Superfund Five-Year Review Report
Brantley Landfill
Island, Mclean County, KY
EPA ID: KYD980501019

PREPARED FOR:

United States Environmental Protection Agency
Region IV
Atlanta, Georgia

PREPARED BY:

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AUGUST 2002

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EPA Five-Year Review Signature Cover
Preliminary Information

Site Name: Brandtly Landfill Site	**EPA ID:** KYD980501019
Region: 04 **State:** Kentucky	**City/Count:** Island, McLean County
LTRA: No	**Construction Completion Date:** June 1998
Who conducted the review? (EPA Region, state, Federal Agency, contr) PRP’s consultant, EnSafe Inc.	
Date Review Conducted: 07/02-08/02	**Date of Site Visit:** 04/22/02 & 08/08/02
Whether first or successive review: First Review	
Circle: [✓ **Statutory**] Policy	**Due Date:** 08/01/02
Trigger for this review (name)	Five years from construction initiation (8/01/97)
Recycling, reuse, redevelopment site (highlight):	No

Deficiencies:
None noted.

Recommendations:
Recommendations are listed in the attached report, Section IX, Recommendations.

Protectiveness Statements:
The remedy at the Brantley Landfill Site currently protects human health and the environment. Security measures at the site restrict access and prevent human exposure. Capping measures also prevent direct contact with site contaminants and minimize infiltration into the landfill; thereby reducing the volume of leachate in groundwater. In order for the remedy to be protective in the long-term, deed restrictions need to be established and recorded prohibiting the use of groundwater as a drinking water source and residential habitation on the site.

Other Comments:
None

Signature of EPA Regional Administrator or Division Director, and Date

James [illegible] for 9/27/02

Richard D. Green, Waste Division Director   Date
U.S. EPA, Region 4

List of Acronyms

AOC	Administrative Order by Consent
ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
ESD	Explanation of Significant Difference
KNREPC	Kentucky Natural Resources and Environmental Protection Cabinet
MCL	Maximum Contaminant Level
NPL	National Priorities List
O&M	Operation & Maintenance
PRP	Potentially Responsible Party
RA	Remedial Action
RAO	Remedial Action Objective
RBC	Risk Based Concentration
RD	Remedial Design
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SCFs	Salt Cake Fines
SMCL	Secondary Maximum Contaminant Level
TCL/TAL	Target Compound List/Target Analyte List
UAO	Unilateral Administrative Order

Executive Summary

The remedy for the Brantley Landfill Site in Island, McLean County, Kentucky included source control via capping of the existing salt cake fine landfill, groundwater monitoring to evaluate shallow and deep groundwater at the site, post-cap air monitoring, institutional controls (site fencing) and deed restrictions.

The site achieved construction completion with the signing of the Preliminary Close Out Report in August 27, 1998. The trigger for this five-year review was the actual start of construction on August 1, 1997.

The review and site inspection conducted for this first five-year review found that the remedy was constructed and operated in accordance with the requirements of the Record of Decision (ROD). An Explanation of Significant Difference will be written for those contingent components of the remedy no longer deemed necessary and those components which have been revised since the ROD was written. The remedy is functioning well to protect human health and the environment.

Because this remedy will result in the potential for the creation of hazardous substance remaining onsite for some time, operation and maintenance activities will continue to be conducted indefinitely. In addition, five-year reviews will need to be conducted for some time. The next scheduled review is August 2007.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN):* Brantley Landfill NPL Site		
EPA ID *(from WasteLAN):* KYD980501019		
Region: IV	**State: KY**	**City/County: Island/McLean**
SITE STATUS		
NPL staus: Final		
Remedation status (choose all that apply): **Complete**		
Multiple OUs? No		**Construction completion date: 06/30/98**
Has site been put into reuse? No		
REVIEW STATUS		
Lead agency: USEPA Region IV, North Site Management Branch		
Author name: Ms. Ginny Gray Davis		
Author title: Vice President		**Author affiliation: EnSafe Inc.**
Review period:* * 7/01/02 to 08/15/02		
Date(s) of site inspection: 08/08/02		
Type of review: Statutory		
Review number: 1 – First five year review post contstruction		
Triggering action: Construction completion		
Triggering action date *(from WasteLAN)*: 08/01/97		
Due date *(five years after triggering action date)*: 08/16/02		

* [“OU” refers to operable unit.]

* * [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Issues:

Kentucky has been experiencing a drought this summer. As a result, several small areas were identified during the site inspection that should be reseeded this fall to maintain proper vegetative cover to control erosion. These areas were identified in the July 2002 O&M Progress Report to USEPA and will be addressed in September or October 2002. Despite these dry conditions, the landfill cover was in excellent condition overall. During inspection of the onsite monitoring wells it was observed that the protective outer casing for leachate monitoring well J12S is corroded through and will be replaced as part of the O&M.

Deed restrictions have not been completed, but will be prepared soon. Because Commonwealth Aluminum does not own this property, these restrictions will have to be coordinated with the owner of the property, Ms. Peggy Drake of Island, Kentucky.

An Explanation of Significant Difference (ESD) needs to be prepared for the site. This ESD should include the following revisions to the remedy outlined in the Record of Decision (ROD):

- Post cap shallow groundwater data confirm that an alkaline recharge trench will not be needed.
- Post cap groundwater and leachate monitoring confirm that a contingent pump & treat remedy will not be needed.
- Post cap FTIR monitoring and access restrictions eliminate the need for abandoned mine shaft air monitoring.
- In 2001, USEPA, during the comment and response period of the Remedial Action Report, verbally agreed to reduce the following: sampling frequency (quarterly to annual); number of monitoring wells for O&M groundwater monitoring, and; parameter list. As a result, the performance standards for groundwater (shallow and deep) need to be revised to reflect those changes.
- The correct performance standard for ammonia is 34 mg/L and therefore should be revised from 34 µg/L listed in the ROD.

Recommendations and Follow-up Actions:

Implement the repairs listed above, finalize deed restrictions, write and submit the ESD, and maintain the current approved O&M monthly inspection program for the landfill.

Table 1
Five-Year Review Follow up Actions

Action	Responsible Party	Oversight Agency(ies)	Milestone Date	Affects Protectiveness? (Y/N)	
				Current	Future
Re-vegetate bare areas	CAC	USEPA/KNREPC	October 2002	N	Y
Repair J12S protective casing	CAC	USEPA/KNREPC	October 2002	N	Y
Write ESD for Site	USEPA	None	FY 2003	N	N
Prepare and record deed restrictions	CAC	KNREPC	Post-ESD	N	Y
Maintain O&M Inspections	CAC	USEPA/KNREPC	Ongoing	N	Y

Protectiveness Statement:

The remedy at the Brantley Landfill Site currently protects human health and the environment. Security measures at the site restrict access and prevent human exposure. Capping measures also prevent direct contact with site contaminants and minimize infiltration into the landfill; thereby reducing the volume of leachate in groundwater. In order for the remedy to be protective in the long-term, deed restrictions need to be established and recorded prohibiting the use of groundwater as a drinking water source and residential habitation.

Five-Year Review Report

I. Introduction

This is the first five-year review of the Brantley Landfill Site (EPA Docket #95-14-C) located in Island, McLean County, Kentucky. The purpose of this review is to determine whether the remedy documented in the Record of Decision (ROD) dated December 14, 1994 is protective of human health and the environment.[1] This report not only documents the findings, but also provides recommendations to address any issues identified with the site during the review process.

This review is statutory pursuant to CERCLA §121[2] and 40 CFR §300.430(f) (4) (ii)[3] which require reviews every five years for those sites where hazardous substances remain onsite post remedial action. The trigger date for completion of this five-year review is the date construction was initiated which was August 1997.

EnSafe Inc., on behalf of Commonwealth Aluminum Concast (CAC), the potentially responsible party (PRP), conducted a five-year review of the remedial actions implemented at the Brantley Landfill Site for USEPA Region IV, North Site Management Branch. This review was conducted from July 2002 through August 2002. Contributors to the review included: Mr. Robert West, Remedial Project Manager, USEPA, Region IV, Mr. Bill O'Steen, USEPA Region IV; Mr. Roger Burden, Site Manager for CAC; Ms. Sandra English, Environmental Services, CAC; Mr. Ben Brantley, Project Geologist, EnSafe Inc.; and, Mr. Ken Logsdon, Project Manager for the Kentucky Natural Resources and Environmental Protection Cabinet.

The selected remedy results in salt cake fines remaining in the landfill at the site. Ammonia and other metals in groundwater remain at levels above those allowed for unrestricted use. Therefore, a review will be conducted every five years until such time that concentrations have decreased to acceptable levels.

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[1] - Protectiveness is generally defined in the NCP by the risk range and hazard index.

[2] - If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five year after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

[3] - If a remedial action is selected that results in hazardous substances, pollutants or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposures, the leady agency shall review such action no less often than every five years after the initiation of the selected remedial action.

II. Site Chronology

Table 2 lists important site events and relevant dates in the site chronology of the Brantley Landfill NPL Site.

Table 2 – Chronology of Site Events
Brantley Landfill Site – Island, McLean Count Kentucy

Event	*Date*
Initial discovery of problem or contamination	1979
Proposed NPL Listing	June 1988
NPL Final Listing (Federal Register)	February 21, 1990
Administrative Order by Consent	January 10, 1990
Remedial Investigation Approved	1994
Feasibility Study Approved	1994
ROD Issued	December 14, 1994
Unilateral Administrative Order	March 31, 1995
Remedial Design Work Plan Submitted	August 25, 1995
Remedial Action Work Plan Submitted	June 17, 1997
Final Remedial Design Approved by USEPA	June 24, 1997
Remedial Action (Construction) Start	August 1, 1997
Final Construction Inspection	May 29, 1998
Final Construction Inspection Report	June 30, 1998
Preliminary Close Out Report	August 27, 1998
First Five-Year Review	August 2002
Operation and Maintenance Plan/Manual	October 12, 1998
Post-Construction Air Monitoring Conducted	June 11-13, 2000
Remedial Action Report Submitted	September 18, 2001
Five Year Review	August 15, 2002

III. Background

The Brantley Landfill Site is an approximate 35-acre parcel located in Island, McLean County, Kentucky. The site was formerly strip-mined to extract coal for commercial sale. In 1977, Barmet Aluminum Corporation (now Commonwealth Aluminum Concast) contracted for the disposal of 250,000 tons of salt cake fines (a by-product of secondary aluminum recycling) in the abandoned mine pit. Following investigation by USEPA Region IV in 1987, the site was listed on the National Priorities List due to elevated ammonia and metals concentrations in site soil.

Physical Characteristics

The Island and McLean County area is situated in the Western Kentucky coal fields region. The coal fields are located in the interior low plateaus province of the interior plains region. This region is characterized by low rolling hills formed of Pennsylvanian age sandstones and Quaternary alluvial deposits from the Green River and its tributaries. The hills rise to a maximum of about 580 feet and the relief totals approximately 200 feet.

The site is located topographically just above the Quaternary alluvium in the Pennsylvanian age Carbondale Formation at an elevation of approximately 400 feet. The Brantley Landfill Site encompasses approximately 4 acres of a 35 acre parcel. The landfill is situated in the center of the site and runs north to south along a gently sloping hillside. Surface water drainage is from the east to west toward the unnamed tributary to Cypress Creek (Attachment A, Figure 1). Shallow groundwater occurs in unconsolidated mine spoil and clay approximately 10-15 feet below ground surface in the unconsolidated sediments above the bedrock. Deep groundwater is found in Pennsylvanian aged sandstones, siltstones, and shales at depths up to 35 feet below ground surface.

Land and Resource Use

The site is bound to the north by KY Highway 85, to the south by the City of Island wastewater treatment plant, to the east by Ms. Peggy Drake's residence (owner of the parcel) and the town of Island, and to the west by an unnamed tributary to Cypress Creek. Land use within a one-mile radius of the site is limited to agricultural and residential with the exception of the wastewater treatment plant to the south.

As stated above, the entire Island area has been heavily mined for coal both above (strip) and underground.

History of Contamination

As stated above, approximately 250,300 tons of salt cake fines were disposed in the landfill during a two-year period starting in 1978. Salt cake fines are a by-product of secondary aluminum recovery that contain salts (sodium and potassium chloride), metals, nitrides, and carbides. When salt cake fines contact water ammonia gas is produced. Odor complaints from area residents sparked investigative efforts by KNREPC and USEPA Region IV in the early 1980s. In 1987, USEPA conducted a Site Inspection (SI) where air, soil, surface water and sediment samples were collected and analyzed. The data revealed ammonia and slightly elevated metals concentrations in soil beneath the landfill. Subsequently, on February 21, 1990, the site was placed on the Final National Priorities List.

Initial Response

In 1990, an Administrative Order by Consent (AOC) was signed by USEPA and Barmet Aluminum Corporation (now CAC). The AOC required Barmet to perform a Remedial Investigation/Feasibility Study (RI/FS) and a response action to minimize the immediate threat to human health and the environment posed by site conditions. The response action as stated in the AOC was as follows: eliminate unrestricted access to the site by securing the landfill areas with a fence or similar barrier. A chain-link fence with three strands of barbed-wire and locking gates was installed around the perimeter of the site on March 7, 1990.

In addition, during the early stages of the RI process, continued erosion and loss of vegetative cover on the landfill cap necessitated some minimal repairs to the southern end of the landfill cap. This area was regarded, capped with clay, and re-vegetated in areas where erosion and salt cake fines were exposed. This cap repair was performed in August/September of 1993.

Basis for Taking Action

The basis for taking action at the site was the presence of hazardous substances (i.e., ammonia, chlorides, aluminum and other metals) detected in site environmental media, primarily soil and groundwater.

IV. Remedial Actions

The Record of Decision for the Site was signed on December 14, 1994.

Remedial Action Objectives

The five principal RAOs for the Site are defined in the Statement of Work as follows:

- Prevent direct ingestion of hazardous constituents of the source material and soil contaminants.
- Prevent exposure through air/groundwater pathways.
- Prevent migration of hazardous components of the source material to the air, groundwater, and underground mine works.
- Prevent ingestion of contaminated water in excess of maximum contaminant levels and secondary maximum contaminant levels (MCLs/SMCLs).
- Prevent further contamination/migration of groundwater at contaminant levels in excess of MCLs/SMCLs.

Remedy Description

The selected remedy described in the Record of Decision included two phases. Phase I addressed surface water infiltration into the landfill and Phase II addressed groundwater issues at the site. In addition institutional controls and deed restrictions were required. Specifically, the selected remedy included:

- Restriction of access to the landfill Site by fencing and posting of signs
- Incorporation of restrictive covenants in property deeds to prevent access to the Site and to prevent installation of drinking water wells onsite.

- Installation of additional piezometers and shallow and deep monitoring wells.
- Construction and maintenance of a new landfill cap which minimizes surface water infiltration.
- Regrading areas of the Site to improve runoff and minimize erosion. Regrading of the Site will eliminate the onsite surface pond at the southern end of the landfill.
- Monitoring groundwater levels and quality in and around the landfill for a period of time. Modeling the expected restoration of landfill groundwater quality.
- Estimating the dissolved contaminant mass, and its rate of migration out of the landfill. Projecting the time for a substantial portion of the residual dissolved contaminant mass to migrate from the landfill. Projecting also the time for the same mass of dissolved contaminants to be removed by short-term leachate collection.
- Contingent installation of a short-term leachate collection system.
- Contingent installation of a long-term leachate collection system.
- Installation of an alkaline recharge trench to restore shallow groundwater adjacent to the landfill.
- Monitoring the natural attenuation of contaminant concentrations in deep groundwater.
- Monitoring groundwater in the coal seam adjacent to the abandoned mine works.
- Monitoring ammonia emissions from the abandoned mine works at closed mine shafts.
- Classification of the shallow and deep aquifers.

The Preliminary Close Out Report, August 1998 summarizes the two phases of remedial action (Attachment B).

Cleanup levels for soil and groundwater at the Brantley Landfill Site were selected based on Maximum Contaminant levels (MCLs), Secondary MCLs, health-based performance standards, and/or background concentrations. The following tables list the cleanup levels established in the ROD.

Table 3
Soil Cleanup Levels, mg/kg

Aluminum	7E+05
Arsenic	30
Iron	7E+04

Table 4
Groundwater Cleanup Levels, ppb

Parameter	Shallow Aquifer	Deep Aquifer
Aldrin	0.04	NA
Aluminum	7,065-47,075	29,373-36,920
Arsenic	50	50
Barium	NA	2,000
Beryllium	4	4
Cadmium	5	5
Chromium	100	100
Cobalt	2,000	2,000
Iron	17,080-85,500	42,605-62,275

Table 4
Groundwater Cleanup Levels, ppb

Parameter	Shallow Aquifer	Deep Aquifer
Manganese	1,359-12,100	687-961
Mercury	2	NA
Nickel	100	100
Potassium	NA	1.4E+6
Silver	100	NA
Sodium	10,678-144,000	119,250-137,750
Vanadium	200	200
Zinc	5,000	5,000
Ammonia	NA	34
Chlorides	250	250
Sulfates	250	250

Remedy Implementation

USEPA issued a Unilateral Administrative Order (UAO) to Barmet Aluminum on March 31, 1995. The Remedial Design for the Site was approved in June 1997. Remedial construction activities were initiated in August 1997 and concluded in June 1998. Based on pre-remedy data collection, the performance standards for the landfill were modified to include:

- Capping the north end and interior area of the landfill;
- Crowning flat areas in the interior portion of the landfill;
- Repairing erosion damage on the south end of the landfill; and,
- Modifying and improving three drainage ditches onsite, as well as drainage patterns on the southern slope of the landfill.

On October 20, 1997, October 30, 1997 and November 14, 1997, USEPA, the PRP, and the PRP's consultant conducted a pre-final construction inspection of Ditches 1 & 2 and the landfill cap, the interior portion of the landfill cap, and Ditch 3 and the southern slope of the landfill, respectively. These pre-final inspections included a site walk through and punch list of items for corrective action identified. The Final Construction Inspection site visit was conducted on May 29, 1998. A Final Construction Inspection Report submitted on June 30, 1998 verified that all punch list items were completed, all field changes made during construction were documented, and all field testing, analytical results, and inspection sheets were attached. Final grading plans were also provided as an Attachment. USEPA and KNREPC determined that remedial actions were performed according to design specifications. As a result, the Preliminary Close Out Report was issued by USEPA on August 27, 1998.

In June 2000, post-cap air monitoring, by Fourier Transform Infrared Spectrometry (FTIR) was conducted to determine whether ammonia emissions from the landfill had been effectively mitigated or eliminated by the new cap. The data obtained during this monitoring event were 50-60% lower than the values collected during the RI in 1992. This study verified that downwind emissions measured onsite were an order of magnitude below any applicable threshold or ARAR. As a result, no additional air monitoring was recommended to USEPA. An *Air Monitoring Technical Memorandum* was submitted to USEPA on August 2, 2000 documenting these findings.

System Operations/Operation and Maintenance (O&M)

The Operation & Maintenance Plan/Manual, dated October 12, 1998 outlined the O&M activities for the Brantley Landfill Site. There are no remedial systems installed at the Brantley Landfill Site. As a result, the normal O&M activities being conducted are:

- Inspection of the landfill cap and erosion controls;
- Monitoring of existing groundwater wells;
- Sampling of the onsite pond;
- Upkeep of the vegetative cover (i.e., seeding, sowing, mowing); and,
- Driveway, fencing, and signage maintenance.

Records of the O&M activities are documented and filed at Commonwealth's Livia, Kentucky facility. EnSafe reviewed a representative number of files during the site inspection to verify that O&M operations are occurring as approved in the O&M Plan/Manual.

Significant costs (approximately $32,000.00) were spent in 2000 on Fourier Transform Infrared Spectrometry (FTIR) monitoring to confirm the effectiveness of the landfill cap on air emissions as required by the ROD. The other costs include routine inspections and maintenance (mowing, seeding, etc.), groundwater sampling, laboratory analysis costs, and validation, and reporting. No unanticipated costs have been incurred to date.

Table 5
Operation & Maintenance Costs - Brantley Landfill Site

From	To	Annual Costs
1/1/99	12/31/99	$62,000.00
1/1/00	12/31/00	$85,000.00
1/1/01	12/31/01	$24,000.00
1/1/02	06/31/02	$11,000.00

V. Progress Since the Last Review

This is the first five-year review for this site post construction completion.

