6, Statement of Work, of the Subcontract Documents.

3.02 TRENCHING

A. Trench subsoils for placement of pipes and HDPE manholes to the depths and minimum dimensions shown on the Construction Drawings. Manage excavated material in accordance with Section 02200.

B. Use sheeting and bracing where necessary to maintain the safety and stability of all slopes and trenches and to protect adjacent structures. Satisfy all applicable local, state, and federal requirements for slope and trench sheeting and bracing, including requirements of the Occupational Safety and Health Administration (OSHA) Construction Standards. Provide sheeting and bracing materials on site prior to the start of trenching. Adjust spacing and arrangement of sheeting and bracing as required by conditions encountered. Remove sheeting and bracing as backfill progresses. Fill any voids left from sheeting or bracing withdrawal with compacted fill or other approved material.

C. Protect and maintain the trench bottom. Remove rock fragments or raveled materials that collect on the trench bottom. Backfill any overexcavation with pipe embedment fill. Excavate any soft subgrade encountered at the trench bottom and backfill to subgrade elevation with embedment fill or compacted fill.

D. In fill areas, perform trenching only after compacted fill has reached an elevation of at least 2 feet above the elevation of the top of the pipe.

E. Limit the maximum length of open trench to 200 feet in advance and 200 feet behind pipe installation.

F. Dewater trenches and HDPE manhole excavations. Perform dewatering in accordance with Section 02200.

G. Stockpile excess material from trenching in accordance with Section 02200.

3.03 BACKFILLING

A. General
   1. Do not backfill with frozen or saturated material.
   2. Do not backfill over frozen, wet, or soft subgrade.

3. Do not disturb or damage pipes or HDPE manholes in trenches and excavations during backfilling.
4. Do not use heavy compaction equipment which exerts greater than 5 pounds per square inch ground pressure over piping that is covered by less than 12 inches of backfill material.

B. Manhole Excavations
1. For HDPE manholes, place and compact manhole embedment fill as follows.
   a. Place manhole embedment fill material in lifts to the elevation of the bottom of the HDPE manhole. Place material in 7-inch ±1-inch thick loose lifts.
   b. Compact the manhole embedment fill with a minimum of 4 passes of a vibratory plate compactor prior to placing manhole.
   c. Place HDPE manholes and manhole flotation anchor on the compacted manhole embedment fill.
   d. Place manhole embedment fill in the annulus between the HDPE manhole and the excavation, the minimum annulus width shall be 3.5 feet horizontally and 6 inches beneath the manholes, in 7-inch ±1-inch thick loose lifts.
   e. Compact with a minimum of 4 passes with a vibratory plate compactor to 3.5 feet below the manhole cover slab.
   f. Place granular filter material above the manhole embedment fill to a thickness of 6 inches.
   g. Compact granular filter material with a minimum of 4 passes of a vibratory plate compactor.
   h. Place compacted fill above the granular filter material to the bottom of the manhole cover slab in accordance with Section 02200.

C. Pipe Trenches
1. Place pipe embedment fill in 7-inch ±1-inch thick loose lifts to the elevation of the bottom of the pipe, except for electrical conduits (Section 16110).
2. Compact pipe embedment fill with a minimum of 4 passes of a vibratory plate compactor prior to placing pipe.
3. Place pipe on top of the compacted pipe embedment fill.
4. Place additional pipe embedment fill on the sides of the pipe and gently hand tamp the fill around the sides of the pipe as needed to insure that intimate contact between the pipe and the pipe embedment fill is maintained below the spring line of the pipe. Continue placing pipe embedment fill until it is even with the top of the pipe. Compact the pipe embedment fill with a minimum of 4 passes of a vibratory plate compactor. Do not compact on top of the pipe unless a minimum of 12 inches of trench backfill separates the compactor from the top of the pipe.