VI. Five-Year Review Process

Administrative Components

USEPA Region IV requested the assistance of the PRP in preparing the first five-year review for the subject Site. Commonwealth Aluminum Concast then solicited the services of the managing consultant, EnSafe Inc. to perform the review. A conference call on July 10, 2002 between USEPA's Remedial Project Manager, Mr. Robert West, CAC's Mr. Roger Burden, and Ms. Ginny Gray Davis and Mr. Ben Brantley of EnSafe Inc. scoped the review and set a tentative schedule for delivery of the draft report. During the conference call, participants agreed upon the following review schedule:

• Document Review	July 2002
• Data Review	August 2002
• Site Inspection	August 8, 2002

• Interviews	August 8, 2002
• Draft Five-Year Review Report	August 16, 2002
• Final Five-Year Review Report	September 1, 2002

Because USEPA representatives, Mr. Femi Akindele (acting RPM) and Mr. Harold Taylor (Kentucky/Tennessee Section Chief) had already performed a site visit while in the area for the Ft. Hartford Stone Quarry Five Year Review on April 22, 2002, they were not present for EnSafe's separate site inspection on August 8, 2002. Mr. Ken Logsdon and Mr. Robert Pugh of Kentucky's Division of Waste Management, Federal Superfund Section were present on August 8, 2002 for the inspection.

Document Review

Documents reviewed during the five-year review included:

• Remedial Investigation/Feasibility Study	March 15, 1994
• Operation & Maintenance Plan/Manual	October 12, 1998
• Remedial Action Report	September 18, 2001
• Record of Decision	March 31, 1995
• Statement of Work	March 31, 1995
• Unilateral Administrative Order	March 31, 1995
• Preliminary Close Out Report	August 27, 1998
• O&M Groundwater Reports	Various

Data Review

All items included in Attachment C.

Site Inspection

As stated above, USEPA visited and inspected the site on April 22, 2002, concurrent with the five-year review for the Ft. Hartford Stone Quarry Site nearby. EnSafe Inc., CAC, and KNREPC conducted the site inspection on August 8, 2002. The purpose of the site inspection was to assess the protectiveness of the remedy, including the adequacy of the selected remedy, specifically: the adequacy of site security measures and the effectiveness of the cap to prevent exposures to salt cake fines. A complete list of inspection attendees is including in Attachment D.

Initially the inspection team met at CAC's Livia, Kentucky facility to discuss the agenda for the inspection and outline the objectives of the review. The team then drove to the site and walked the entire four acre fenced parcel containing the landfill. Overall, the site was well secured and maintained. Photographs were taken in the few small areas where reseeding of the vegetative cover needs to be performed. The site visit was completed in approximately one hour.

Following the site visit, EnSafe and CAC returned to the Livia plant to review pertinent site records and complete the site inspection checklists and interviews. The following items were noted and comments made during the inspection. Figures and photos of the inspection are in Attachment E.

1. The site was properly secured with chain link fence and locked gates.

2. The fence was in excellent condition.

3. Signage was visible from Kentucky Highway 85 with a CAC Security phone number.

4. The landfill cap appeared to be in excellent condition with no visible erosion present.

5. Vegetation was well maintained and mowed.

6. One monitoring well through the landfill (J12S) had a corroded outer protective casing. The casing was corroded through and will require replacement.

7. O&M inspection records are well maintained and available for review from 1998 through the current inspection (July 2002).

VII. Technical Assessment

<u>Question A: Is the remedy functioning as intended by the decision documents?</u>

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. Some of the contingencies built into the ROD are not needed and therefore an ESD needs to be written to revise the remedy accordingly. (See Section IV. Remedial Actions for a detailed discussion.

<u>Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid ?</u>

There have been no changes in the physical conditions of the site or the adjacent land uses that would potentially affect the protectiveness of the selected remedy. Performance standards for groundwater need to be reduced to reflect post-cap data evaluation and USEPA approval of a reduced monitoring well and parameter list. The RAOs for the site are still valid and in effect at the site.

<u>Question C: Has any other information come to light that could call into question the protectiveness of the remedy?</u>

No other issues have arisen out of the five-year review that call into question the protectiveness of the remedy handed down in the ROD.

Technical Assessment Summary

In summary, no significant issues were noted during the five-year review of the remedial action components. The cap is effective at drastically reducing ammonia emissions well below ARARs and minimizing the infiltration of precipitation.

This limits leachate production and stabilizes groundwater concentrations at the site. Site security measures protect the cap and minimize the potential direct human exposure.

VIII. Issues

Kentucky has been experiencing a drought this summer. As a result, several small areas were identified during the site inspection that should be reseeded this fall to maintain proper vegetative cover to control erosion. These areas were identified in the July 2002 O&M Progress Report to USEPA and will be addressed in September or October 2002. Despite these dry conditions, the landfill cover was in excellent condition overall. When inspecting the monitoring wells onsite, it was it was observed that the protective outer casing for leachate monitoring well J12S is corroded through and should be replaced.

Deed restrictions have not been completed, but will be prepared soon. Because Commonwealth Aluminum does not own this property, these restrictions will have to be coordinated with the owner of the property, Ms. Peggy Drake of Island, Kentucky and KNREPC.

An Explanation of Significant Difference (ESD) will be prepared for the site. This ESD should include the following revisions to the remedy outlined in the Record of Decision (ROD):

- Post cap shallow groundwater data confirm that an alkaline recharge trench will not be needed.
- Post cap groundwater and leachate monitoring confirm that a contingent pump & treat remedy will not be needed.
- Post cap FTIR monitoring and access restrictions eliminate the need for abandoned mine shaft air monitoring.
- In 2001, USEPA, during the comment and response period of the Remedial Action Report, verbally agreed to reduce the following: sampling frequency (quarterly to annual); number of monitoring wells for O&M groundwater monitoring, and; parameter list. As a result, the performance standards for groundwater (shallow and deep) need to be revised to reflect those changes.
- The correct performance standard for ammonia is 34 mg/L and therefore should be revised from 34 µg/L listed in the ROD.

IX. Recommendations and Follow-up Actions

Implement the repairs listed above, finalize deed restrictions, write and submit the ESD, and maintain the current approved O&M monthly inspection program for the landfill. Table 6 summarizes follow-up actions.

Table 6
Five-Year Review Follow up Actions

Action	Responsible Party	Oversight Agency(ies)	Milestone Date	Affects Protectiveness? (Y/N)	
				Current	Future
Re-vegetate bare areas	CAC – PRP	USEPA/KNREPC	October 2002	N	Y
Repair J12S protective casing	CAC – PRP	USEPA/KNREPC	October 2002	N	Y
Write ESD for Site	USEPA	None	FY 2003	N	N
Propare and record deed restrictions	CAC – PRP	KNREPC	Post-ESD	N	Y
Maintain O&M Inspections	CAC – PRP	USEPA/KNREPC	Ongoing	N	Y

X. Protectiveness Statement

The remedy at the Brantley Landfill Site currently protects human health and the environment. Security measures at the site restrict access and prevent human exposure. Capping measures also prevent direct contact with site contaminants and minimize infiltration into the landfill; thereby reducing the volume of leachate in groundwater. In order for the remedy to be protective in the long-term, deed restrictions need to be established and recorded prohibiting the use of groundwater as a drinking water source and residential habitation on the site.

XI. Next Review

Because this remedy will result in the potential for creation of hazardous substances, which would remain in site groundwater for some time, five-year reviews will be need to continue to be performed indefinitely. The next five-year review is thus scheduled for August 2007.

Surface Soil Contaminants of Concern

Aluminum
Arsenic
Chromium
Iron
Vanadium

Notes:
Compounds/parameters listed are those which accounted for 99 per
and/or
hazard computed in the screening risk analysis (Appendix L). Due t
disturbed
nature of soils, background was defined as any offsite soil sample
12-24 inch depth).

Table 3

Surface Water Contaminants of Concern

Instream Surface
Parameter Water Onsite Pond
Benzene X
Dieldrin X
Aluminum X
Arsenic X
Iron X
Selenium X
Sodium X
Thallium X
Cyanide X
Ammonia X

Notes:
X indicates the surface water source type from which the contaminant concentration was derived.

Table 4

Sediment Contaminants of Concern

Parameter Instream Sediments Onsite Pond
Tetrachlorobenzene X
alpha-Chlordane X
Heptachlor epoxide
Dieldrin X
gamma-BHC X
delta-BHC X
beta-BHC X
Aluminum X
Barium X
Manganese X
Nickel X
Vanadium X

Notes:

X indicates the sediment source type from which the contaminant concentration was derived.

Table 5

Groundwater Contaminants of Concern

Deep Aquife
Shallow
Aquifer
Wells
(Composite Shallow
GMW/H13/DG &
Data Set) Background GMW/16/DG GMW/K7/DG
Heptachlor alpha-BHC Dieldrin Benzene Aluminum
alpha-BHC Aldrin Heptachlor Aluminum
Arsenic Aluminum Heptachlor
beta-BHC Dieldrin epoxide Arsenic Chromium
gamma-BHC Aluminum Aluminum Barium Iron
Aldrin Antimony Beryllium Chromium
Manganese Beryllium Barium
Dieldrin Arsenic Cadmium Iron
Sodium Chromium Chromium
Heptachlor Barium Chromium Manganese
epoxide Beryllium Cobalt Nickel Sulfate
Aluminum Cadmium Iron Sodium
Arsenic Chromium Manganese Chlorides
Beryllium Cobalt Nickel
Cadium Iron Sodium
Chromium Manganese Zinc Ammo
Cobalt Nickel Ammonia
Iron Sodium Chlorides
Manganese Vanadium Sulfates
Mercury Sulfates
Nickel
Silver
Sodium
Vanadium
Zinc
Chlorides
Sulfate

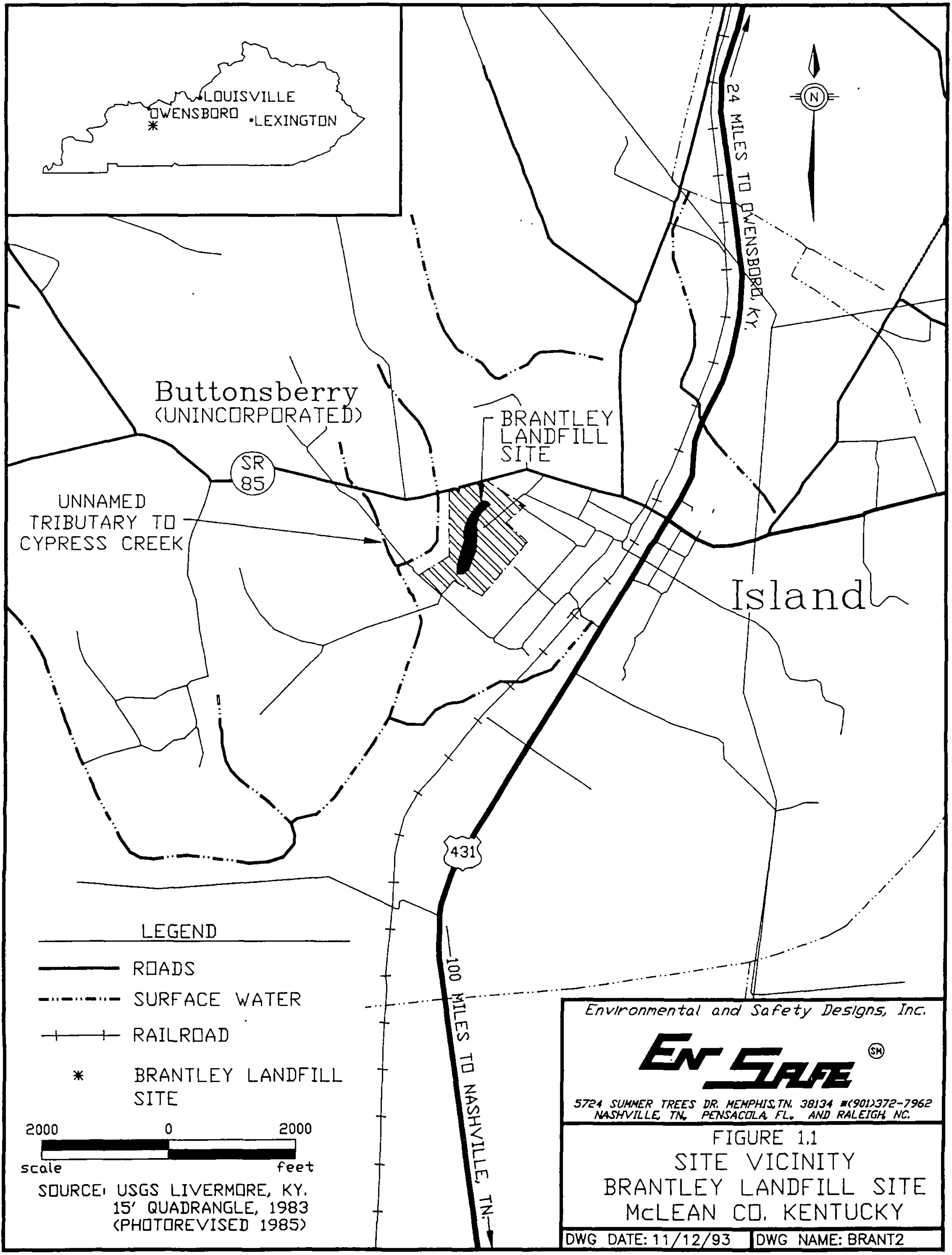
Notes:

Shallow aquifer contaminants of concern were derived from a hypo 'worst-case' shallow well. Individual shallow wells did not necessarily produce sample with unacceptable concentrations of each of these parameters

A total of twelve monitoring wells (six shallow and six deep) were installed to monitor the groundwater at the Site. See Figure 6. Two of the shallow wells (GMW/K13/S and GMW/O8/S) represent background in the shallow aquifer. Both wells were installed east of the landfill in apparently unimpacted zones. An additional shallow groundwater monitoring well was installed north of Kentucky Highway 85 in a former strip mine area (GMW/L1). This well location was selected in order to provide some appreciation for shallow groundwater quality in mine spoils absent any possible salt cake fines impacts. Only one deep monitoring well was installed east of the landfill due to the presence of the former underground mine works void in this area. Due to the drilling hazards associated with the underground mine works (i.e. explosion hazards) on and in the vicinity of the Site, it was not possible to establish a definitive upgradient background location in the shale (deep) aquifer.

Attachment A

Figures



SOURCE: USGS LIVERMORE, KY.
15' QUADRANGLE, 1983
(PHOTOREVISED 1985)

Environmental and Safety Designs, Inc.

EnSafe (SM)

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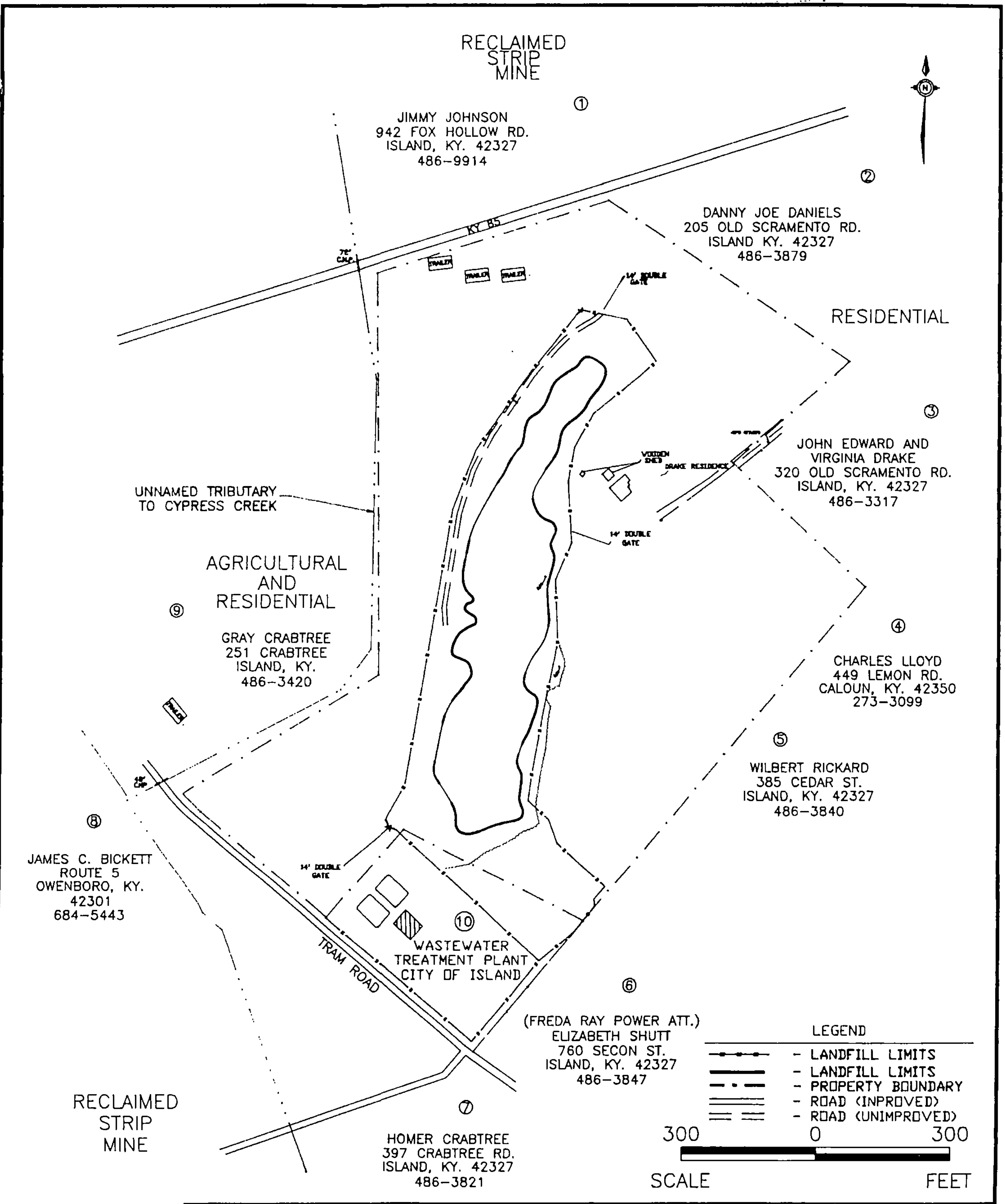
NASHVILLE, TN, PENSACOLA, FL, AND RALEIGH, NC.

FIGURE 1.1
SITE VICINITY
BRANTLEY LANDFILL SITE
McLEAN CO. KENTUCKY

DWG DATE: 11/12/93 DWG NAME: BRANT2



BOUNDARY OF LANDFILL
FURNISHED BY: HARRY S. BUTTON, RLS
HAROLD SNODGRASS, PE

Environmental and Safety Designs, Inc.

EnSafe ℠

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FIGURE 1.2
LAND USE
BRANTLEY LANDFILL SITE

DWG DATE: 11/22/93	DWG NAME: BRAN10A

Attachment B
Preliminary Close Out Report

PRELIMINARY CLOSE OUT REPORT

BRANTLEY LANDFILL SITE
ISLAND, KENTUCKY

AUGUST 1998

PREPARED BY
U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4

PRELIMINARY CLOSE OUT REPORT
BRANTLEY LANDFILL SITE
ISLAND, KENTUCKY

I. INTRODUCTION

This Preliminary Closeout Report (PCOR) documents that the U. S. Environmental Protection Agency (EPA) completed construction activities for the Brantley Landfill site in accordance with *Close Out Procedures for National Priorities List Sites* (OSWER Directive 9320.2-09). Three Pre-Final Inspections were conducted by the potentially responsible party (PRP) on October 20, October 30, and November 11, 1997. EPA and the Kentucky Department for Environmental Protection (the State) conducted a Final Inspection on May 29, 1998, and determined that the PRP constructed the remedy in accordance with remedial design plans and specifications. The PRP has initiated the activities necessary to achieve performance standards and Site completion.

II. SUMMARY OF SITE CONDITIONS

Background

The Brantley Landfill site (the Site) consists of approximately four acres located in Island, McLean County, Kentucky. The Site is bordered to the north by KY Highway 85, to the south by the City of Island Waste Water Treatment Plant, to the east by Mrs. Peggy Drake's residence (owner) and the Town of Island, and to the west by an unnamed tributary to Cypress Creek. The Site was formerly a strip mine pit from which the No. 9 Coal seam was extracted for commercial use. Land use within a 1-mile radius of the landfill is primarily restricted to agriculture and residences.

In 1977, Barmet Aluminum Corporation contacted Mr. Doug Brantley to locate a disposal site for the salt cake fines generated at its Livia, Kentucky, aluminum recycling operation plant. Mr. Brantley, who represented Doug Brantley and Sons, Inc. of Frankfort, Kentucky, located an abandoned mine pit in Island, Kentucky and entered into a leasing arrangement with the owner of the property. In 1978, Kenvinrons, Inc. of Frankfort, Kentucky, an engineering firm, submitted an industrial landfill permit application to the Kentucky Department for Environmental Protection (KDEP), Division of Hazardous Waste and Waste Management. Mr. Brantley stated that during the approximately two-year operation of the Site (May 1978 to November 1980), salt cake fines were the only material disposed of in the landfill with the exception of diesel fuel used as a dust control measure. A total of 250,306 tons of salt cake fines (SCFs) were deposited in the landfill.

In 1979, the Kentucky Division of Air Pollution Control conducted a compliance inspection based on complaints from area residents that unpleasant odors were coming from the landfill during disposal activities. At the time of the inspection, the landfill was found to be in violation of 401 KAR 63:010, Section 3(1)(c), and 401 KAR 63:010, Section 3(2) regarding: "... failure to take reasonable precautions to prevent particulate matter from becoming airborne and allowing the discharge of visible fugitive dust emissions beyond the property lines of the landfill". During subsequent inspections by KDEP, officials noted vigorous reactions with water and complained of irritating gaseous emissions continuing to be released from the landfill. This discovery prompted KDEP to submit a letter to EPA in 1980 requesting an evaluation of salt cake fines in reference to 40 CFR 261.23 (a)(4), hazardous waste characteristic of reactivity. EPA concluded that the waste should be regulated as a hazardous waste, based on information supplied by KDEP inspection reports. In November 1980, KDEP notified Barmet Aluminum Corporation (PRP) of its intent to regulate salt cake fines as a hazardous waste and requested Barmet to register as a hazardous waste generator under the Resource Conservation and Recovery Act (RCRA). The Brantley Landfill closed on November 15, 1980. The Site was covered, graded and vegetated. In 1981, Barmet Aluminum Corporation filed a civil action in a United States District Court against the EPA and KDEP, protesting their intent to regulate salt cake fines as a hazardous waste. The United States District Court, Western District of Kentucky handed out a decision on August 5, 1981, declaring that salt cake fines are not a hazardous waste material within the meaning of the Solid Waste Disposal Act, 42 U.S.C.S. 6901, et seq. and KRS Chapter 224. Following this ruling, the Brantley Landfill remained under investigation by EPA officials regarding complaints about gaseous emissions at the Site.

In 1987, EPA conducted field investigations at the Brantley Landfill site, collecting air, soil, water, and sediment samples for analysis. Results of the analysis revealed ammonia concentrations slightly higher than background and elevated metals concentrations below the landfill cap. In June of 1988, the Site was proposed for inclusion on EPA's National Priorities List (NPL), and became final on February 21, 1990. On January 10, 1990, EPA and Barmet Aluminum Corporation signed an Administrative Order by Consent (AOC) for Barmet to conduct the Remedial Investigation (RI) and Feasibility Study (FS) at the Site. The AOC also included a requirement for the restriction of access to the Site. In March 1990, Barmet installed a chain-link fence around the Site. The RI/FS at the Brantley Landfill site was conducted between 1992 and 1994. When drilling began in the Summer 1992, unacceptable levels of explosive gases, and ammonia gas readings of approximately 150 ppm, were detected along the eastern perimeter of the landfill where the underground mine works were encountered. In late August/early September 1993, Barmet Aluminum Corporation performed minimal repairs to the landfill cover in order to prevent further erosion and subsequent exposure of source material. These repairs included regrading, clay capping, and replacement of the vegetative cover. The findings of the RI/FS showed that the ground water and soil pathways were the only pathways to pose a risk to human health.

Remedial Construction Activities

On December 14, 1994, EPA issued a Record of Decision (ROD) documenting the Remedial Action (RA) for the Brantley Landfill site. The RA was to be conducted in two phases: Phase I would address surface water infiltration, and Phase II any ground water infiltration. The construction activities described in this PCOR complete Phase I of the remedial action. The selected remedy included:

PHASE I

- Installation of additional ground water monitoring wells, and piezometers;
- Ground water sampling prior to cap construction to: confirm background concentrations; determine the extent of the landfill cap, and alkaline recharge trench; address RI data gaps; and, classify the shallow aquifer using EPA's Ground Water Classification System;
- Surface water sampling of a nearby lake to determine any off-site migration;
- Construction of a landfill cap to prevent contact with source material and to minimize surface water infiltration including elimination of the onsite pond;
- Drainage improvements;
- Installation of an alkaline recharge trench to restore shallow ground water;
- Sampling of source material and landfill leachate to determine the depletion of SCFs; and,
- Ambient air monitoring at closed mine shafts to evaluate any ammonia emissions.

PHASE II

- At least one year of post-construction ground water monitoring to determine the need for a pump-and-treat contingent remedy; and,
- Deep Ground water classification using EPA's Ground Water Classification System.

Cleanup levels for soil and ground water at the Brantley Landfill site were selected based on Maximum Contaminant Levels (MCLs), Secondary MCLs, health-based performance standards, and/or background concentrations. The following tables show the cleanup levels established in the ROD.

Soil Cleanup Levels, mg/kg

ALUMINUM	7E+05
ARSENIC	30
IRON	7E+04

Ground Water Cleanup Levels, ppb

PARAMETER	SHALLOW AQUIFER	DEEP AQUIFER
ALDRIN	0.04	NA
ALUMINUM	7,065 - 47,075	29,373 - 36,920
ARSENIC	50	50
BARIUM	NA	2000
BERYLLIUM	4	4
CADMIUM	5	5
CHROMIUM	100	100
COBALT	2,000	2,000
IRON	17,080 - 85,500	42,605 - 62,275
MANGANESE	1,359 - 12,100	687 - 961
MERCURY	2	NA
NICKEL	100	100
POTASSIUM	NA	1.4E+6
SILVER	100	NA
SODIUM	10,678 - 144,000	119,250 - 137,750
VANADIUM	200	200
ZINC	5,000	5,000
AMMONIA (ppm)	NA	34
CHLORIDES (ppm)	250	250
SULFATES (ppm)	250	250

NA - not applicable

In March 1995, EPA issued a Unilateral Administrative Order to Barmet Aluminum for the Remedial Design (RD) and Remedial Action (RA) at the Brantley Landfill site. Fourteen additional monitoring wells and six piezometers were installed in and around the landfill between September and November 1995. Pre-design data collection occurred from September 1995 through September 1996. Sampling at an offsite lake believed to be a discharge body for ground water entering the mine works at the landfill occurred in September 1995. Salt Cake Fines and leachate sampling was conducted from November through December 1995, and ground water sampling occurred from November 1995 through September 1996.

Analytical results from the offsite lake showed no indication of impacts from the Site. The elevated sulfate concentrations in the lake, however, can be attributed to coal mining and associated mine spoils/mine drainage. Results of the SCFs and leachate sampling showed a significant volume of water in the northern end of the landfill but not in the southern end. This new finding prompted a modification in the design of the landfill cap as specified in the ROD. The cap design was modified to include crowning and capping the northern end of the landfill, crowning flat areas of the landfill, and repairing erosion and rerouting drainage at the south end of the landfill. Also, in lieu of grading and elimination of the onsite pond, erosion control measures were going to be implemented because regrading of the landfill and subsequent closure of the pond may obstruct the apparent existing drainage in this area resulting in a greater accumulation and diversion of water back into the landfill.

The collection of ground water data prior to the remedial design, including ground water classification and water level monitoring in the landfill, provided a better understanding of the landfill and surrounding area resulting in further modification of the selected remedy. The alkaline recharge trench was eliminated because the high metal concentrations in the shallow mine spoils ground water were attributed to acid mine drainage associated with the mine spoils, and also due to the ground water quality in this area. Ground Water in the vicinity of the Brantley Landfill site has been heavily impacted by surface and underground coal mining. The Ground Water Classification System was used to determine whether the ground water in this area is a potential source of drinking water. The shallow mine spoils ground water west of the landfill and the deep ground water in the shale were classified as Class III, non-potable while the shallow ground water in the sandstone aquifer on the east side of the landfill and the deeper sandstone unit were classified as Class II, or a potential source of drinking water. The shallow sandstone aquifer is believed to be the source of ground water for Island residents before municipal water was introduced to the area in 1969. The Town of Island municipal water system derives its raw water supply from well fields along the Green River approximately three miles north/northeast of the Site.

The Remedial Action was initiated on June 24, 1997, upon EPA's approval of the Remedial Design Report. The PRP conducted remedial activities as planned and no additional areas of contamination were identified. Three Pre-Final Construction Inspections were performed by the PRP at the Brantley Landfill site. The first inspection, performed on October 20, 1997, addressed Ditches 1 and 2, and the north end landfill cap. The second inspection, performed on October 30, 1997, addressed the interior portion of the landfill. The third inspection, performed on November 14, 1997, addressed the southern slope and Ditch 3. The Final Construction Inspection was conducted by EPA and the State on May 29, 1998. The Final Construction Inspection consisted of a walk-through of the entire Site and a review of the punch lists generated from the Pre-Final Inspections. EPA and the State determined that the following RA activities were completed according to design specifications.

- The landfill cap on the northern end of the Site and interior area were in-place. Due to strong ammonia odors during cap construction on the crown of the interior area, clay thickness on this area was increased to 2' thick cap. The western area outside the fenceline was cleared, grubbed, graded, seeded and mulched.

- Ditches 1, 2 and 3 were constructed in accordance with specs and a temporary erosion control matting was placed in the bottom and sidewalls. A high density polyethylene liner was placed in the bottom of ditch 2 and a swale directs water from this ditch to a natural stream in the woods to the west of the site. A temporary erosion control matting was also placed in steep areas of the interior area and the swale.

- On the southern slope of the Site, the originally designed riprap chute at the center of the slope was relocated to a natural drainage ditch encountered to the east of the proposed riprap location and an erosion control/turf reinforcement mat was installed.

Topsoil used for the cap was sampled and analyzed for soil contaminants of concern. All analytical results were below the performance standards for soils.

EPA is currently evaluating the pre-design data to determine the need to modify the background concentrations, as stated in the ROD, which in turn changes the performance standards for those contaminants of concern whose cleanup level is based on background concentrations. If there is the need to modify the performance standards, the changes will be documented in an Explanation of Significant Differences (ESD). The next step following the Remedial Action is to conduct a one-time monitoring of air emissions to confirm that ammonia emissions from the landfill have been mitigated by the landfill cap. Ambient air monitoring at an abandoned mine shaft is still pending due to problems in obtaining access to the shaft located on a private property. Also, at least one year of ground water monitoring will be performed to determine the need to implement a contingent remedy. The contingent remedy was originally proposed to address contaminant migration caused by ground water infiltration. The pre-design data shows that ground water entering the landfill is minimal compared to percolation of surface water through the landfill cover but it also suggests that this water is leaving the landfill through the underground mine works. Monitoring of the Crowe Spring, which is a downgradient discharge point for water in the mine works, found no impacts from SCF constituents. Cap measures are expected to significantly decrease the amount of water entering the landfill thus decreasing the amount of water leaving the landfill. Also, the data shows that ground water contamination appears limited to the immediate vicinity of the landfill, and movement of mine-related constituents into areas where coal mining has not occurred would precede the potential migration of any SCF constituents into those areas. For these reasons, the contingent remedy seems less likely, at this point, to be implemented. The post-construction ground water data will determine with certainty the need for a contingent remedy at the Brantley Landfill site.

EPA is currently taking the necessary steps to prepare the ESD that will document all the changes and modifications to the selected remedy that occurred during the remedial design and construction phase, and any changes to the performance standards.

III. DEMONSTRATION OF CLEANUP ACTIVITY QUALITY ASSURANCE AND QUALITY CONTROL

Activities at the Site were consistent with the remedial design, and all work plans were issued to contractors for design and construction of the RA, including sampling and analysis. The RD Work Plan, including a Quality Assurance Project Plan, incorporated all EPA and State quality assurance and quality control (QA/QC) procedures and protocol. EPA analytical methods were used for all validation and monitoring samples during pre-Design activities. Sampling of soil, surface water, and ground water followed the EPA Protocol. The Final Design Report contains documentation of sampling results to date.

The QA/QC program used was rigorous and in conformance with EPA and state standards; therefore, EPA and the State determined that all analytical results are accurate to the degree needed to assure satisfactory execution of the RA and are consistent with the ROD and the RD plans and specifications.

IV. ACTIVITIES AND SCHEDULE FOR SITE COMPLETION

The remedial action activities that remain to be completed for the Brantley Landfill site include a one-time monitoring of air emissions at the Site, conducting at least one year of post-construction monitoring, ambient air monitoring at the mine shaft, approving the Operation and Maintenance Plan (O&M), determining the Operational and Functional (O&F) period, preparing the RA Report, conducting a Five-Year Review, and preparing the Five-Year Review Report, and Final Close-Out Report. This activities will be completed according to the following schedule.

	Estimated Completion	Responsible organization
Approve O&M Plan	09/30/98	EPA/State
Determine O&F Period	09/30/99	EPA/State
Explanation of Significant Differences	To be Determined	EPA
Determine Need for Contingent Remedy	07/13/00	EPA/State
Long-Term Monitoring Completion/Cleanup Verification	To be Determined	EPA/State
Approve RA Report*	09/30/00*	EPA/State
Approve Final Close Out Report*	03/30/01*	EPA
Deletion from NPL*	09/30/01*	EPA

* Dependent upon contingent remedy

V. FIVE-YEAR REVIEW

Hazardous substances will remain at the Site above health-based levels after the completion of remedial action. Pursuant to CERCLA section 121(c) and as provided in OSWER Directive 9355.7-02, *Structure and Components of Five-Year Reviews*, May 23, 1991, and OSWER Directive 9355.7-02A, *Supplemental Five-Year Review Guidance*, July 26, 1994, EPA must conduct a statutory five-year review. The Five-Year Review Report will be completed prior to August 2002 (five-years after the first RA onsite mobilization).

8/27/98

Richard D. Green, Director
Waste Management Division

Date

Attachment C
Groundwater & Air Data Summaries

Appendix B

Post-Remedy Effectiveness Monitoring Data Evaluation

Table of Contents

List of Figures

List of Tables

List of Graphs

B.0 POST-REMEDY EFFECTIVENESS MONITORING EVALUATION

The effectiveness monitoring specified by the ROD was implemented after Phase I of the remedy to determine whether the contingent remedy was warranted. The post-remedy effectiveness monitoring consisted of the following:

- Two years of monitoring for: (1) leachate levels in the landfill and groundwater outside the landfill, (2) contaminant concentrations in groundwater and (3) downgradient monitoring at the offsite spring for possible impacts from SCF constituents. Monitoring consisted of quarterly sampling and water-level measurement of all monitoring wells and daily water level monitoring of select wells inside and outside the landfill. Groundwater samples were collected quarterly from all monitoring wells and analyzed for the list of performance standards in the ROD, including chlorides, ammonia, aluminum, sodium, and select other metals. Data collection was extended an additional year to further understand the effects of the remedy on concentrations in groundwater.

- One-time monitoring of air emissions using OP-FTIR spectroscopy to confirm that ammonia emissions from the landfill had been effectively mitigated or eliminated by the RA construction activities.

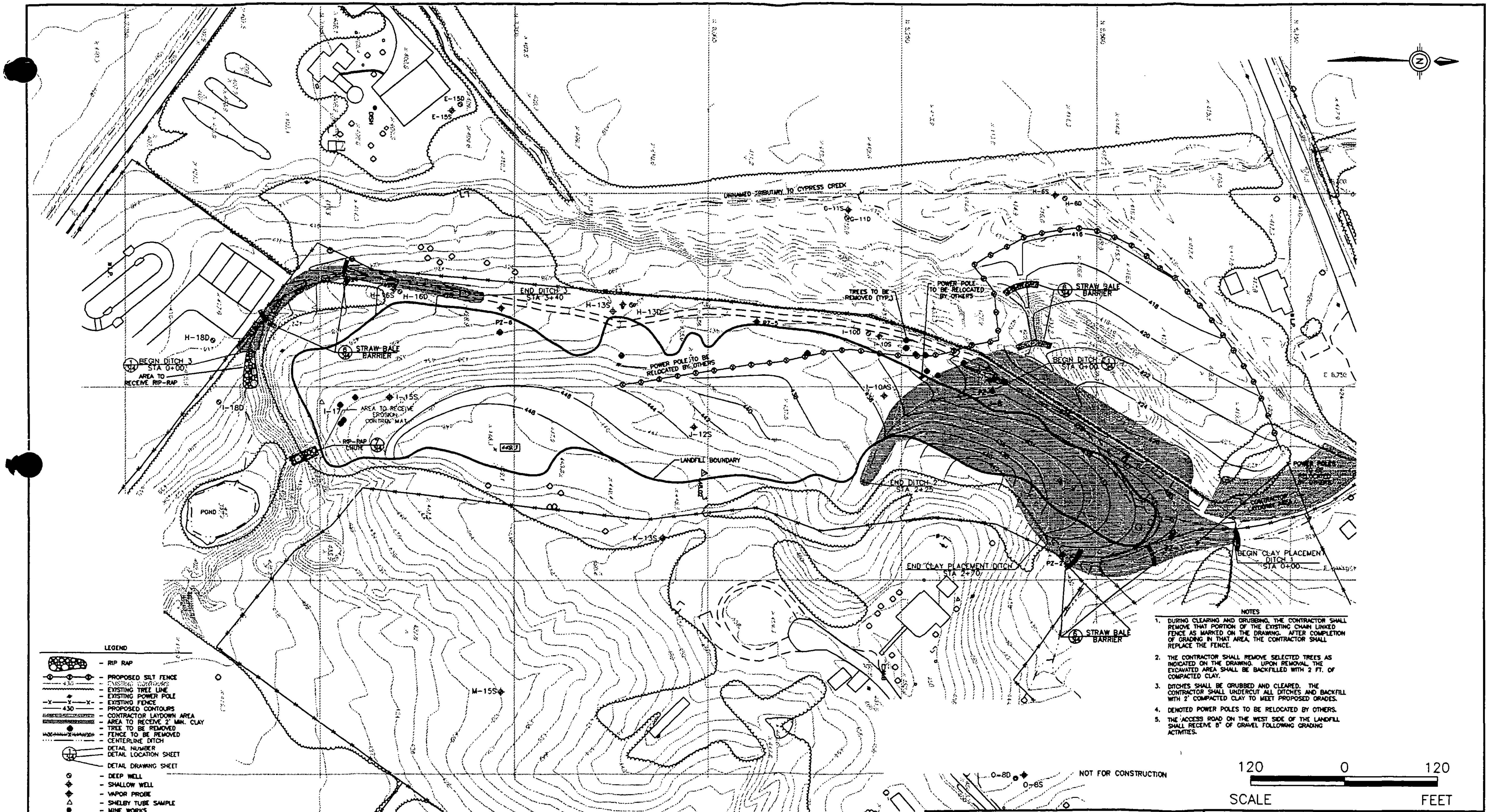
B.1 Leachate in the Landfill

The objective of RA construction was to minimize the amount of water contacting the landfill's contents to reduce further impacts to groundwater and the underground mine works. Hydraulic data presented in the *Final Design Report* (EnSafe, May 1997) showed that groundwater intrusion along the sides of the landfill and infiltration through its cover were conduits for water entering the north end of the landfill. To minimize these conduits, the capped area included both the north end of the landfill and its west side where shallow groundwater was intruding through the landfill wall.

Post-remedy water levels were recorded daily from wells J-9S, K-7S, and I-10S to determine whether: leachate accumulation has declined since construction and leachate is remaining in the landfill, rather than emptying into shallow groundwater through a "bathtub effect." Well locations are shown on the proposed grading plan (Figure B-1). The final grading plans are provided in the *Final Construction Inspection Report* (EnSafe, 1998) in Appendix A. Leachate has not accumulated in the central and southern sections of the landfill; therefore, these areas were not the focus of the remedial action, except for continued maintenance of the cover.

To show the remedy effects, post-remedy leachate levels, precipitation, and water levels outside the north end of the landfill have been compared with those measured before the remedy. Graph 1A plots post-remedy leachate levels (red line), water levels outside the landfill (blue and green lines), and precipitation (silver spikes) measured over a 22-month period after the remedy was implemented. Water levels were recorded both quarterly (denoted with circles, squares, and triangles) and continuously, as shown with the solid lines. Graph 1B plots the pre-remedy leachate levels, water levels outside the landfill, and precipitation measured over a 12-month period before the remedy was implemented. Water levels were recorded using the same methods employed in the post-remedy as noted on the graph.