5. For HDPE pipe trenches between HDPE manholes, construct a soil-bentonite plug in the trench to the limits shown in the Construction Drawings. Prepare soil-bentonite mixture consisting of pipe embedment fill at its natural moisture content mixed with minimum 10 percent (by dry weight basis) bentonite powder or granules by thoroughly mixing with a portable cement mixer or other suitable method. Place and compact the soil-bentonite mixture in the same manner as the pipe embedment fill.
6. After placement and compaction of pipe embedment fill and soil-bentonite plugs, place the first lift of trench backfill material in a 12-inch loose lift. Place subsequent lifts of trench backfill material in 8-inch $\pm$1-inch loose lifts.
7. Compact each lift to 95 percent of the maximum standard Proctor dry unit weight and at a moisture content with $\pm$3 percent of the standard proctor optimum moisture content as determined by ASTM D 698.

D. Place underground warning tape in trench backfill 12 inches below finished grade and directly above all HDPE and PVC pipes, electrical conduits, control cables, and underground utilities.

3.04 CONSTRUCTION QUALITY REQUIREMENTS

A. The CQC Consultant will perform conformance testing on the pipe embedment fill, manhole embedment fill, and trench backfill materials to establish compliance with this Section and Section 02200, as applicable. The conformance testing to be performed and the testing frequencies are given in the CQA Plan.

B. The CQC Consultant will perform performance testing on compacted fill trench backfill materials to establish compliance with this Section and Section 02200, as applicable. The performance testing to be performed and the testing frequencies are given in the CQA Plan.

[END OF SECTION]

NON-CONTROLLED DOCUMENT

SPECIFICATION COVER SHEET

SPECIFICATION SECTION: 02605 **TITLE:** HIGH DENSITY POLYETHYLENE (HDPE) MANHOLE

Specifications By: (Cognizant Engineer)
Signature Brian D Jacobson — Date 20 Aug 1996
Printed Name and Title BRIAN JACOBSON, SENIOR STAFF ENGINEER

Scope and Format Checked By: (Checker)
Signature Dennis L. Vander Linde — Date 20 August 1996
Printed Name and Title DENNIS L. VANDER LINDE, PROJECT ENGINEER

Detailed Requirements Checked by: (Checker)
Signature J.F. Beech — Date 20 Aug 96
Printed Name and Title J.F. BEECH

Overall Review By: (PDP)
Signature J.F. Beech — Date 20 Aug 96
Printed Name and Title J.F. BEECH

Approved by: (DTL)
Signature [illegible] — Date 20 Aug 96
Printed Name and Title Kenneth W. Cargill, Associate

Record of Revision (Number and initial all revisions)

Rev. No.	Reason	Date	By	Checked	Approval
A	Issued to FERMCO for Review	20 Aug 96	BJ	DLVL	[illegible]
B	Issued to DOE for Review	09.04.96	BJ	DLVL	[illegible] 7 Oct 96
0	Certified for Construction	7 Oct 96	—	—	[illegible]

SECTION 02605

HIGH DENSITY POLYETHYLENE (HDPE) MANHOLES, PIPES, AND FITTINGS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes high density polyethylene (HDPE) manholes, pipes, fittings, supports, gussets, and appurtenances.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 - Surveying

B. Section 02200 - Earthwork

C. Section 02215 - Trenching and Backfilling

D. Section 03100 - Concrete

E. Section 15000 - Mechanical

F. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest version of the American Society for Testing and Materials (ASTM) standards:

1. ASTM D 638. Test Method for Tensile Properties of Plastics.
2. ASTM D 790. Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
3. ASTM D 1238. Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
4. ASTM D 1248. Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
5. ASTM D 1505. Test Method for Density of Plastics by the Density-Gradient Technique.
6. ASTM D 1603. Standard Test Method for Carbon Black in Olefin Plastics.

7. ASTM D 1693. Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
8. ASTM D 2122. Method for Determining Dimensions of Thermoplastic Pipes and Fittings.
9. ASTM D 2657. Standard Practice for Heat Joining Polyolefin Pipe and Fittings.
10. ASTM D 2837. Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
11. ASTM D 3350. Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
12. ASTM F 714. Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
13. ASTM F 1055. Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

B. Latest version of the American National Standards Institute (ANSI) standards:
1. ANSI B16.1. Standard Specifications for Cast-Iron Pipe Flanges and Flange Fittings.