Comparing leachate levels before and after the remedy indicates the remedy has been effective in reducing leachate volume in the landfill. Leachate elevations measured before the remedy (Graph 1B) ranged from a winter low of 411.5 feet above mean sea level (msl) to a spring high of 421 feet above msl. Relative to the base of the landfill at J-9S (407 feet above msl), leachate thicknesses ranged from 4.5 feet to 14 feet before the remedy. Leachate levels after



LEGEND

	- RIP RAP
	- PROPOSED SILT FENCE
430	- EXISTING CONTOURS
	- EXISTING TREE LINE
	- EXISTING POWER POLE
—X——X——X—	- EXISTING FENCE
430	- PROPOSED CONTOURS
	- CONTRACTOR LAYDOWN AREA
	- AREA TO RECEIVE 2' MIN. CLAY
●	- TREE TO BE REMOVED
	- FENCE TO BE REMOVED
	- CENTERLINE DITCH
1	DETAIL NUMBER
3	DETAIL LOCATION SHEET
4	DETAIL DRAWING SHEET
	- DEEP WELL
	- SHALLOW WELL
	- VAPOR PROBE
△	- SHELBY TUBE SAMPLE
●	- MINE WORKS
▲	- SEDIMENT SAMPLE
	- SHALLOW SOIL SAMPLE
◆	- PIEZOMETER
448.3	- PROPOSED SPOT ELEVATION

NOTES

1. DURING CLEARING AND GRUBBING, THE CONTRACTOR SHALL REMOVE THAT PORTION OF THE EXISTING CHAIN LINKED FENCE AS MARKED ON THE DRAWING. AFTER COMPLETION OF GRADING IN THAT AREA, THE CONTRACTOR SHALL REPLACE THE FENCE.
2. THE CONTRACTOR SHALL REMOVE SELECTED TREES AS INDICATED ON THE DRAWING. UPON REMOVAL, THE EXCAVATED AREA SHALL BE BACKFILLED WITH 2 FT. OF COMPACTED CLAY.
3. DITCHES SHALL BE GRUBBED AND CLEARED. THE CONTRACTOR SHALL UNDERCUT ALL DITCHES AND BACKFILL WITH 2' COMPACTED CLAY TO MEET PROPOSED GRADES.
4. DENOTED POWER POLES TO BE RELOCATED BY OTHERS.
5. THE ACCESS ROAD ON THE WEST SIDE OF THE LANDFILL SHALL RECEIVE 8" OF GRAVEL FOLLOWING GRADING ACTIVITIES.

NOT FOR CONSTRUCTION

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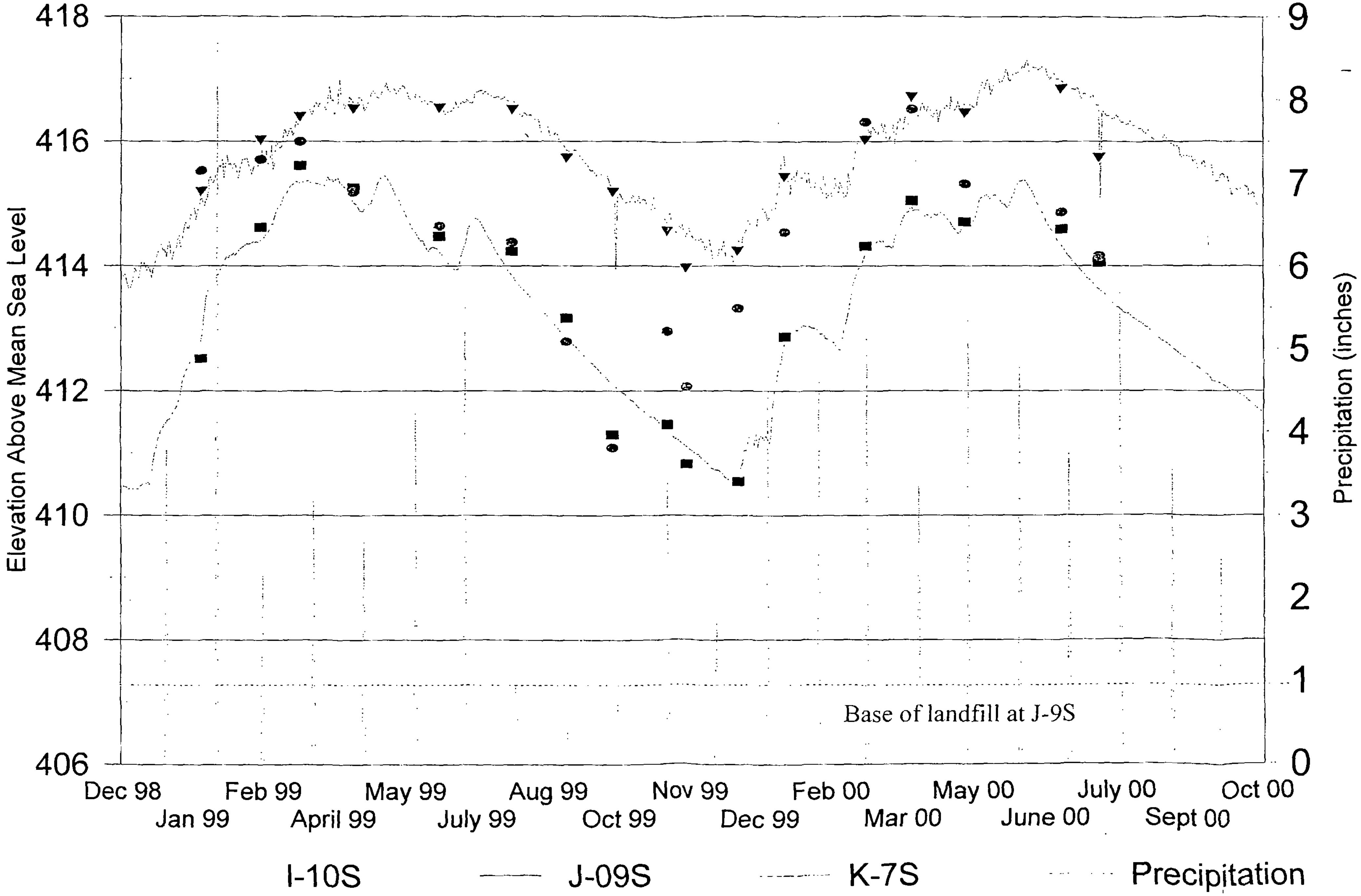
LITTLE ROCK,AR JACKSON,MS CLEVELAND,OH

FIGURE B-1
PROPOSED GRADING PLAN
REMEDIAL ACTION REPORT
BRANTLEY LANDFILL NPL SITE
ISLAND, KENTUCKY

DWG DATE: 12/04/00 | DWG NAME: 2032W001

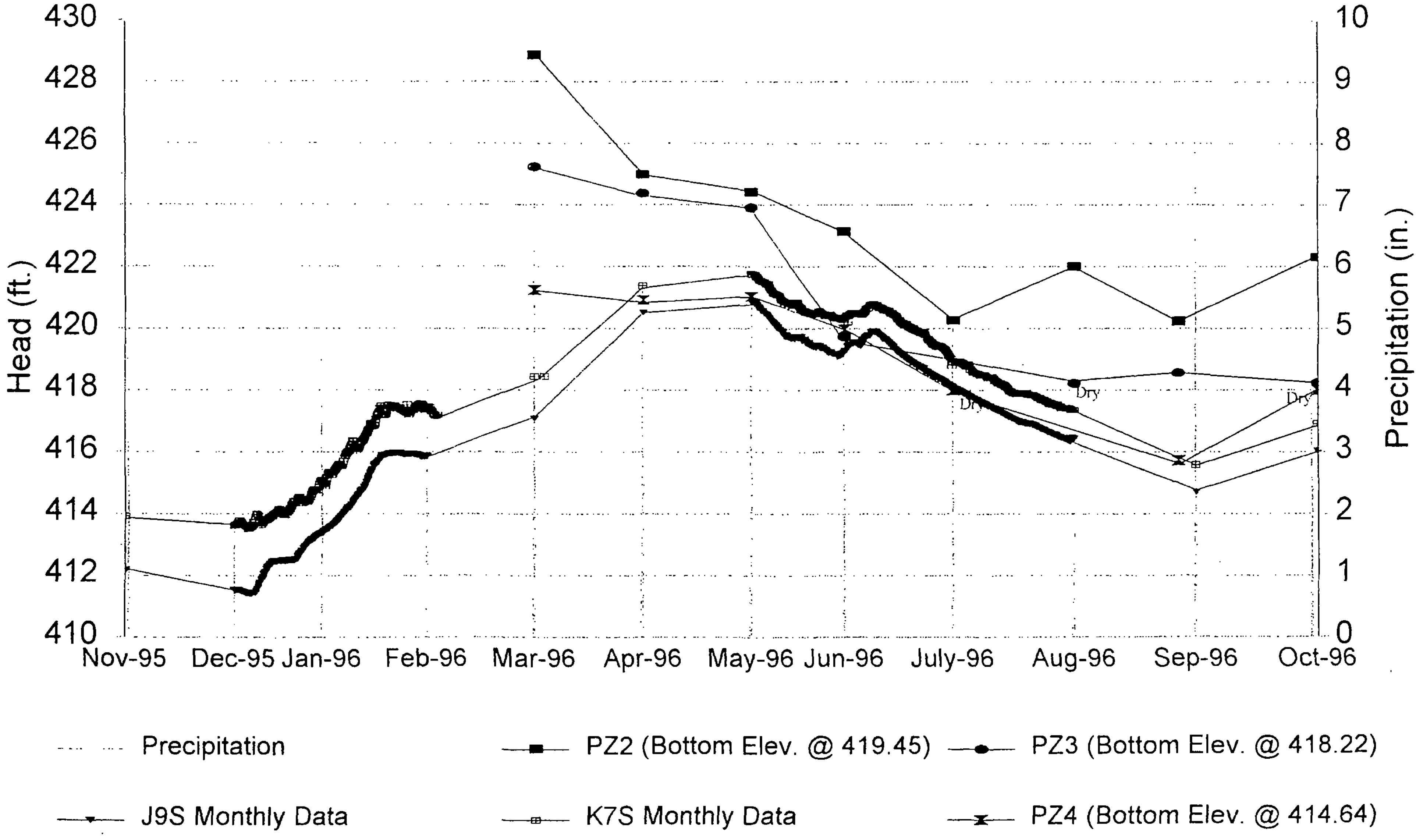
Graph 1A
Post-Remedy Leachate (J-9S) and Groundwater Elevations (K-7S & I-10S)



Note: Symbols denote monthly hand monitoring data

Graph 1B

Pre-Remedy Leachate Elevations (J-9S) versus Groundwater Elevations (K-7S, PZ-2, and PZ-4)



the remedy (Graph 1A) ranged from a winter low of 410.5 feet above msl to a spring high of 415.5 feet above msl, with thicknesses ranging from 3.5 to 8.5 feet. Comparing maximum leachate thicknesses before and after the remedy indicates a 40% reduction in leachate volume based on the levels recorded at J-09S. Peak high and low leachate levels correspond with the months of May and December during both monitoring periods.

The effects of the remedy are also evident in reduced groundwater elevations outside the landfill. Monitoring well K-7S (blue line on Graph 1A), outside the west side of the landfill's north end, was included in the capped area of the remedial action. Comparing peak high groundwater elevations measured during the post-remedy (417 feet above msl) to the pre-remedy (421.75 feet above msl) indicates a 4.75-foot reduction in water levels outside the landfill (or 30% of the well's saturated thickness)[1]. Graphs 1A and 1B also show that groundwater elevations have remained above the leachate levels during most of the monitoring period, indicating that leachate is not exiting the landfill into the shallow groundwater to its west.

The varying pre- and post-remedy leachate and groundwater levels should be evaluated relative to precipitation levels reported during the two monitoring periods to gauge whether the noted reductions are attributable solely to the remedy or to less precipitation. Graph 1A shows that 50.05 inches of precipitation were reported during the last 12 months of post-remedy monitoring compared with 56 inches during the 12 months of *pre-remedy* monitoring (Graph 1B).[2]

---

[1] Elevation at the base of well K-7S is approximately 404 feet above msl.

[2] Precipitation information was provided by Mr. Kenneth Kane, Ohio County weather observer, who resides in Beaver Dam, Kentucky, approximately 25 miles southwest of the site. McLean county does not have a weather observer.

Although approximately 10% less precipitation fell post-remedy, proportionally, a substantially less amount of leachate (40%) and groundwater (30%) accumulated, indicating that the differences are attributable more to the remedy than varying precipitation. It should be noted that pre- and post-remedy monitoring periods were wetter than the same periods in average years — the average annual precipitation reported for Ohio County is 43 inches, indicating that the recorded leachate and water levels are likely higher than normal.

B.2 Groundwater Monitoring Data

Monitoring wells were sampled for eight quarters after the remedy, starting from December 1998 to July 2000. Groundwater samples were collected and analyzed as presented in the *RD Work Plan* (EnSafe, 1995). Analytical services were provided by RECRA Laboratories, Amherst, New York, until the fourth quarter of monitoring when Savannah Laboratories in Savannah, Georgia, began providing analytical services. Tables B-1 to B-3 summarize the post-remedy monitoring for the three groundwater units at the site — shallow groundwater in the mine spoils and unconsolidated material outside the landfill, deep groundwater in the shale unit beneath the shallow groundwater, and the UPS groundwater east of the landfill. Data from the onsite pond and landfill wells are listed in Table B-1 with the shallow groundwater data, while data from the offsite spring monitoring are listed in Table B-2 with the deep groundwater data.

Shallow Mine Spoils/Unconsolidated Groundwater

Analytical data from shallow wells screened in the unconsolidated sediments and mine spoils adjacent to the landfill are listed in Table B-1. Contaminants exceeded shallow groundwater cleanup levels in three of the four wells adjacent to the landfill.

- Well I-10S, off the west side of the landfill's central section, exceeded the cleanup level for manganese (seven of seven events) and sodium (one of eight events);

- Well H-13S, also west of the landfill's central section, exceeded the cleanup level for cadmium (seven of eight events) and beryllium (five of eight events);

Table B-1
Post-Remedy Quarterly Monitoring; Shallow Groundwater

Well ID	**Analytes**	**1st Quarter Aug. 1998**	**2nd Quarter Dec. 1998**	**3rd Quarter March 1999**	**4th Quarter June 1999**	**5th Quarter Sept. 1999**	**6th Quarter Dec. 1999**	**7th Quarter March 2000**	**8th Quarter July 2000**	**Performance Standards**
E15S	Aluminum	38	50	225	51.5 J	75.1 J	14.4	6	83	7,065 - 4,7075 (c)
	Sodium	75,500	71,600	71,300 J	77,100	70.200	39,300	76,000	76,000	10,678 - 144,000 (c)
	Ammonia	3,200	3,300 J	3,000 J	3,300	1,600	3,200 J	3,900	3,100	NA
	Chloride	23,900	22,700 J	20,800	22,300	24,000	23,000	22,000	23,000	250,000 (b)
G11S	Aluminum	1,270	3,900	830	2,000 J	3,490	5,230	2,700 J	5,400 J	7,065 - 47,075(c)
	Sodium	62,500	100,000	56,500 J	69,700	58,600	57,200	55,000	58,000	10,678 - 144,000(c)
	Ammonia	440	660	280 J	71	300	390 J	310	330	NA
	Chloride	31,300	28,400	26,300	30,200	33,000	32,000	29,000	33,000	250,000 (b)
H06S	Aluminum	466 J	429	848	427 J	574	33.2 J	810 J	1,100 J	7,065 - 47,075(c)
	Sodium	85,800	80,000	76,100 J	90,300	75,900	115,000	68,000	76,000	10,678 - 144,000(c)
	Ammonia	ND	ND	ND	ND	ND	240 J	ND	ND	NA
	Chloride	25,800 J	27,000 J	23,500	23,600	27,000	18,000	24,000	28,000	250,000 (b)
H13S	Aluminum	7,110 J	566 J	15,600	4,750 J	9,010	20,000 J	14,000 J	14,000	7,065 - 47,075(c)
(adjacent to landfill)	Beryllium	2.3 J	1.5	**8**	**4.9 J**	4 J	**8.6**	**5.6**	**7.5 J**	4 (a)
	Cadmium	**6.8**	2.8 J	**24.4**	**6.2**	**5.4**	**14**	**9.7**	**7.4**	5 (a)
	Sodium	29,900 J	44,000	24,800 J	31,700	34,700	25,000	21,000	23,000	10,678 - 144,000 (c)
	Ammonia	240	100 J	380 J	230	350	190	330	370	NA
	Chloride	42,300	48,200	31,300	36,800	36,000	35,000	24,000	27,000	250,000 (b)

Table B-1
Post-Remedy Quarterly Monitoring; Shallow Groundwater

Well ID	Analytes	1st Quarter Aug. 1998	2nd Quarter Dec. 1998	3rd Quarter March 1999	4th Quarter June 1999	5th Quarter Sept. 1999	6th Quarter Dec. 1999	7th Quarter March 2000	8th Quarter July 2000	Performance Standards
H16S	Aluminum	647 J	6,340	774	418 J	820	7,500 J	880 J	710	7,065 - 47,075 (c)
(adjacent to landfill)	Iron	42,300	24,000 J	21,300	22,500 J	32,100	23,000 J	26,000	33,000 J	17,080 - 85,500 (c)
	Sodium	**383,000 J**	**337,000 J**	**223,000 J**	**352,000**	**249,000**	130,000	**150,000**	**170,000**	10,678 - 144,000 (c)
	Ammonia	8,200	6,500 J	4,400 J	1,000	5,600	2,700	4,600	5,300	NA
	Chloride	22,7000	**323,000**	136,000	106,000	220,000	110,000	110,000	160,000	250,000 (c)
K07S	Aluminum	256 J	165 J	919	28.2	314	136 J	6	110 J	7,065 - 47,075 (c)
(adjacent to landfill)	Ammonia	100	66 J	300 J	940	81	39 J	210	85	NA
	Chloride	82,400	75,800	51,100	63,400	83,000	79,000	72,000	75,000	250,000 (b)
I10S	Aluminum	3,070	1,590 J	2,590	633 J	3,130	2,300	2,600 J	4,100	7,065 - 47,075 (c)
(adjacent to landfill)	Iron	15,700 J	17,200	10,100	1,290 J	4,080	13,000	7,000	2,800 J	17,080 - 85,500 (c)
	Manganese	**85,000 J**	**61,700**	**76,000**	**76,000**	**65,600**	NA	**53,000**	**77,000 J**	1,359 -12,100 (c)
	Sodium	93,800	78,600	**147,000 J**	77,600	95,800	81,000	70,000	98,000	10,678 - 144,000 (c)
	Zinc	ND	ND	ND	ND	ND	310	ND	ND	5,000 (b)
	Ammonia	2,100	1,900 J	1,600 J	1,600	1,400	1,600	1,300	1,200	NA
	Chloride	101,000	111,000	119,000	130,000	120,000	90,000	96,000	110,000	250,000 (b)
Pond	Sodium	3,790 J	42,000	11,500 J	1,580 J	2,850	3,460	1,500	3,100	10,678 - 144,000 (c)
	Ammonia	260	1,600 J	61 J	53	210	930 J	69	4,500	NA
	Chloride	8,400	15,200	3,000	3,500	6,300	5,300	2,400	5,600	250,000 (b)
L1S	Aluminum	3,750	432 J	630	802 J	629	400	1,600 J	820 J	7,065 - 47,075 (c)

Table B-1
Post-Remedy Quarterly Monitoring; Shallow Groundwater

Well ID	Analytes	1st Quarter Aug. 1998	2nd Quarter Dec. 1998	3rd Quarter March 1999	4th Quarter June 1999	5th Quarter Sept. 1999	*6th* Quarter Dec. 1999	7th Quarter March 2000	*8th* Quarter July 2000	Performance Standards
Background	Sodium	**201,000**	**175,000**	**182,000 J**	**152,000**	**159,000**	**158,000**	**150,000**	**170,000**	10,678 - 144,000(c)
	Ammonia	770	190	260 J	230	130	68 J	170	95	NA
	Chloride	8,600	7,400 J	7,300	8,300	8,500	8,600	18,000	8,500	250,000 (b)
I15S (in landfill)	Aluminum	NA	NA	9,560	NA	NA	NA	13,000 J	NA	7,065 - 47,075 (c)
	Sodium	NA	NA	**58,200,000 J**	NA	NA	NA	**62,000,000**	NA	10,678 - 144,000 (c)
	Ammonia	NA	NA	11,400,000 J	NA	NA	NA	330,000	NA	NA
	Chloride	NA	NA	**108,000,000**	NA	NA	NA	**71,000,000**	NA	250,000 (b)
J09S (in landfill)	Aluminum	2,620	**187,000**	4,130	2,320	16,700	12,000 J	4,000 J	3,000 J	7,065 - 47,075 (c)
	Sodium	**14,200,000**	**24,000,000**	**36,200,000**	**4,170,000**	**45700000**	**70000000**	**77,000,000**	**9,100,000**	10,678 - 144,000 (c)
	Ammonia	625,000	1,100,000 J	1,010,000 J	354,000	870,000	1,200,000	1,100,000	630,000	NA
	Chloride	**21,300,000**	**96,400,000**	**61,000,000**	**6,900,000**	**50,000,000**	**130,000,000**	**8,900,000**	**24,000,000**	250,000 (b)
J12S (in landfill)	Aluminum	**133,000 J**	NA	25,900	**148,000**	**421,000**	**65,000 J**	15,000 J	6,100 J	7,065 - 47,075 (c)
	Sodium	**36,200,000 J**	NA	**35,800,000 J**	**29,600,000 J**	**32,400,000**	**33,000,000**	**41,000,000**	**8,200,000**	10,678 - 144,000 (c)
	Ammonia	2,160,000	NA	2790000 J	2,300,000	2,400,000	2,300,000	1,800,000	1,800,000	NA
	Chloride	**64,000,000**	NA	**62,900,000**	**632,000**	**57,000,000**	**62,000,000**	**46,000,000**	**49,000,000**	250,000 (b)

Notes:
All units are in micrograms per liter (μg/L).
Bold = Concentrations that exceed the maximum of the performance standard range (where applicable).
NA = Not analyzed due to the lack of water/leachate or not applicable due to the absence of a ROD-specified cleanup level for the analyte.
ND = Not detected.
J = Estimated value.
(a) = Maximum Contaminant Level (MCL).
(b) = Secondary Maximum Contaminant Level (SMCL).
(c) = Background Concentration.

Table B-2
Post Remedy Quarterly Monitoring; Deep Groundwater

Well ID	Analytes	1st Quarter Aug. 1998	2nd Quarter Dec. 1998	3rd Quarter March 1999	4th Quarter June 1999	5th Quarter Sept. 1999	6th Quarter Dec. 1999	7th Quarter March 2000	8th Quarter July 2000	Performance Standards
08D	Aluminum	803 J	590 J	4,220	1,080	507	31,000 J	1,400J	310	29,373 - 36,920 (c)
	Chromium	53.2	50.1	**303**	NA	27.2	**500 J**	15	9J	100 (c)
	Iron	4,810 J	1,610	9,720	1,730	780	43,000 J	1,800	520J	42,605 - 62,275 (c)
	Sodium	**2,550,000**	**2,080,000**	**152,000 J**	**1,710,000 J**	**1,880,000 J**	**2,200,000**	**1,600,000**	**1,700,000**	119,250 - 137,750 (c)
	Ammonia	32,300	30,300 J	23,800 J	19,800	16,000	16,000	15,000	9,700	34,000 (d)
	Chloride	**5,460,000**	**5,240,000**	**4,780,000**	**3,430,000**	**4,300,000**	**4,900,000**	**4,500,000**	**3,500,000**	250,000 (b)
E15D	Aluminum	38	200 J	829	49.6 J	77.8 J	14.4	6	19J	29,373 - 36,920 (c)
	Sodium	67,000	64,300	67,900 J	66,500	64,200	64,800	61,000	66,000	119,250 -137,750 (c)
	Ammonia	2,300	2,200 J	2,200 J	2,500	3,100	1,600 J	1,900	1,600	34,000 (d)
	Chloride	18,200	19,900 J	1,6800	18,900	16,000	16,000	15,000	16,000	250,000 (b)
G11D	Aluminum	200 J	18,300 J	292	286 J	272	654	1,000 J	810J	29,373 - 36,920 (c)
	Sodium	133,000	128,000	**148,000 J**	**152,000**	**163,000**	125,000	**140,000**	96,000	119,250 - 137,750 (c)
	Ammonia	360	640 J	360 J	410	490	210 J	510	310	34,000 (d)
	Chloride	17,900	19,900 J	16,800	19,300	22,000	24,000	20,000	27,000	250,000 (b)
H06D	Aluminum	38	4,220 J	1,040	130 J	567	1,410	26 J	36J	29,373 - 36,920 (c)
	Sodium	132,000	113,000	125,000 J	126,000	109,000	108,000	99,000	110,000	119,250 -137,750 (c)
	Ammonia	360	400 J	380 J	330	270	240 J	340	290	34,000 (d)
	Chloride	14,900	16,100 J	15,000	16,900	19,000	19,000	18,000	18,000	250,000 (b)

Table B-2
Post Remedy Quarterly Monitoring; Deep Groundwater

Well ID	Analytes	1st Quarter Aug. 1998	2nd Quarter Dec. 1998	3rd Quarter March 1999	4th Quarter June 1999	5th Quarter Sept. 1999	6th Quarter Dec. 1999	7th Quarter March 2000	8th Quarter July 2000	Performance Standards
H13D	Aluminum	38	430 J	190	20	331	6,940	130 J	1,600J	29,373 - 36,920 (c)
	Sodium	**157,000 J**	**156,000 J**	**318,000 J**	**152,000 J**	**148,000**	**155,000**	130,000	**140,000**	119,250 - 137,750 (c)
	Ammonia	**810**	**690 J**	**740 J**	**950**	**930**	**610 J**	380	**830**	34,000 'd'
	Chloride	225,000	219,000	247,000	**288,000**	**360,000**	**340,000**	220,000	240,000	250,000 (b)
H16D	Aluminum	1,890 J	4,310	50	265 J	885	910 J	540 J	650	29,373 - 36,920 (c)
	Iron	**154,000**	**121,000 J**	**151,000**	**121,000 J**	**186,000**	**170,000**	**170,000**	**190,000 J**	42,605 - 62,275 (c)
	Manganese	**103,000**	**62,000 J**	**88,500**	**86,9000**	**97,000**	**88,000**	**70,000**	**92,000J**	687 - 961 (c)
	Sodium	**2,000,000J**	**1,600,000**	**1,320,000J**	**150,000**	**2,010,000**	**1,700,000**	**1,200,000**	**1,500,000**	119,250 -137,750 (c)
	Zinc	791	284	713	363 J	759 J	800	570	610J	5,000 (b)
	Ammonia	**88,400**	**69,800 J**	**84,800 J**	**69,600**	**90,000**	**79,000**	**83,000**	**83,000**	34,000 (d'
	Chloride	**2,740,000**	**2,660,000**	**2,200,000**	**2,060,000**	**3,600,000**	**2,900,000**	**2,600,000**	**2,600,000**	250,000 (b)
H18D	Aluminum	38	159 J	107	30	85.6 J	14.4	6	8.2J	29,373 - 36,920 (c)
	Sodium	**352,000**	**276,000**	**241,000 J**	**271,000**	**277,000**	**285,000**	**240,000**	**270,000**	119,250 -137,750 (c)
	Ammonia	1,500	1,600 J	1,500 J	1,600	1,300	1,400 J	1,500	1,400	34,000 (d'
	Chloride	**899,000**	**879,000**	**856,000**	**843,000**	**960,000**	**1,000,000**	**950,000**	**1,000,000**	250,000 (b)
I10D	Aluminum	1,660 J	1,080	449	5,220	259	22.3 J	300 J	4,600J	29,373 - 36,920 (c)
	Sodium	**160,000 J**	**239,000 J**	**549,000 J**	**233,000 J**	**220,000**	**205,000**	**310,000**	**260,000**	119,250 -137,750 (c)
	Zinc	ND	ND	ND	ND	ND	ND	17 J	ND	5,000 (b)
	Ammonia	1,900	1,000	1,000 J	1,000 J	700	680 J	1,300	**40,000**	34,000 (d'
	Chloride	153,000	**396,000**	**307,000**	**252,000**	**320,000**	**260,000**	**580,000**	**450,000**	250,000 (b)

Table B-2
Post Remedy Quarterly Monitoring; Deep Groundwater

Well ID	Analytes	1st Quarter Aug. 1998	2nd Quarter Dec. 1998	3rd Quarter March 1999	4th Quarter June 1999	5th Quarter Sept. 1999	6th Quarter Dec. 1999	7th Quarter March 2000	8th Quarter July 2000	Performance Standards
I18D	Aluminum	933 J	1,500 J	4,480	4,590 J	5,020	3,700 J	2,000 J	1,400	29,373 - 36,920 (c)
	Iron	7,960 J	1,4200	2,6100	12,800 J	19,700	15,000 J	17,000	22,000J	42,605 - 62,275 (c)
	Sodium	**467,000**	**444,000**	**319,000 J**	77,200	**323,000**	**330,000**	100,000	120,000	119,250 - 137,750 (c)
	Ammonia	3,500	2,300 J	1,40 0 J	86	1,400	2,100	850	970	34,000 (d)
	Chloride	**1,130,000**	**1,180,000**	**1,120,000**	**357,000**	**900,000**	**810,000**	**340,000**	**340,000**	250,000 (b)
K7D	Aluminum	200 J	3,400 J	120	84.5 J	14.4	14	6	28	29,373 - 36,920 (c)
	Iron	29,100	41,100	30,700	47,400 J	34,300	36,000 J	37,000	34,000J	42,605 - 62,275 (c)
	Sodium	NA	**4,230,000**	**3,680,000 J**	**3,980,000**	**3,780,000**	**4,100,000**	**3,300,000**	**3,600,000**	119,250 - 137,750 (c)
	Ammonia	11,700	10,200 J	13,500 J	9,600	8,200	11,000	11,000	11,000	34,000 (d)
	Chloride	**14,500,000**	**24,100,000**	**12,400,000**	**12,800,000**	**18,000,000**	**18,000,000**	**13,000,000**	**15,000,000**	250,000 (b)
SPRING	Aluminum	NA	NA	NA	23.9	NA	NA	NA	NA	29,373 - 36,920 (c)
	Sodium	NA	NA	NA	69,200 J	NA	NA	NA	NA	119,250 - 137,750 (c)
	Ammonia	NA	NA	NA	2,300	NA	NA	NA	NA	34,000 (d)
	Chloride	NA	NA	NA	14,600	NA	NA	NA	NA	250,000 (b)

Notes:
All units are in micrograms per liter (μg/L).

Bold = Denotes exceedance of performance standard.
ND = Not detected.
NA = Not applicable due to the absence of water.
J = Estimated value.
NA = Not applicable due to the absence of water.
(a) = Maximum Contaminant Level (MCL).
(b) = Secondary Maximum Contaminant Level (SMCL).
(c) = Background Concentration.
(d) = Health Advisory Limit.

Table B-3
Post-Remedy Quarterly Monitoring; UPS Groundwater

Well ID	Analytes	1st Quarter Aug. 1998	2nd Quarter Dec. 1998	3rd Quarter March 1999	4th Quarter June 1999	5th Quarter Sept. 1999	6th Quarter Dec. 1999	7th Quarter March 2000	8th Quarter July 2000	Performance Standards
008S	Aluminum	109 J	126 J	340	108 J	240	107 J	130 J	170 J	7,065 - 47,075(c)
	Sodium	15,600	18,100	19,100 J	15,300	15,000	14,300	14,000	15,000	10,678 - 144,000(c)
	Ammonia	ND	ND	67 J	ND	ND	17	ND	ND	NA
	Chloride	19,900	20,000	15,200 J	17,900	18,000	20,000	18,000	22,000	250,000(b)
K13S	Aluminum	1,350	831 J	1,000	591 J	879	873	1,300 J	1,100 J	7,065 - 4,7075(c)
	Sodium	**210,000**	80,800	79,600 J	86,600	78,900	76,300	69,000	71,000	10,678 - 144,000(c)
	Ammonia	ND	ND	ND	ND	ND	26 J	ND	ND	NA
	Chloride	42,800	42,300	29,400	33,600	35,000	36,000	43,000	24,000	250,000(b)
M15S	Aluminum	125 J	131 J	500	384 J	1,730	198 J	130 J	370 J	7,065 - 47,075(c)
	Sodium	14,400	17,700	19,600 J	12,700	13,800	9,140	18,000	16,000	10,678 - 144,000(c)
	Ammonia	ND	ND	ND	ND	ND	34 J	ND	ND	NA
	Chloride	5,600	5,400	6,000	5,600	6,100	5,900	7,100	7,200	250,000(b)

Notes:
All units are in micrograms per liter (μg/L).

Bold	=	Denotes exceedance of performance standard.
ND	=	Not detected.
J	=	Estimated value.
NA	=	Not applicable due to the absence of a ROD-specified cleanup level for the analyte.
(a)	=	Maximum Contaminant Level (MCL).
(b)	=	Secondary Maximum Contaminant Level (SMCL).
(c)	=	Background Concentration.

- Well H-16S, outside the south end of the landfill, exceeded the cleanup level for sodium (seven of eight events) and chloride (one of eight events). Sodium also exceeded its cleanup level (eight of eight events) in background monitoring well L-01S, screened in mine spoils upgradient of the landfill.

Chlorides have been selected to graphically illustrate the pre- and post-remedy contaminant data based on their definite association with salt cake fines and their high solubility. Graph 2 compares chloride concentrations in shallow groundwater adjacent to the landfill's west side before and after the remedy. The most notable trend is the decrease in chlorides in well H-16S, the only shallow well to have consistently exceeded its cleanup level (250 mg/L) due to an anomalous increase in concentrations before the pre-remedy monitoring was implemented. Chloride concentrations in seven of eight post-remedy monitoring events are below chloride's cleanup level. Post-remedy chloride trends for the remaining wells are generally consistent with the pre-remedy trends and remain below the chloride cleanup level. The shallow groundwater in the mine spoils/unconsolidated material outside the landfill has been classified as Class III groundwater, not a potential source of drinking water.

Surface water data from the pond (Table B-1) has been compared to the shallow groundwater cleanup levels to gauge whether any impacts are due to the landfill. After eight quarters of monitoring, there's no evidence of site-related impacts to the pond. Continued monitoring of the pond is not planned during the O&M monitoring due to the absence of site related constituents.

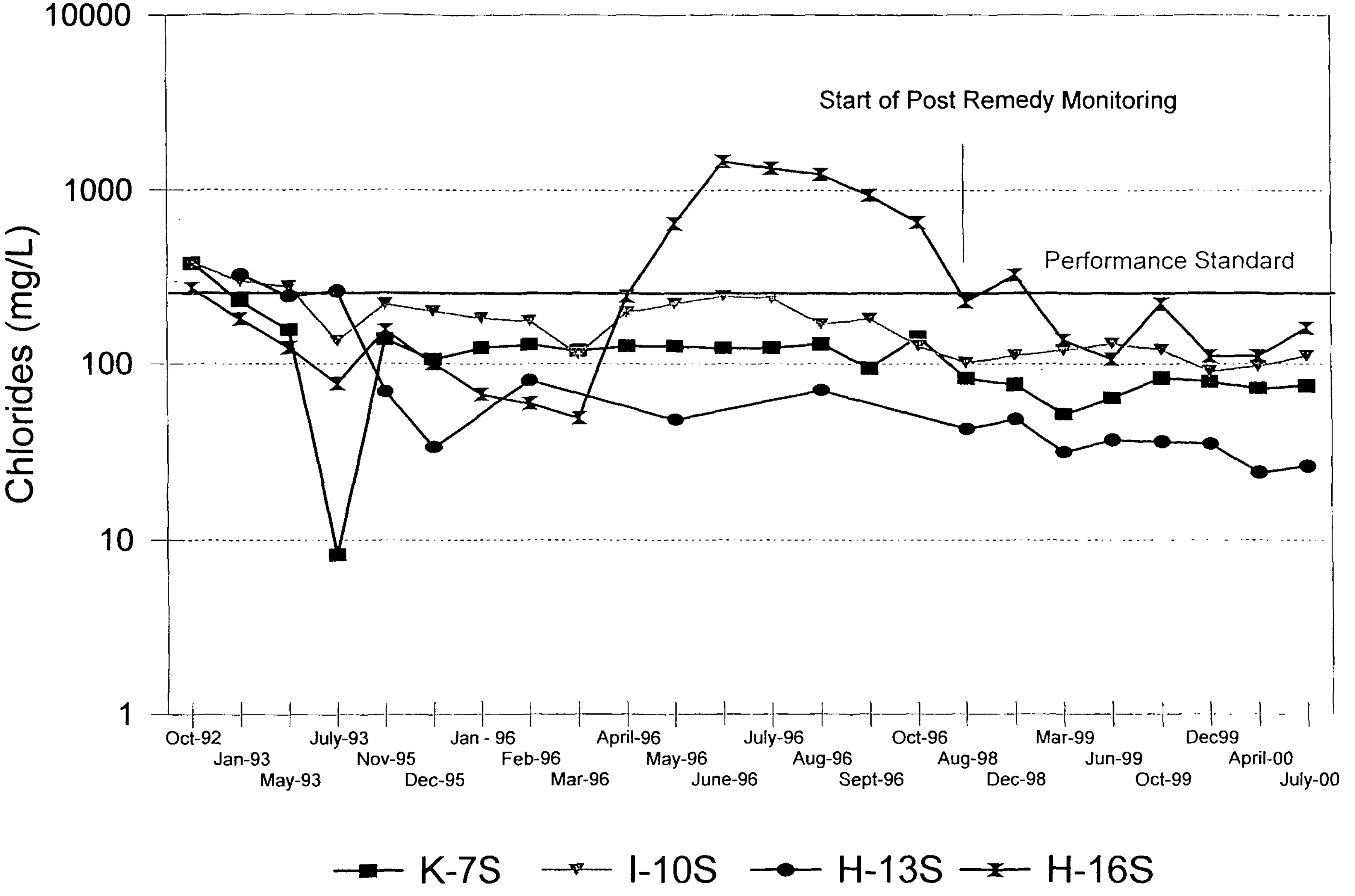
Deep Groundwater

Table B-2 shows that deep groundwater impacts are limited to wells immediately adjacent to the landfill (i.e., K-7D, I-10D, H-13D, H-16D, H-18D and I-18D). Contaminants in these wells that exceeded the cleanup levels were chloride and sodium (all the above wells), ammonia (H-16D), iron (H-16D), manganese (H-16D), and chromium (O-8D). Sodium was the only contaminant identified in the downgradient wells west of the landfill to exceed the cleanup level. In monitoring well G-11D, sodium exceeded the cleanup level in four of eight sampling events.

Graph 2

Chlorides in Shallow Groundwater

Adjacent to Landfill



However, the absence of other indicator parameters at similarly high concentrations and the presence of sodium in background well L-1S at similar concentrations indicates that the sodium exceedances are not site-related, but naturally occurring.

Chlorides detected in deep groundwater adjacent to the landfill (before and after the remedy) are plotted on Graph 3. The effects of the remedy are not yet evident in the deep groundwater likely due to the relatively short period of post-remedy monitoring (two years) compared with the 20 years in which the deep groundwater has been impacted by the landfill. Many of the chloride trends established before the remedy have continued through the effectiveness monitoring period — a *general decrease* is noted in wells outside the southern end of the landfill (H16D and I-18D), while a *general increase* is noted in wells outside the central (H-13D and I-10D) and north end of the landfill (K-7D). The continued decreasing chloride and ammonia trend in groundwater at O-8D (Graph 4) is significant in the effectiveness monitoring data. O-8D is screened immediately below a No. 9 coal pillar, east of the landfill, and is thought to representative of leachate leaving the landfill via the underground mine works. As evident in Graph 4, chloride and ammonia mass leaving the landfill continue to decline, particularly the ammonia mass, which has decreased markedly to below the performance standard since the remedy.

Data from the offsite Crowe Spring, which is fed by water in the underground mine works, was monitored through the post-remedy period; however, it was dry during seven of the eight sampling events.[3] Again, using chloride as an indicator parameter, the chloride concentration detected during the fourth quarter (14.6 mg/L) was consistent with pre-remedy concentrations (15.8 to 29.9 mg/L), indicating this area of the mine works has not been impacted by leachate leaving the

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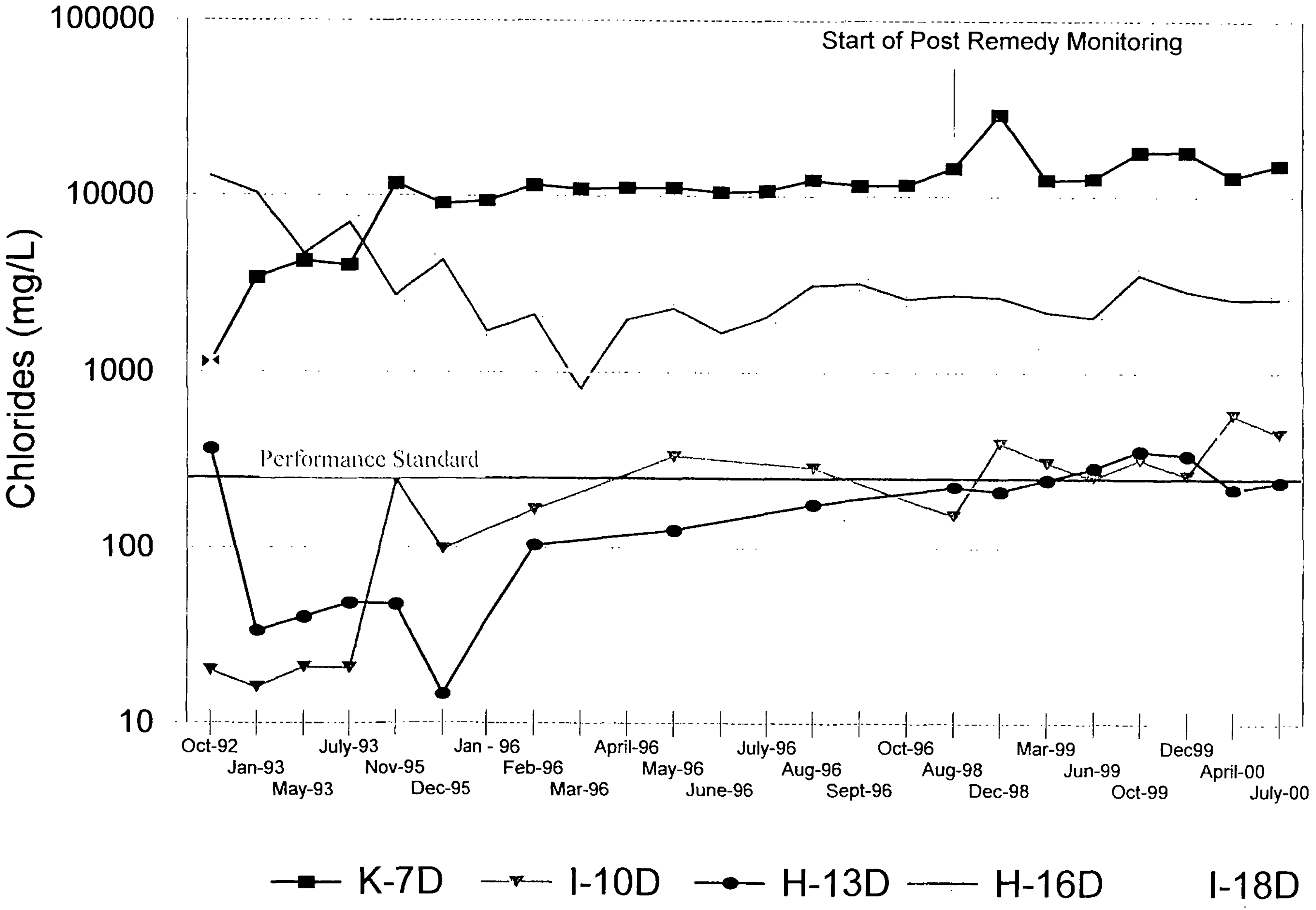
[3] A network of underground mine works struck by Sextet Mining Company in June 1999 released an estimated 30 million gallons of water into the Sextet Mine (Owensboro Messenger Inquirer, June 9, 1999). The lack of water at the Crowe's spring, which is approximately 0.7 mile updip of the Sextet mine, may be the result of the mining activities.