C. Latest version of the American Society of Mechanical Engineers (ASME) standard:
1. ASME B31.9 §937.1 through 937.3 Building Services Piping.

1.04 SUBMITTALS

A. Submit the following to the Construction Manager for review within 30 calendar days from Notice to Proceed:
1. detailed shop drawings of all HDPE manholes, pipes, support centralizers, fittings, supports, gussets, and appurtenances;
2. a list of materials to be furnished;
3. the names of the suppliers and the proposed dates of delivery of the materials to the site;
4. detailed procedures to be used for hydrostatic testing of the manholes, pipes, and fittings;
5. a list of completed facilities for which the Manufacturer has manufactured 7-ft diameter or larger HDPE manholes. Provide the following information for each facility:
   a. name, location, purpose of facility, and date of installation;
   b. names of owner, project manager, design engineer, and installer; and
   c. diameter and height of the manholes provided;

6. documentation demonstrating that the Manufacturer has adequate quality control procedures to ensure that fabrication of the HDPE manholes complies with the requirements of this Section;
7. origin (resin supplier's name, resin production plant) and identification (brand name, number) of the polyethylene resin used;
8. minimum Manufacturer certifiable values and the corresponding test procedures for HDPE material properties listed in Tables 02605-1 and 02605-2; submit values that are specific to the resin used in manufacture.

B. Submit to the Construction Manager for review at least 30 calendar days prior to shipment, the following documentation on the resin used to manufacture the HDPE manholes, pipes, fittings, supports, and gussets.
   1. Copies of quality control certificates issued by the resin supplier including the production dates and origin of the resin used to manufacture the HDPE products for this Subcontract.
   2. Results of tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the HDPE products assigned to the project.
   3. Certification that no reclaimed polymer is added to the resin during the manufacturing of the HDPE products to be used for this project.

C. Submit at least 30 calendar days prior to installation of any material covered by this Section, Manufacturer's written certification of compliance with these Specifications for that material. Include in this certification of compliance a final inspection and a written record of this inspection. The inspection shall include the following:
   1. HDPE manholes, including attached pipes, fittings, supports, gussets, and appurtenances;
      a. dimensional check;
      b. material quality check;
      c. weld quality; and
      d. leak check;
   2. HDPE pipes, fittings, and appurtenances:
      a. dimensional check; and
      b. material quality check.

D. Submit at least 14 calendar days prior to installation documentation of training and certification of personnel qualified for performing HDPE manhole installation and HDPE pipe joining operations.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and proportion all parts to have adequate strength and stiffness and to be adapted for the purposes shown on the Construction Drawings.

B. Furnish each HDPE manhole completely assembled with all pipes, valves, fittings, supports, gussets, and appurtenances such that field work involves only installation and connection of external products.

C. Furnish each HDPE manhole with watertight construction of welds and pipe penetrations.

2.02 HDPE COMPOUND

A. Furnish HDPE manholes and flat stock manufactured from new, high performance, high molecular weight, HDPE resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P34), ASTM D 3350 (minimum cell classification as shown in Table 02605-1), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. Furnish material having minimum certifiable property values listed in Table 02605-1.

B. Furnish HDPE pipe and fittings manufactured from new, high performance, high molecular weight, HDPE resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P34), ASTM D 3350 (minimum cell classification as shown in Table 02605-2), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. Furnish material having minimum certifiable property values listed in Table 02605-2.

2.03 HDPE MANHOLE

A. Furnish manholes of the types, and to the dimensions, shown on the Construction Drawings.

B. Furnish manholes having exterior and interior surfaces that are smooth with no sharp projections, homogeneous throughout with respect to resin compound, and free of foreign inclusions and surface defects. Furnish HDPE manholes that are as uniform as commercially achievable in color, opacity, density, and other physical properties.