Graph 3

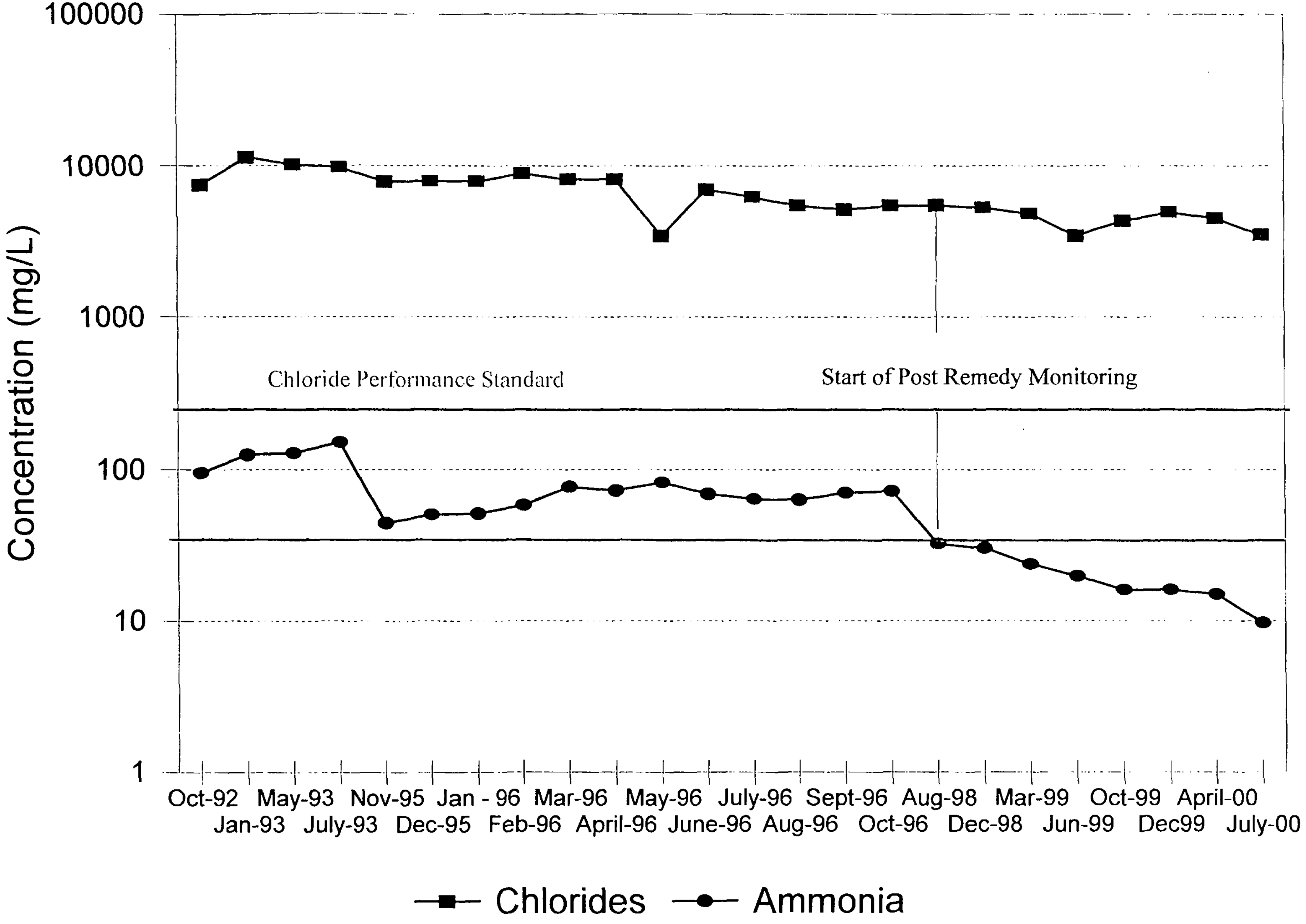
Chlorides in Deep Groundwater

Adjacent to Landfill



Graph 4

Chlorides and Ammonia at O-8D



landfill. Due to the absence of site-related impacts in the spring, additional monitoring is not planned during the O&M.

UPS Groundwater

Groundwater quality in the UPS east of the landfill remains free from salt cake fine impacts as shown in Table B-3, except for a single detection of sodium during the first quarter of post-remedy monitoring. The sodium exceedances do not appear to be site-related based on the lack of exceedances in the remaining seven sampling events and the fact that other indicator parameters have remained below cleanup levels. As shown in Graph 5, site-related constituents have not historically been present in the UPS groundwater, which has been classified as Class II groundwater, a potential source of drinking water. Due to the absence of site-related impacts in the UPS groundwater, additional monitoring is not planned during O&M.

Potentiometric Data

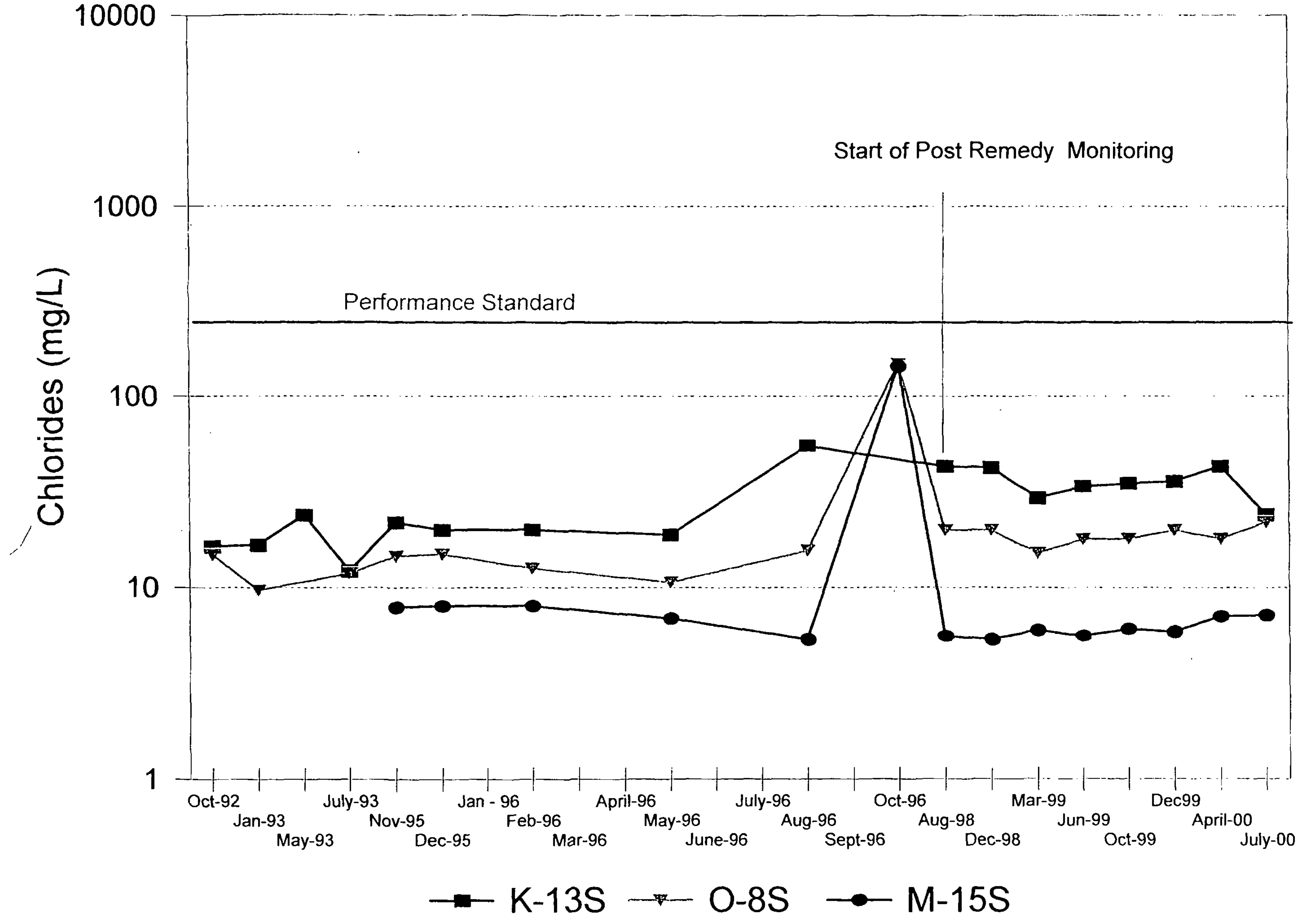
Potentiometric maps from the third quarter of post-remedy monitoring (March 1999) are provided for the shallow and deep groundwater in Figures B-2 and B-3. Flow directions since the remedy are basically similar to those measured before the remedy, showing shallow and deep groundwater divides running along the west side of the landfill, while groundwater in the UPS continues to flow south-southeast with dip.

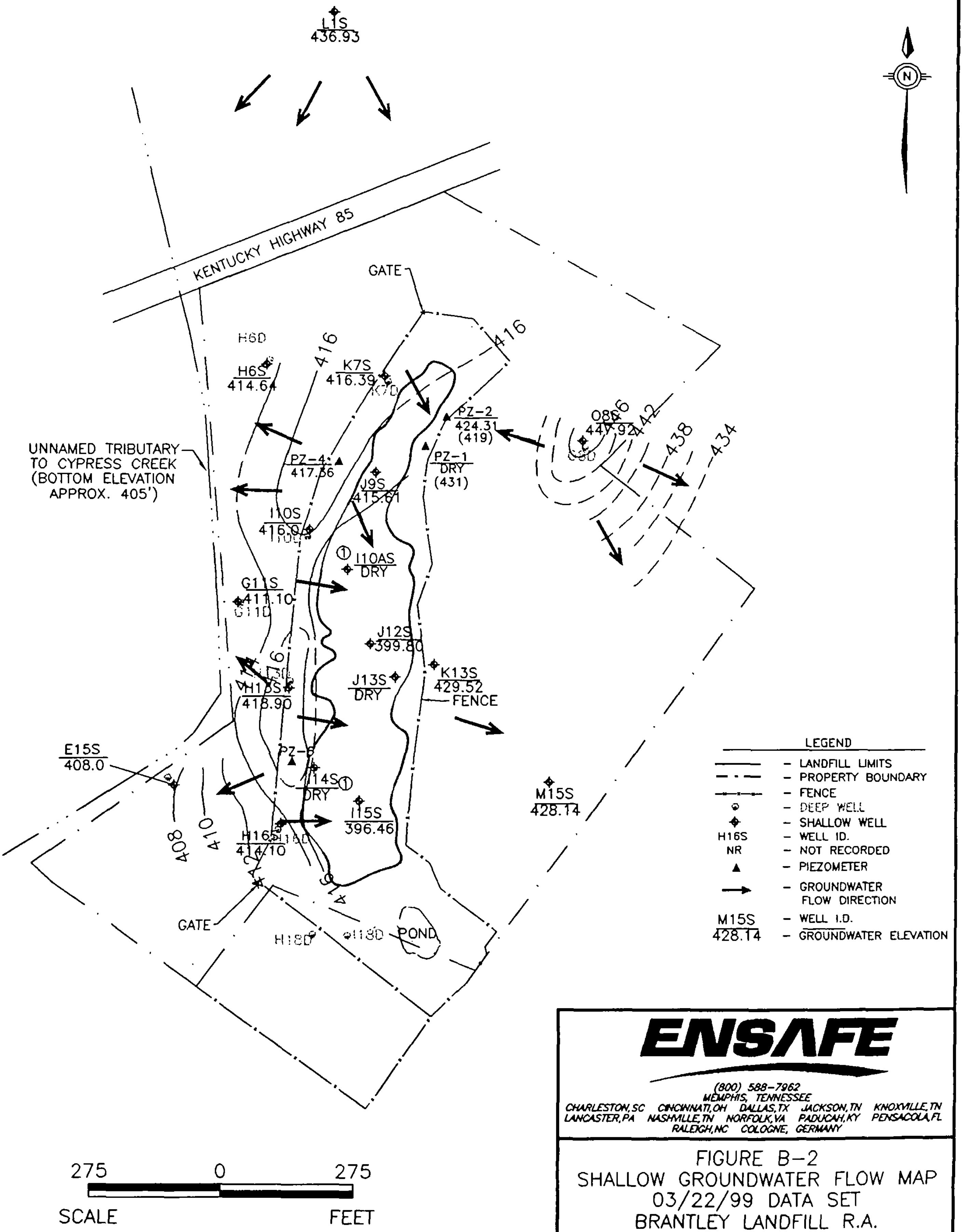
B.3 Air Monitoring

OP-FTIR monitoring was conducted to determine whether the ammonia emissions from the landfill were effectively mitigated by the new cap. During the initial air pathway investigation in 1992, ammonia emissions from the site ranged from 46.36 micrograms per cubic meter ($\mu g/m^3$) to 215.10 $\mu g/m^3$, a range below the earlier repealed Kentucky standard and the USEPA Region IV standard for evaluating chronic and acute ammonia. To verify that the clay cap was properly constructed, Remote Sensing Air, Inc. and Met Associates, Inc. conducted OP-FTIR monitoring

Graph 5

Chlorides in UPS Groundwater





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LANCASTER, PA NASHVILLE, TN NORFOLK, VA PADUCAH, KY PENSACOLA, FL
RALEIGH, NC COLOGNE, GERMANY

FIGURE B-2
SHALLOW GROUNDWATER FLOW MAP
03/22/99 DATA SET
BRANTLEY LANDFILL R.A.

DWG DATE: 11/21/00
DWG NAME: 2032W002

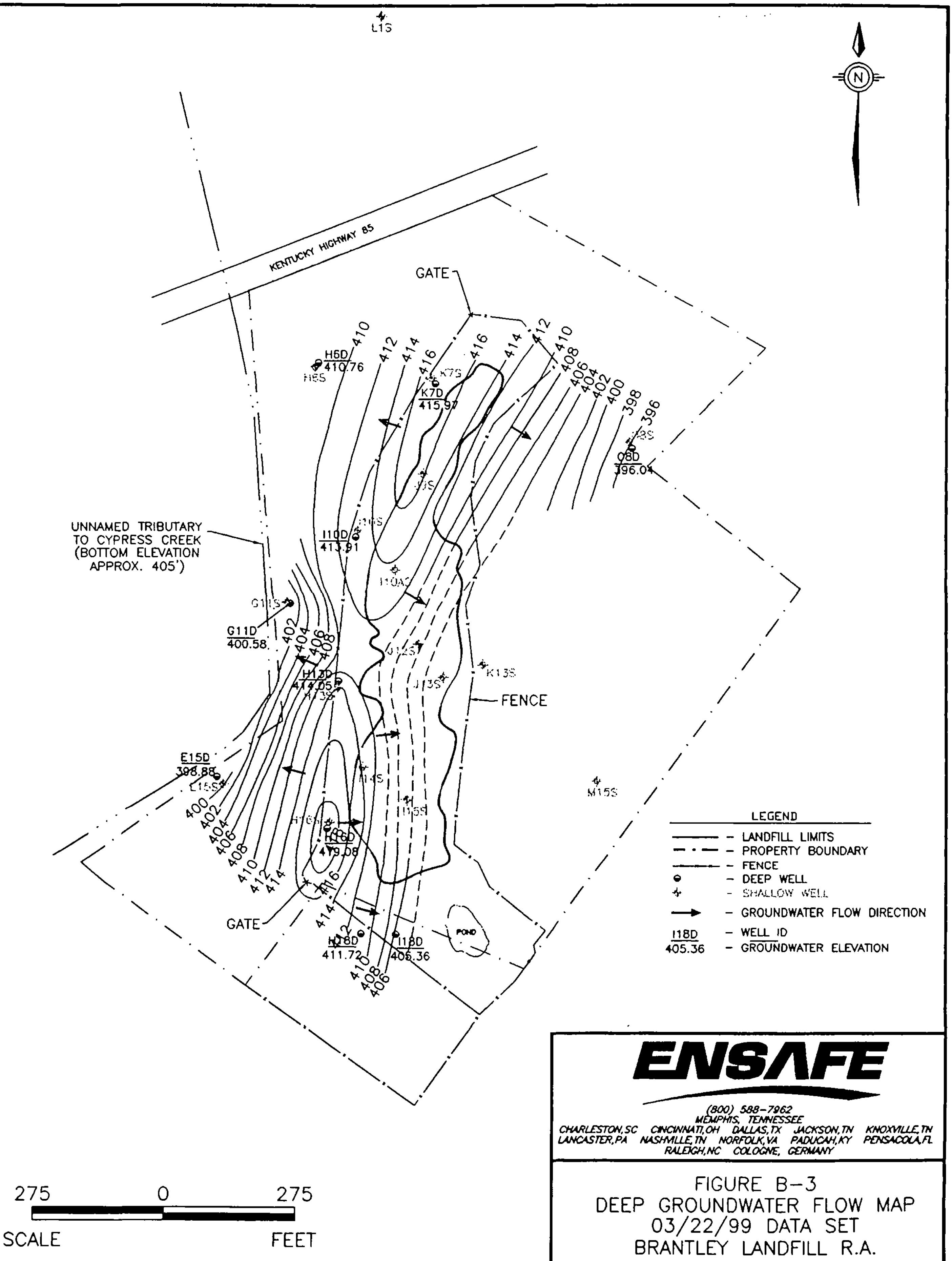

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FIGURE B–3
DEEP GROUNDWATER FLOW MAP
03/22/99 DATA SET
BRANTLEY LANDFILL R.A.

DWG DATE: 11/21/00 | DWG NAME: 2032W003

from June 11 to 13, 2000. The results confirm that ammonia emissions continue to be effectively mitigated. The 8-hour and 24-hour results were an order of magnitude below the acceptable concentrations and well below the values measured during the earlier 1992 monitoring, indicating that the standards are being met. OP-FTIR testing results are provided in the *Air Monitoring Technical Memorandum* (EnSafe, 2000) in Appendix D.

Appendix D
Air Monitoring Technical Memorandum

AIR MONITORING TECHNICAL MEMORANDUM

BRANTLEY LANDFILL SITE
ISLAND, KENTUCKY

EnSafe Project Number
2032-004

Prepared for:

COMMONWEALTH ALUMINUM
Aluminum Manufacturing Leadership

Barmet Aluminum — Division of Commonwealth Aluminum
1372 State Road 1957
Lewisport, KY 42351

Prepared by:

ENSAFE

Environmental and Safety Designs, Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

August 5, 2000

1.0 INTRODUCTION

In accordance with the Brantley Landfill Record of Decision, Open Path Fourier Transform Infra-Red (OP-FTIR) monitoring was conducted post-cap to determine whether the ammonia emissions from the landfill have been effectively mitigated or eliminated by the new cap. During the initial air pathway investigation (1992) at the site, emissions from the site were regulated under KAR 63:022. This regulation has since been repealed. The remaining standards for determining site compliance are the 24-hour and annual standards established by USEPA Region IV for evaluating chronic and acute NH_3 exposure. The standards are listed in Table 1 below.

Source	Concentration	Averaging Time
KAR 63:022	0.43 mg/m^3	8-hr
USEPA Region IV (ACGIH)	0.4 mg/m^3	24-hr
USEPA Region IV (IRIS)	0.1 mg/m^3	Annual

2.0 SITE BACKGROUND

The original OP-FTIR monitoring was conducted in June 1992, and the *Final Draft Air Pathway Analysis* was submitted in November of 1993. During that investigation, the ammonia concentrations ranged from 46.36 ug/m^3 to 215.10 ug/m^3, which are below the action levels presented above. The Record of Decision required the confirmation OP-FTIR sampling to verify that the clay cap that was placed over the landfill was properly constructed. This sampling was performed June 11th - 13th as described below. The results confirm that ammonia emissions continue to be effectively mitigated.

3.0 MONITORING

The monitoring was not completed immediately after the new cap was in place for the following reasons: the first year (1998), was too late in the season (September) to compare the results to the previous monitoring event (conducted in June after a rainy spring), monitoring was not completed during the second year after the cap was installed because the Western Kentucky area was under extreme drought conditions which would not be representative of the previous monitoring event.

The monitoring was conducted June 11-13, 2000. The attached report (Attachment A), prepared by Remote Sensing Air, Inc. and Met Associates, Inc. details the monitoring event and site conditions during the event. Weather conditions during the monitoring were consistent with our predicted worst case situation of warm temperatures, high humidity, and a good southerly wind flow. The meteorological data are also included in the attached report.

4.0 RESULTS

The results of the monitoring demonstrate that the ammonia concentrations from the landfill are well below the concentrations listed in Table 1. The maximum 8-hour and 24-hour concentration observed during the monitoring period were 49.19 ug/m^3 (0.04919 mg/m^3) and 33.23 ug/m^3 (0.03323 mg/m^3) respectively. Since the 8-hour and 24-hour results are an order of magnitude below the acceptable concentrations and are well below the values measured during the first monitoring event, it is apparent that the annual standard will also be met.

5.0 CONCLUSIONS

The results of the OP-FTIR monitoring demonstrate that the ammonia emissions from the landfill to the ambient air have been effectively mitigated by the new cap. The data obtained during this monitoring event, which are 50-60% lower than the values collected in 1992, clearly demonstrates that downwind emissions measured onsite are an order of magnitude below any applicable threshold. As a result, no additional air monitoring is proposed at the Brantley Landfill Site.

ATTACHMENT A

FINAL REPORT

DETERMINATION OF AMMONIA CONCENTRATIONS USING OPEN PATH FOURIER TRANSFORM INFRARED SPECTROSCOPY AT THE BRANTLEY LANDFILL

JUNE 11-13, 2000

Report

Project #R130
Report #FR-0001.1

DETERMINATION OF AMMONIA CONCENTRATIONS USING OPEN-PATH FOURIER TRANSFORM INFRARED SPECTROSCOPY AT THE BRANTLEY LANDFILL

JUNE 11 – 13, 2000

FINAL REPORT

June 30, 2000

Prepared by:

Judith O. Zwicker Remote Sensing≡Air, Inc.
Timothy Waldron Met Associates, Inc.

Prepared for:
Ensafe Inc.
5724 Summer Trees Drive
Memphis, TN 38134

BACKGROUND

Remote Sensing Air, Inc. (RS≡A) was contracted by Ensafe Inc. to provide monitoring for ammonia concentrations near the downwind fence line at the Brantley Landfill in Island, Kentucky using open-path Fourier Transform Infrared spectroscopy (OP-FTIR). The landfill contains salt cake fines (SCF) from Barmet's Livia facility, which is no longer in operation. Ammonia is produced by interaction of the (SCF) with water. Monitoring was required by the Record of Decision on the property to verify that the cap has mitigated the release of ammonia. In order to verify meteorological conditions during the monitoring and to verify that the emissions from the landfill would cross the beam path, meteorological monitoring was conducted simultaneously with the OP-FTIR monitoring.

MONITORING

Monitoring was performed from early evening on June 11 through the morning of June 13, 2000 to provide more than 24-hours of data for review. The forecast for the period was for winds from the south to southwest, high temperatures (greater than 80°F) and high dew points (greater than 60°F) with the possibility of thunder showers. The weather was as predicted except that there were no thunder showers. The area had been saturated with heavy rains during the previous month.

The site is shown in Figure 1. The landfill is about 100 meters wide and 300 meters long. It is situated approximately north-south with a waste water treatment plant and holding pond at the south end. There are trees to the east and west and a field to the west of the trees. The landfill is capped and rises to about 10 feet (3 meters) above its lowest points. Given the configuration of the landfill and the predicted wind directions, the optimum beam path was along the northeastern edge of the landfill. The beam path chosen is shown in Figure 1. This beam path would provide the maximum average fence line concentrations since there would be impact from the entire landfill as well as possible impact from the holding pond and waste water treatment plant. The meteorological equipment was set up at approximately mid-beam path and about the same height as the beam to provide accurate information on transport through the beam with the predicted southerly winds.

With the southerly to southwesterly winds and the trees to east and west, there was good transport from the south during the daytime monitoring. The nighttime monitoring had calm and variable winds.

OP-FTIR Set-up and Operation

The OP-FTIR system used for this monitoring was an MDA monostatic system with the source, interferometer, and detector in the same instrument box. With this type of system, the beam is modulated before being transmitted from the box through a telescope to the retroreflector to reduce the impact of infrared radiation from other sources. The beam is then returned by the retroreflector to the telescope and to the detector. A single beam path was set up as shown in Figure 1 with a path-length of 115 meters from the telescope to the retroreflector. The beam height was set at approximately 3 meters to provide monitoring near the breathing zone and to be above the high ground between the OP-FTIR and the retroreflector.

The OP-FTIR system was operated with 1 cm^{-1} spectral resolution and used a Stirling engine to cool the MCT detector. Spectra were collected at approximately 1-minute intervals with each saved spectrum providing the average of 16 coadded spectra. Spectra were collected continuously from

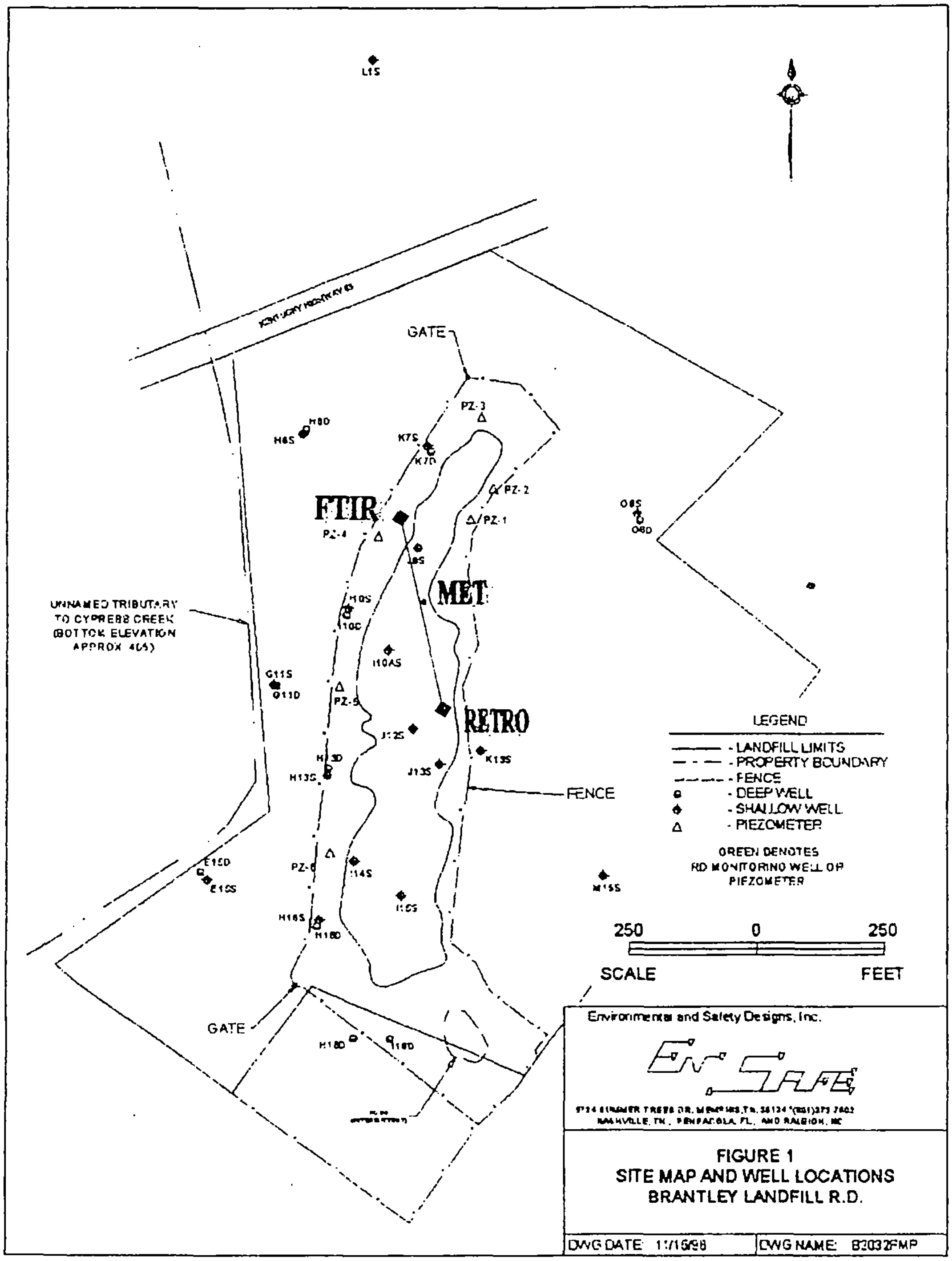


Figure 1. Site map with location of meteorological equipment (MET) as well as beam from FTIR to RETO.

19:00 CST on June 11, 2000 through 08:00 CST on June 13, 2000 except for time off line for downloading data and changing real-time viewing windows.

Meteorological Equipment and Set-up

Meteorological monitoring was performed simultaneously with the OP-FTIR monitoring in order to provide information for proper locations of beams and evaluation of the OP-FTIR data relative to the possible landfill emissions as well as possible impact from holding pond, waste water treatment plant and spraying of an adjacent field.

Meteorological monitoring was provided by MetAssociates (MetA). MetA provided two portable towers set up with equipment at about 3 meters above ground to be at approximately the same height as the OP-FTIR beam. The meteorological equipment was set up about 8 feet from the OP-FTIR beam near the center point of the beam (see Figure 1).

The towers were equipped with sensors for measurement of temperature, pressure, relative humidity, wind speed, and wind direction. A Campbell CR-10 datalogger was used to collect the meteorological data by sampling the sensors at one-second intervals and providing one-minute and five-minute average values as well as standard deviations of all parameters. Data were provided in real-time plots and tables on the field computer provided for the project.

Table 1. Specifications for the Meteorological System

VARIABLE	INSTRUMENT TYPE	MANUFACTURER AND MODEL	SYSTEM ACCURACY	SENSOR SPECIFICATIONS
Horizontal Wind Speed	Cup Anemometer	Climatronics 100108-1	±0.25 mph ±1%	Starting threshold <1 mph (maintained at 0.5 mph) distance constant <15 ft
Wind Direction	Vane	Climatronics 100108-2	±3 deg linearity ±2 deg orientation	
RH	Strain Gauge	Climatronics 100098	±2% linearity. ±2% hysteresis ±1% reproducibility	Time constant = 3 min
Temperature	Thermistor	Climatronics 200093-1	±0.27 °F	Time constant = 10 sec
Pressure	Piezo Resistance	Climatronics 101448	±0.04 "Hg	
Datalogger	Digital Intelligent	Campbell Scientific CR-10		

DATA ANALYSIS

Both the OP-FTIR and meteorological data were plotted and reviewed for erroneous data points. Detailed plots of the meteorological data are provided in Appendix A. The OP-FTIR data were then evaluated for maximum 24-hour, 8-hour, 1-hour, and 1-minute path-average ammonia concentrations in ug/m^3.

OP-FTIR Data

Spectra were collected and saved as single beam spectra to allow for easier post-processing if needed. All spectra were transformed from single-beam to absorbance spectra in real-time using the zero-path background spectrum collected on June 11, 2000. The zero-path spectrum provides the absorbance features of the instrument box and internal optics without ambient interferents. Spectra were analyzed using the Continuous Monitor (CM) Software developed by MDA and updated by ETG.

The CM software determines path-integrated concentrations from the absorbance spectra using a Classical Least Squares algorithm and standard reference spectra for each compound to be determined as well a those which might provide interference with the compounds of interest. The CM software version used provides the path-integrated concentrations in parts per million-meter (ppm-m) over the full beam-path. The CM software also provides a minimum detectable limit (MDL) for each spectrum based on three times the residual of the CLS calculations. The MDL is very useful for tracking interferences, low signal, and other possible problems.

The real-time path-integrated values were converted to path-average concentrations – the average concentration over the path – by dividing by the path length in meters. The path-average concentrations of ammonia are reported in ug/m^3 for easier comparison with the standards. Path-average concentrations for the nitrous oxide (used for ambient quality assurance) is reported in parts per billion (ppb) to be consistent with comparison to the ambient standard value of 360 ppb. The value of 360 ppb was determined by plotting the data reported in Trends '93 and extrapolating to June 2000.

All data reported are those collected in real-time, no post-processing was required. Figure 2 provides time series plots of the ammonia data during the full monitoring period overlaid with wind direction (a), wind speed (b), and temperature (c). The OP-FTIR data include a correction for the ammonia produced in the sealed instrument box during operation. The growth has been shown in studies at the RS≡A office to be about 0.002 ppm-m/minute or 3.61 ppm-m/day. This is consistent with the data collected using the zero path spectra collected at the beginning and end of this monitoring program. Corrections were made for each 1-minute data point. Also, the spectra collected on June 12, 2000 at 13:35, 14:10, and 14:11 CST were determined to have insufficient signal to provide accurate concentration data (see discussion under Quality Assurance). These data points have been removed from the dataset before averaging and plotting.

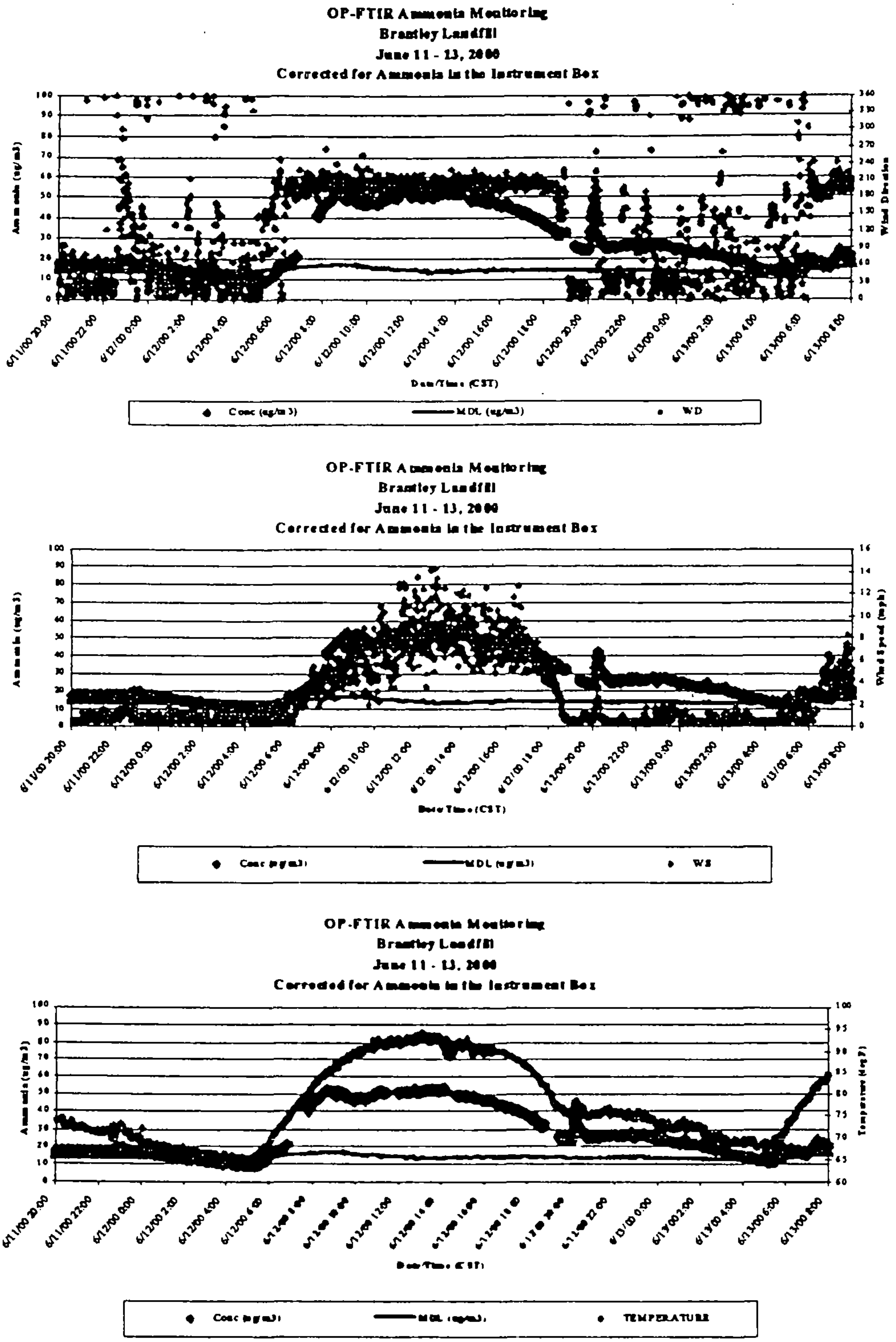


Figure 2. Ammonia concentrations plotted with simultaneously collected a) wind direction, b) wind speed, and c) temperature data.

Running 24-hour, 8-hour, 1-hour, and 1-minute averages were calculated for the path-averaged ammonia concentrations. The maximum values are provided in Table 2.

Table 2. Summary of maximum rolling average path-average concentrations of ammonia determined at the Brantley Landfill, June 11-13, 2000.

	Ammonia
Maximum 24-hour average	33.23 ug/m^3
Maximum 8-hour average	49.19 ug/m^3
Maximum 1-hour average	52.33 ug/m^3
Maximum 1-minute average	54.16 ug/m^3

The meteorological conditions during the maximum 24-hour average (6/12/00 06:17 through 6/13/00 06:35 CST) cover the full range of temperatures, relative humidity, wind speeds, and wind directions encountered during the monitoring.

The meteorological conditions during the maximum 8-hour average (6/12/00 07:56 through 6/12/00 15:56 CST) cover mainly the highest temperatures, the lowest relative humidity, the highest wind speeds, and wind directions mainly from the south through southwest.

The meteorological conditions during the maximum 1-hour average (6/12/00 13:15 through 6/12/00 14:15 CST) cover the highest temperatures, the lowest relative humidity, the highest wind speeds, and wind directions mainly from the south through southwest.

Meteorological Data

Following the field measurement portion of the study, all of the meteorological data were checked for quality control, processed, summarized, and displayed in time series graphics for the sampling period of the field program (Appendix A). Final review of the data resulted in the following changes being made to the raw field measurement data.

1. Barometric Pressure: Invalidated BP and StDev of BP from 1856-1904 CST on 6/11/00
2. *Relative Humidity: Set values to 100.0 from 0448-0536 on 6/12/00 (from 100.1 - 100.3)*
3. Unit Vector WD: Reset 1 value from 0.001 to 360.0 to avoid spreadsheet display of 0.00

QUALITY ASSURANCE

The quality of the OP-FTIR data were assured by following quality assurance procedures based on the USEPA Method TO-16 as described below. The quality of the meteorological data was assured by pre-monitoring calibration of the equipment, following USEPA standards for calibration and setup, and review of standard deviations of all parameters. The full calibration report for the meteorological monitoring is found in Appendix B.

OP-FTIR Data

A total of 1800 1-minute average spectra were collected over the monitoring period. Three of these were removed due to low signal as discussed below.

Detection Limits

MDLs are calculated automatically by the CM software as three times the residual of the CLS analysis and are very useful for tracking problems with beam signal, presence of interfering compounds, and other problems. The average detection limit for the monitoring period is 14.02 ug/m^3. This detection limit is sufficient for the present monitoring requirements since it is significantly below the criteria for comparison.

There were three spectra with high MDLs and unusual concentrations. All three also had high MDLs for the ambient N_2O monitoring. On reviewing the single beam spectra for these points, it was obvious that there was insufficient signal. There is no certain reason for these three spectra, all on June 12, 2000 (13:35; 14:10, and 14:11 CST), to have low signal. Generally such low signals are due to beam blockage. There did not seem to be any objects in the area which could have caused such blockage. There is a possibility of an electrical drain on the source during this period due to soldering being performed using the same power line.