C. Shop fabricate manhole from HDPE pipe meeting the requirements of this Section. Shop fabricate 7-foot diameter manholes using HDPE Class 100 material conforming to ASTM F 894. Shop fabricate 54-inch diameter manholes using an HDPE Standard

Dimension Ratio (SDR) of 32.5 conforming to ASTM F 714. The primary containment of the permanent lift station shall be shop fabricated using Class 160 material and the secondary containment shall be shop fabricated using Class 250 material conforming to ASTM F 894.

D. Shop fabricate manhole pipe stub-outs with the same pipe SDR as the HDPE pipe specified in the Article "HDPE Pipes, Fittings, and Appurtenances" of this Section. Fabricate with a minimum stub-out length of 12 inches, or more if necessary for thermal butt fusion of external pipes.

E. Shop fabricate cover, base, gussets, and supports from minimum 1-inch thick HDPE flat stock.

F. Shop weld components of the HDPE manhole. Weld pipes and fittings to each other by thermal butt fusion. Weld other components, including gussets and supports, to the manhole by extrusion welding. Hot air welding is not acceptable. Do not join the pipe supports with the pipes unless specifically called for on the Construction Drawings.

G. Extrusion weld manhole cover and base at both inside and outside intersections with the riser section.

H. Extrusion weld stiffener rings to the permanent lift station primary containment. Perforate stiffener rings to provide 1 square inch of open area at bottom to allow flow of liquid to the annular space liquid level transmitter.

I. Provide manholes and the permanent lift station with adequate lugs for lifting and placement.

J. Permit the CQC Consultant and/or Construction Manager to visit the manufacturing plant for project specific visits. If possible, such visits will be prior to, or during, the manufacturing of the manholes for this project.

2.04 HDPE PIPES, FITTINGS, AND APPURTENANCES

DCN 1700-007

A. Unless otherwise shown on the Construction Drawings, furnish HDPE pipe and fittings that have a SDR of 11 and conform to ASTM F 714.

B. Furnish HDPE pipes in standard laying lengths not exceeding 50 feet.

166

C. Furnish HDPE pipes and fittings that are homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and are uniform in color, density, melt index, and other physical properties.

D. Furnish HDPE end caps at the end of pipes as shown on the Construction Drawings.

E. Furnish electrofusion couplings meting the requirements of ASTM F 1055 and as recommended by the electrofusion coupling manufacturer.

F. Furnish HDPE pipe supports which cradle the pipe for a length of at least 1 pipe diameter and encircle the pipe 180 degrees of the pipe diameter. Furnish pipe supports conforming to the Construction Drawings.

G. Perforate pipe by factory drilling at locations shown on the Construction Drawings.

2.05 HDPE DUAL CONTAINMENT PIPING SYSTEM

A. Furnish dual containment piping system consisting of field or factory fabricated carrier and containment pipes and pre-fabricated fittings.

B. Furnish components of the dual containment piping system, including carrier piping, containment piping, fittings, and appurtenances meeting the requirements for HDPE pipes, fittings, and appurtenances given in this Section.

C. Furnish pipe and fittings with the carrier pipe/fitting ends extending 6 inches beyond the containment pipe/fitting ends. Provide pipe in nominal lengths of 20 to 50 feet, and allow for field adjustment of pipe length.

D. Furnish pre-fabricated dual containment fittings with the carrier fitting factory installed within the containment fitting, with all necessary support centralizers installed.

E. Fabricate all carrier to carrier containment to containment joints using thermal fusion procedures recommended by the Manufacturer and as required by this Section. Fabricate carrier to carrier joints and containment to containment joints independently of each other. Inspect carrier to carrier joints before final closure of the containment.

F. Furnish support centralizers to provide a continuous annular space between the carrier and the containment pipes in conformance with the recommendations of the Manufacturer or with a maximum allowable spacing of 4 feet, whichever is less.

Centralizers shall not inhibit flow of carrier pipe leakage in the containment pipe. Material for centralizers shall be as recommended by HDPE pipe manufacturer.

2.06 IDENTIFICATION

A. Identify each HDPE manhole using a manhole number, as indicated on the Construction Drawings. Mark the number on the interior and exterior of the manhole.

B. Mark the HDPE manhole with the Manufacturer's name, production code, date, and place of manufacture on the interior of the manhole.

C. Continuously indent print on the HDPE pipe, or space at intervals not exceeding 5 feet the following:
   1. name and/or trademark of the HDPE pipe manufacturer;
   2. nominal HDPE pipe size;
   3. standard dimension ratio (e.g., SDR-11);
   4. the letters PE followed by the polyethylene grade per ASTM D 1248, followed by the Hydrostatic Design Stress in 100's of psi (e.g., PE 3408);
   5. manufacturing Standard Reference (e.g., ASTM F 714); and
   6. a production code from which the date and place of manufacture can be determined.

2.07 MANHOLE FRAME AND COVER

A. Furnish manhole frame and access cover meeting the requirements of Section 15000.

2.08 MANUFACTURER TECHNICAL SUPPORT

A. Furnish on-site services of Manufacturer's technical representative as required for the installation of HDPE manholes.

2.09 EMBEDMENT FILL AND BACKFILL MATERIALS

A. Furnish pipe and manhole embedment fill materials in accordance with Section 02215.

B. Furnish trench backfill and compacted fill materials in accordance with Sections 02215 and 02200, respectively.

PART 3 EXECUTION

3.01

A. Perform HDPE manhole installation and pipe joining operations with trained and certified personnel.

3.02 HDPE MANHOLE HANDLING

A. Drain all entrapped water and prevent the entrance of water during shipment, storage, and handling.

B. Exercise care when transporting, handling, and placing the manhole, such that the HDPE manhole is not damaged. Handle manhole only by the lifting lugs specifically designed and installed by the Manufacturer for lifting. Protect finished surfaces.

C. Store HDPE manhole as recommended by Manufacturer.

3.03 HDPE MANHOLE INSTALLATION

A. Carefully examine HDPE manholes, fittings, supports, gussets, and appurtenances for cracks, damage or defects before installation. Remove defective materials from the site.

B. Install HDPE manholes, fittings, supports, gussets, and appurtenances in accordance with the Manufacturer's recommendations.

C. Inspect the HDPE manhole interior and HDPE pipe, fittings, supports, gussets, and appurtenances and remove any foreign material present before installation into the final position.

D. Perform excavation and backfilling for each manhole in accordance with Section 02215.

E. Perform a hydrostatic test of each installed manhole in accordance with this Section.

3.04 HDPE PIPE, FITTINGS AND APPURTENANCES

A. Deliver HDPE pipe, fittings, and appurtenances to the site at least 10 calendar days prior to the planned installation date.

B. Provide proper handling and storage of the HDPE pipe, fittings, and appurtenances at the site. Protect materials from excessive heat or cold, dirt, moisture, cutting, or other damaging or deleterious conditions. Provide any additional storage procedures required by the Manufacturer.

C. Exercise care when transporting, handling, and placing HDPE pipe and fittings. Use rope, fabric, or nylon slings and straps when handling HDPE pipe. Do not position slings, straps, etc., at butt-fusion joints or at fittings.

D. The maximum allowable depth of cuts, gouges or scratches on the exterior surface of HDPE pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. Replace any HDPE pipe and fittings that become gouged, twisted, or crimped. Remove from the work area damaged pipes and fittings.

E. Whenever pipe laying is not actively in progress, close the open ends of all installed pipes using watertight plugs.

F. Perform trenching and backfilling of all installed pipe, fittings, and appurtenances in accordance with Section 02215.

G. Perform testing of all installed pipe, fittings, and appurtenances in accordance with this Section.

3.05 HDPE PIPE AND FITTINGS INSTALLATION

A. General:
1. Carefully examine HDPE pipe and fittings for cracks, damage or defects before installation. Do not use cracked, damaged, or defective material.
2. Inspect the interior of all pipe and fittings and remove any foreign material from the pipe interior before the pipe is moved into final position.
3. Perform field-cutting of pipes, where required, with a machine specifically designed for cutting pipe. Make cuts carefully without damage to pipe, so as to leave a smooth end at right angles to the axis of pipe. Taper cut ends and smooth sharp edges. Flame cutting is not allowed.
4. Do not lay pipe until the Construction Manager has verified the bedding conditions.
5. Install HDPE pipe and fittings in accordance with the Manufacturer's recommendations and the requirements of this Section.
6. Install pipe and fittings to the lines and grades shown on the Construction Drawings.

7. Place and compact pipe embedment fill and trench backfill material as shown on the Construction Drawings in accordance with Section 02215.
8. Provide all necessary adapters and/or fittings required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

B. Install pipe marker in accordance with Section 02215.

3.06 HDPE PIPE JOINTS, FITTINGS, AND APPURTENANCES CONNECTIONS

A. Qualify all personnel performing joining operations as specified in this Section.

B. Weather Conditions for Joining:
1. Do not join HDPE pipes and fittings at ambient temperatures below 40°F or above 104°F, unless authorized in writing by the Construction Manager. For cold (<40°F) or hot (>104°F) weather joining, use the additional procedures authorized in writing by the Construction Manager.
2. Measure ambient temperatures at fusion machine.
3. Do not join HDPE pipe and fittings during any precipitation, in the presence of heavy fog or dew, or in areas of ponded water.

C. Prior to joining, clean the joint area to be free of moisture, dust, dirt, debris of any kind, and foreign material.

D. Joining equipment shall be approved for the applicable field joining processes which are thermal butt fusion and eletrofusion. Fusion-welding apparatus shall be automated devices equipped with gauges giving the applicable temperatures and pressures.

E. Make trial but-fusion joints on spool pieces of HDPE pipe to verify that joining conditions are adequate. Conduct trial joints on the same material to be installed and under similar field conditions as production joints. Conduct trial joining at the beginning of each day for each fusion apparatus used that day. Also, each joiner shall make at least one trial joint each day. Conduct trial joining under the same conditions as the actual joining. Prepare trial joints that are at least 2 feet long (after seaming) with the joint at the midpoint.

F. Weld HDPE carrier and containment pipe with thermal butt-fusion joints or electrofusion adapters. Fabricate joints in compliance with ASTM D 2657, ASTM F 1055, the Manufacturer's recommendations, and the requirements of this Section.

G. Install flanged connections of HDPE pipe and fittings as shown on the Construction Drawings and as follows:
   1. Thermal butt-fuse HDPE flange connection (flange adapter) to HDPE pipe.
   2. Use Type 316 stainless steel lap joint flange. Outside diameter and drillings shall comply with American National Standards Institute (ANSI) B16.1.
   3. Use Type 316 stainless steel flange bolts, nuts and washers that meets the requirements of ANSI B16.1. Lubricate bolt threads prior to attaching nuts. Tighten bolts to a torque of 100 ±5 foot-pounds.

H. Bolt HDPE flange adapter and stainless steel lap joint flanges at the ambient temperature of the surrounding soil to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene. Draw bolts up evenly and in line. Retighten bolts 1 and 4 hours after initial tightening.

3.07 FIELD TESTING AND INSPECTION

A. Notify the CQC Consultant a minimum of 24 hours in advance of any manhole or pipe testing or pipe inspection.

B. HDPE Manhole Hydrostatic Testing:
   1. Provide testing apparatus, including pumps, hoses, gauges, taps, plugs, drains, temporary connections, and fittings to perform testing in accordance with this Section.
   2. Hydrostatically test each HDPE manhole and primary containment after final pipe connections have been completed and after backfilling. Hydrostatically test each HDPE manhole, each primary containment vessel of each LDS manhole, and the primary containment of the permanent lift station using the following method.
      a. Perform each test in the presence of the CQC Consultant and in accordance with the detailed procedure approved under this Section.
      b. Temporarily seal any holes or gaps.
      c. Fill the HDPE manhole to 6 inches below its top with clean water.
      d. Monitor the level of water for a 4-hour period.
      e. Identify any leaks, remove the water, and make repairs to the HDPE manhole or primary containment. A leak is defined as any water level drop over the test period except for an anticipated drop due to material relaxation and expansion. The anticipated drop must be demonstrated in the approved test procedure submitted by the Subcontractor in accordance with this Section.
      f. Retest the HDPE manhole or primary containment until a passing test is achieved.

g. After completion of the test, remove temporary seals, pump the HDPE manhole or primary containment dry, and dispose of test water.

C. HDPE Pipe and Fittings Hydrostatic Testing:

1. Provide testing apparatus, including pumps, hoses, gauges, taps, plugs, drains, temporary connections, and fittings to perform testing in accordance with this Section.
2. HDPE pipe hydrostatic testing:
   a. Pressure test all installed HDPE solid wall, carrier, and containment pipe prior to placing fill over the pipes. (See exception allowed in DCN 1700-033)
   b. Perform tests in the presence of the CQC Consultant and in accordance with the detailed test procedure submitted by the Subcontractor in accordance with this Section.
   c. Test HDPE solid wall and carrier pipe at ~~120~~ 50 psi internal pressure for gravity pipe systems and at ~~150~~ 75 psi internal pressure for force main system. Test pipes in accordance with ASME B31.9 §937.1 through §937.3. DCN 1700-033
   d. Test HDPE containment pipe at 15 psi internal pressure. Test containment pipe in accordance with ASME B31.9 §937.1 through §937.3.
   e. Test pipes at the required internal pressure for a minimum of one hour after the pressure in the pipe has stabilized. The test duration does not include the initial expansion phase after the pipe is first pressurized. The duration of the expansion phase shall be as recommended by the Manufacturer.
   f. Identify any leaks, remove the water, and make repairs to the pipe.
   g. Retest the pipe until acceptance criteria are achieved in accordance with the approved procedures for testing prior to placing backfill over the pipe.
   h. Test gauges shall be calibrated within one year of date of test. Calibration shall be traceable to national or industry standards where possible.
   i. Acceptance criteria for hydrostatic testing is zero leakage for the stabilized pressure for the minimum duration of the test.

D. Subcontractor may substitute air testing in lieu of hydrostatic testing if authorized in writing by the Construction Manager. Submit detailed work plan for review and approval by the Construction Manager.

E. HDPE Pipe Inspection

1. Inspect fusion joints for evidence of excess or insufficient bead size, contamination, offset, or any other evidence of inadequate joining. The surface of the HDPE pipe shall be clean at the time of inspection. Wipe or wash the HDPE pipe surface if surface contamination inhibits inspection.
2. Repair any pipe sections where greater than 4 percent pipe diameter deflection from vertical is observed. in 6" pipe.

F. Defects and Repairs:
   1. Repair Procedures:
      a. Repair any portion of the HDPE pipe exhibiting a flaw, or poor quality fusion joint by removing bad joint or pipe section and replacing with a new pipe section.
      b. When making repairs, satisfy the following:
         (1) clean and dry all pipe surfaces immediately prior to repair;
         (2) only use approved fusion equipment; and
         (3) extend repairs at least 12 inches in all direction beyond the extent of the defect.
   2. Repair Verification:
      a. Inspect each repair using the methods described in the this Article. Repair areas that fail the inspection.

3.08 SURVEY CONTROL

A. Survey location and elevation of the manholes, pipes, and appurtenances in accordance with Section 02100.

B. Survey the top of HDPE containment pipe on no greater than 50-foot centers and at manhole inlets and outlets in accordance with Section 02100.

3.10 TOLERANCES

A. Install HDPE manholes and the permanent lift station to within ±0.1 feet of the elevations indicated on the Construction Drawings.

B. Install HDPE manholes within 0.5 degrees of plumb.

C. Install all HDPE pipes to within ±0.1 feet of bottom of pipe elevations of the containment pipes as indicated on the Construction Drawings.

D. Provide positive slope of gravity lines at all locations to within ±10 percent of the values indicated on the Construction Drawings.

TABLE 02605-1

REQUIRED HDPE MANHOLES AND FLAT STOCK PROPERTIES ASTM D 3350 CELL CLASSIFICATION PROPERTIES AND RANGES

	Cell Range	Qualifiers	Units	Specified Values	Test Method
Specific Gravity	3	minimum	N/A	0.94	ASTM D 1505
Melt Flow Index	3 to 5	maximum	g/10 min	<0.4	ASTM D 1238 (Condition E)
Flexural Modulus	5	minimum	lb/in^2	110,000	ASTM D 790
Tensile Strength	4 or 5	minimum	lb/in^2	3,000	ASTM D 638
Environmental Stress Crack	3	minimum	hrs	$F_{20} > 192$	ASTM D 1693
Hydrostatic Design Basis at 73°F	4	minimum	lb/in^2	1,600	ASTM D 2837
UV Stabilizer	C	minimum	% Carbon Black	2	ASTM D 1603

TABLE 02605-2

REQUIRED HDPE PIPE AND FITTINGS PROPERTIES
ASTM D 3350 CELL CLASSIFICATION PROPERTIES AND RANGES

Properties	Cell Range	Qualifiers	Units	Specified Values	Test Method
Specific Gravity	3	minimum	N/A	0.94	ASTM D 1505
Melt Flow Index	4 or 5	maximum	g/10 min	<0.15	ASTM D 1238 (Condition E)
Flexural Modulus	5	minimum	lb/in^2	110,000	ASTM D 790
Tensile Strength	4 or 5	minimum	lb/in^2	3,000	ASTM D 638
Environmental Stress Crack	3	minimum	hrs	$F_{20} > 192$	ASTM D 1693
Hydrostatic Design Basis at 73°F	4	minimum	lb/in^2	1,600	ASTM D 2837
UV Stabilizer	C	minimum	% Carbon Black	2	ASTM D 1603

[END OF SECTION]

F. Defects and Repairs:
   1. Repair Procedures:
      a. Repair any portion of the HDPE pipe exhibiting a flaw, or poor quality fusion joint by removing bad joint or pipe section and replacing with a new pipe section.
      b. When making repairs, satisfy the following:
         (1) clean and dry all pipe surfaces immediately prior to repair;
         (2) only use approved fusion equipment; and
         (3) extend repairs at least 12 inches in all direction beyond the extent of the defect.
   2. Repair Verification:
      a. Inspect each repair using the methods described in the this Article. Repair areas that fail the inspection.

3.08 SURVEY CONTROL

A. Survey location and elevation of the manholes, pipes, and appurtenances in accordance with Section 02100.

B. Survey the top of HDPE containment pipe on no greater than 50-foot centers and at manhole inlets and outlets in accordance with Section 02100.

3.10 TOLERANCES

A. Install HDPE manholes and the permanent lift station to within ±0.1 feet of the elevations indicated on the Construction Drawings.

B. Install HDPE manholes within 0.5 degrees of plumb.

C. Install all HDPE pipes to within ±0.1 feet of bottom of pipe elevations of the containment pipes as indicated on the Construction Drawings.

D. Provide positive slope of gravity lines at all locations to within ±10 percent of the values indicated on the Construction Drawings.

TABLE 02605-1

REQUIRED HDPE MANHOLES AND FLAT STOCK PROPERTIES ASTM D 3350 CELL CLASSIFICATION PROPERTIES AND RANGES

	Cell Range	Qualifiers	Units	Specified Values	Test Method
Specific Gravity	3	minimum	N/A	0.94	ASTM D 1505
Melt Flow Index	3 to 5	maximum	g/10 min	<0.4	ASTM D 1238 (Condition E)
Flexural Modulus	5	minimum	lb/in^2	110,000	ASTM D 790
Tensile Strength	4 or 5	minimum	lb/in^2	3,000	ASTM D 638
Environmental Stress Crack	3	minimum	hrs	$F_{20} > 192$	ASTM D 1693
Hydrostatic Design Basis at 73°F	4	minimum	lb/in^2	1,600	ASTM D 2837
UV Stabilizer	C	minimum	% Carbon Black	2	ASTM D 1603