Accuracy and Precision

The accuracy and precision of the data reported for the specific compounds of interest and analysis routine used were determined by the use of NIST certified gas mixtures flowed through the internal QA cell of the instrument. The internal QA cell has a path length of 15 cm (0.15 m) with the beam passing only once through the QA cell. The NIST certified gas mixture consisted of a mixture of ammonia in dry nitrogen at 170 ppm.

The accuracy is determined as the difference between the average path-average concentration during the flow of QA gas corrected for the average background before and after the flow minus the certified concentration divided by the certified concentration from the standard gas mixture: [(((Cm-Cb)-Ck)/Ck)*100% where Cm is the average measured value, Cb is the background value determined as the average of the values before and after the flow of QA gas, and Ck is the known (certified) value]. The ammonia QA check was performed using a zero path at the RS≡A office on June 8, 2000 before shipment of the equipment, at the beginning of the monitoring on June 11, 2000, and at the end of the monitoring on June 13, 2000. An open-path test was performed at the end of the monitoring on June 13, 2000. The results of these tests are reported in Table 3 and the data plotted in Figure 3.

The precision relative to the specific compounds is determined as the relative standard deviation [(Std. Dev./Average)*100%]of the values determined during the QA cell tests. The precision results are also reported in Table 3.

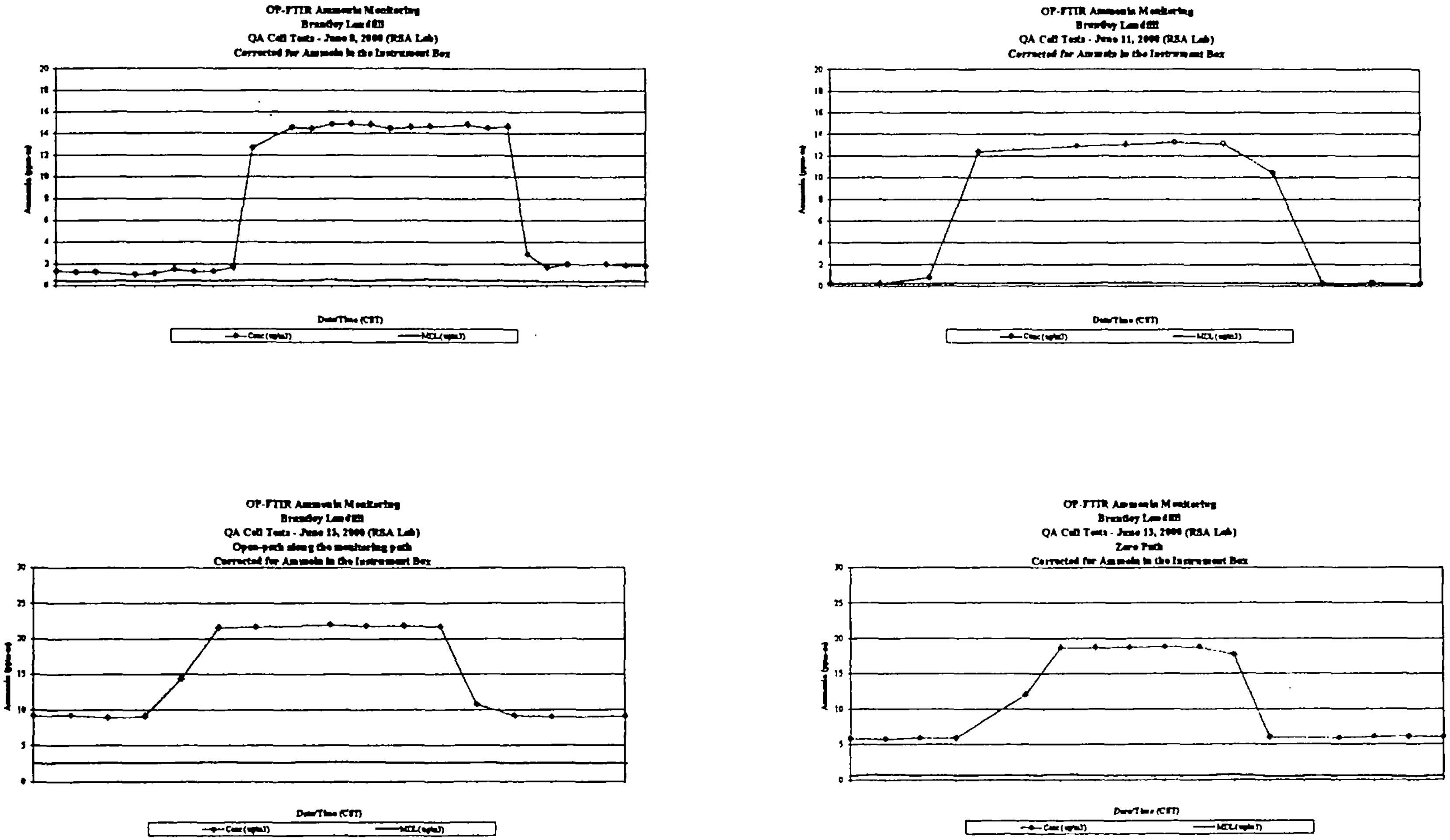
The overall accuracy of the system and analysis routine was determined using the ambient gas nitrous oxide which has a consistent ambient value of about 360 ppb world wide. The results for all valid data (sufficient signal) are provided in Figure 4. These data validate the system as well as the determination of path-length. The certified value for N_2O were obtained from the Trends '93 volume providing ambient concentrations of these gases at various points in the world. The ambient gas results can only be obtained using the full open-path spectra and a zero-path background. The average path-average concentration for N_2O over the full monitoring period was 347 ppb with a standard deviation of 3.11 ppb. Thus, the accuracy over the monitoring period is –4.52% and the precision is 2.17% over 1797 spectra.

Table 3. Results of QA cell tests.

Date		NH_3 (ppm)
Certified		***170***
6/8/2000	Concentration	171
Zero Path	Accuracy	0.8%
RS≡A Lab	Precision	1.2%
6/11/2000	Concentration	169
Zero Path	Accuracy	-0.3%
Brantley	Precision	2.7%
6/13/2000	Concentration	169
Open Path	Accuracy	-0.7%
Brantley	Precision	0.5%
6/13/2000	Concentration	170
Zero Path	Accuracy	0.5%
Brantley	Precision	0.4%

Accuracy = [(Cm-Ck)/Ck]*100%
Precision = [Standard Deviation of Cm/Average of Cm]*100%
Where Cm = measured value
Ck = known (NIST certified) value

Figure 3. QA cell tests: prefield zero path, premonitoring zero path, end monitoring open path, and end monitoring zero path.



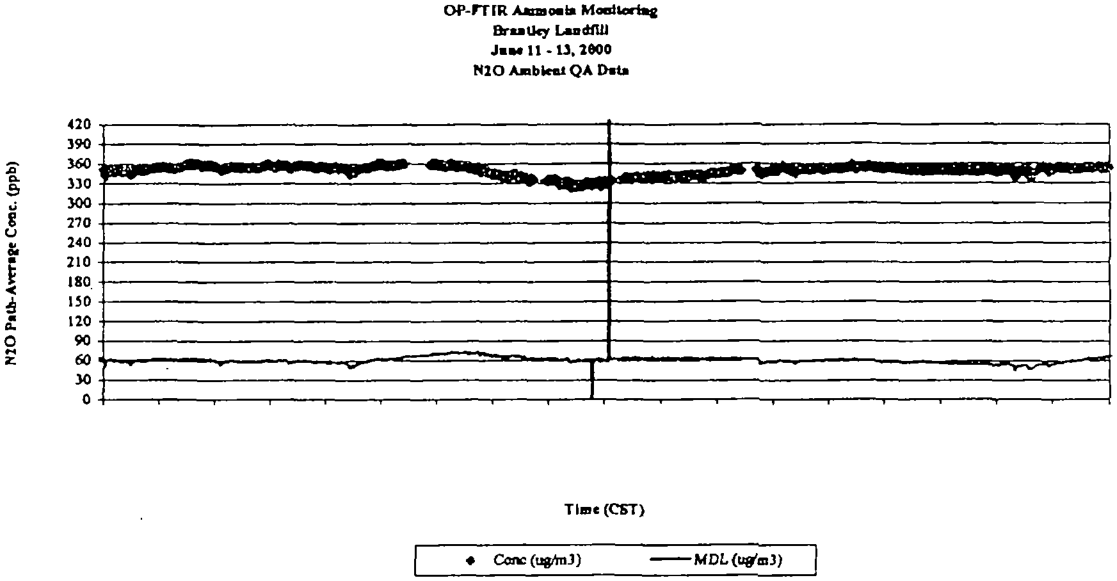
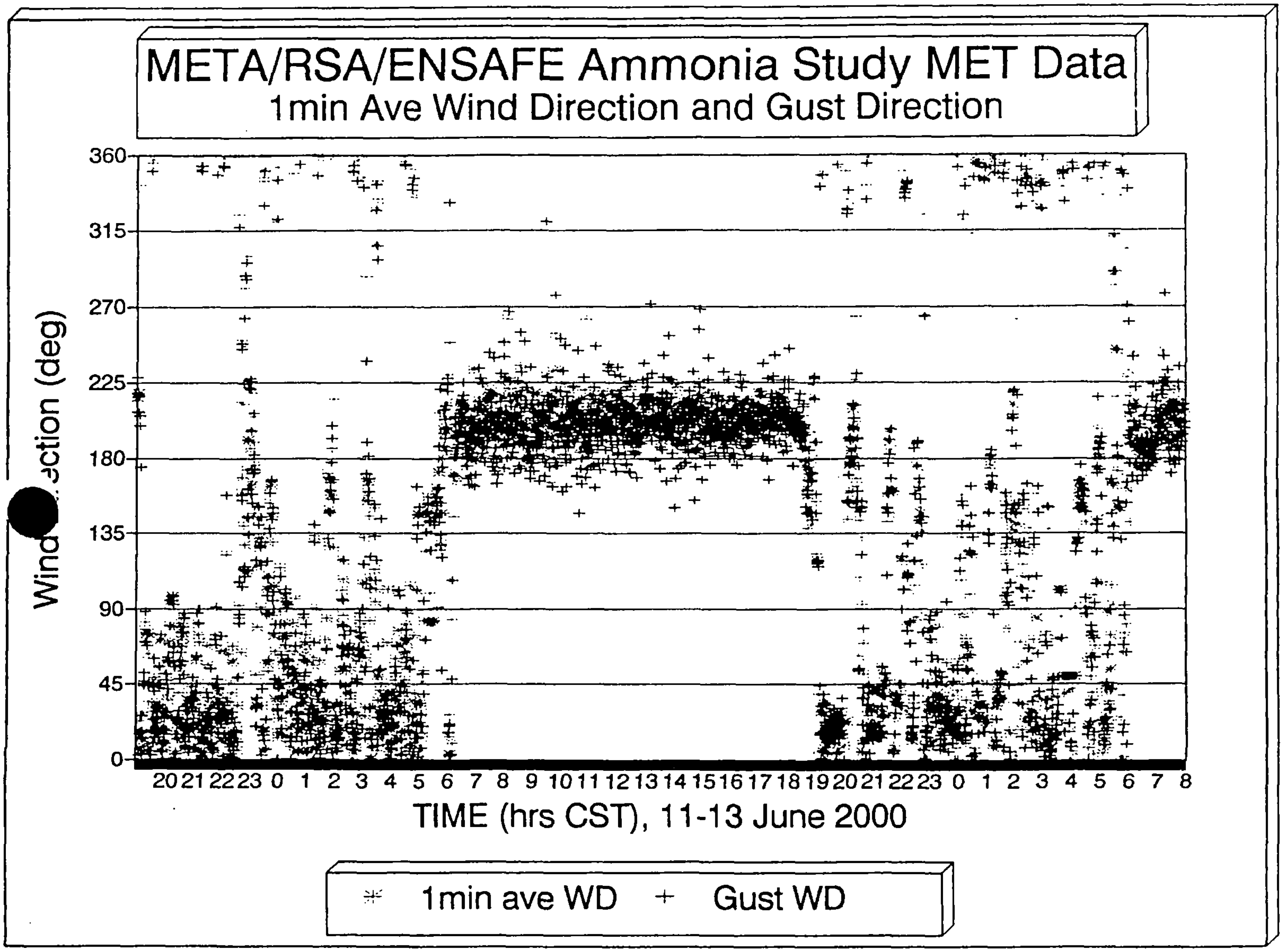
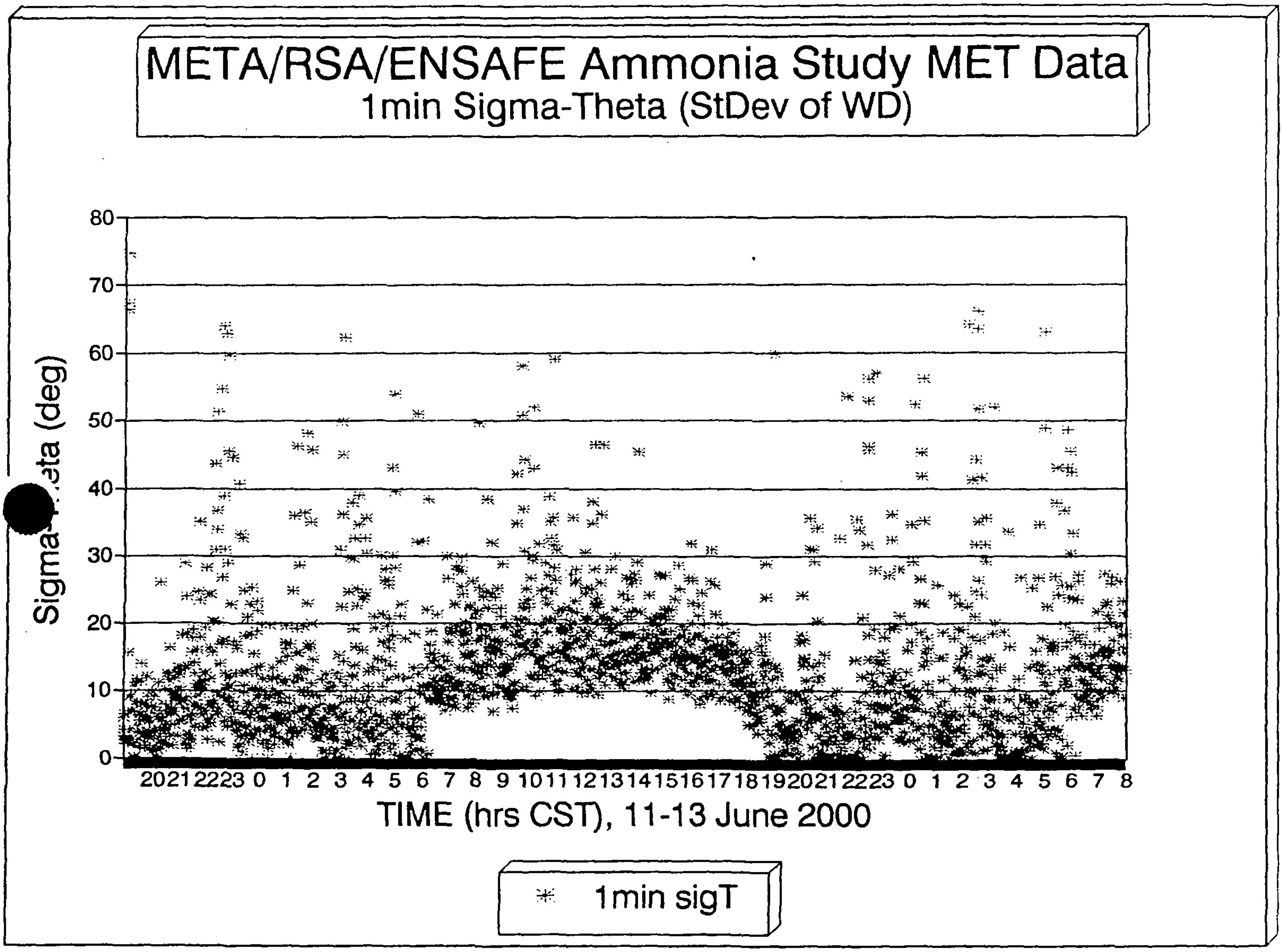


Figure 4. Ambient QA data using N_2O showing that the instrument was operating properly over the study period.

APPENDIX A

DETAILED METEOROLOGICAL DATA PLOTS


META/RSA/ENSAFE Ammonia Study MET Data
1min Ave Wind Direction and Gust Direction
Wind Direction (deg)
360
315
270
225
180
135
90
45
0
20 21 22 23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0 1 2 3 4 5 6 7 8
TIME (hrs CST), 11-13 June 2000
1min ave WD
Gust WD


META/RSA/ENSAFE Ammonia Study MET Data
1min Sigma-Theta (StDev of WD)
Sigma .ta (deg)
80
70
60
50
40
30
20
10
0
20
21
22
23
0
1
2
3
4
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7
8
9
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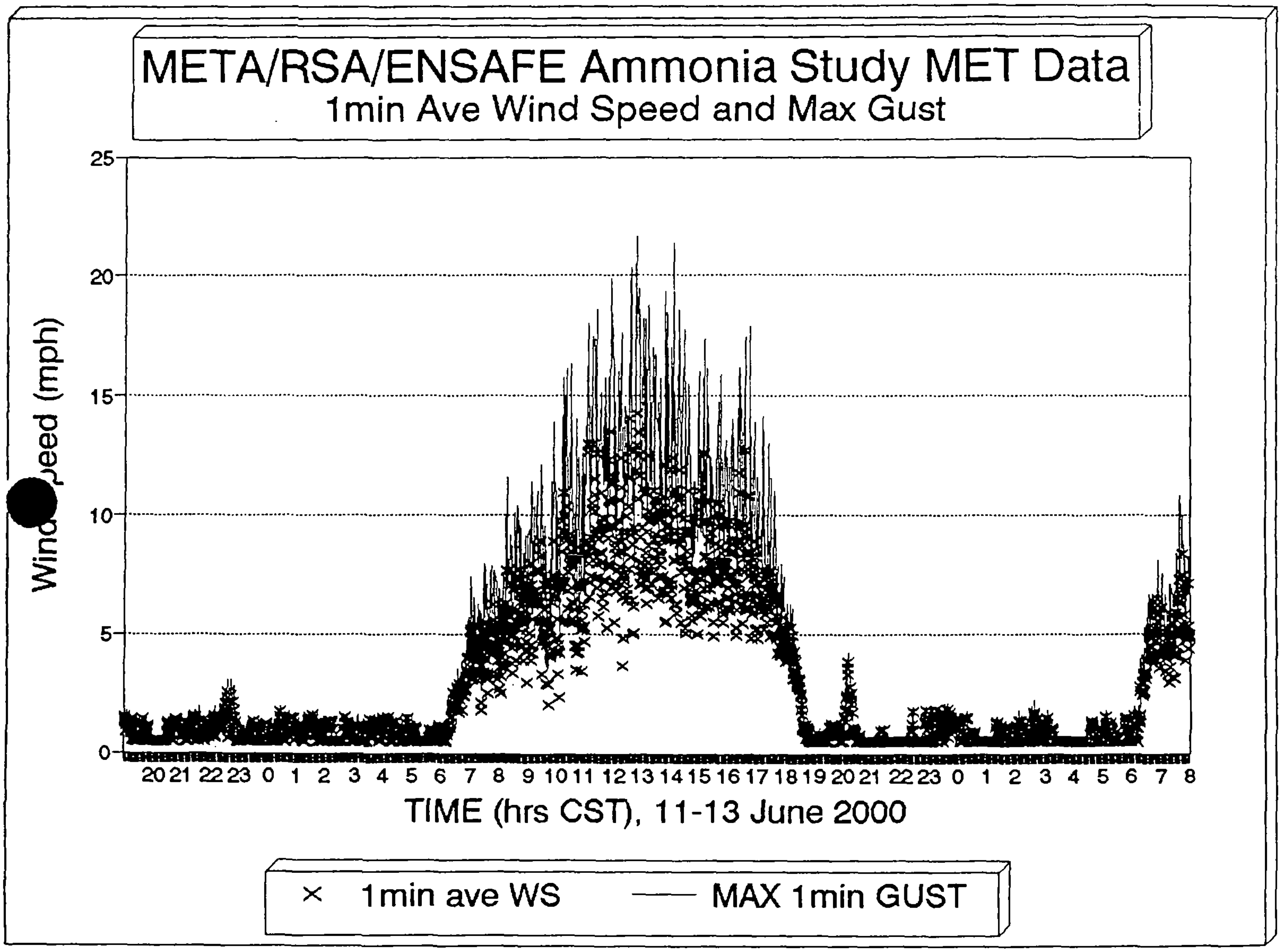
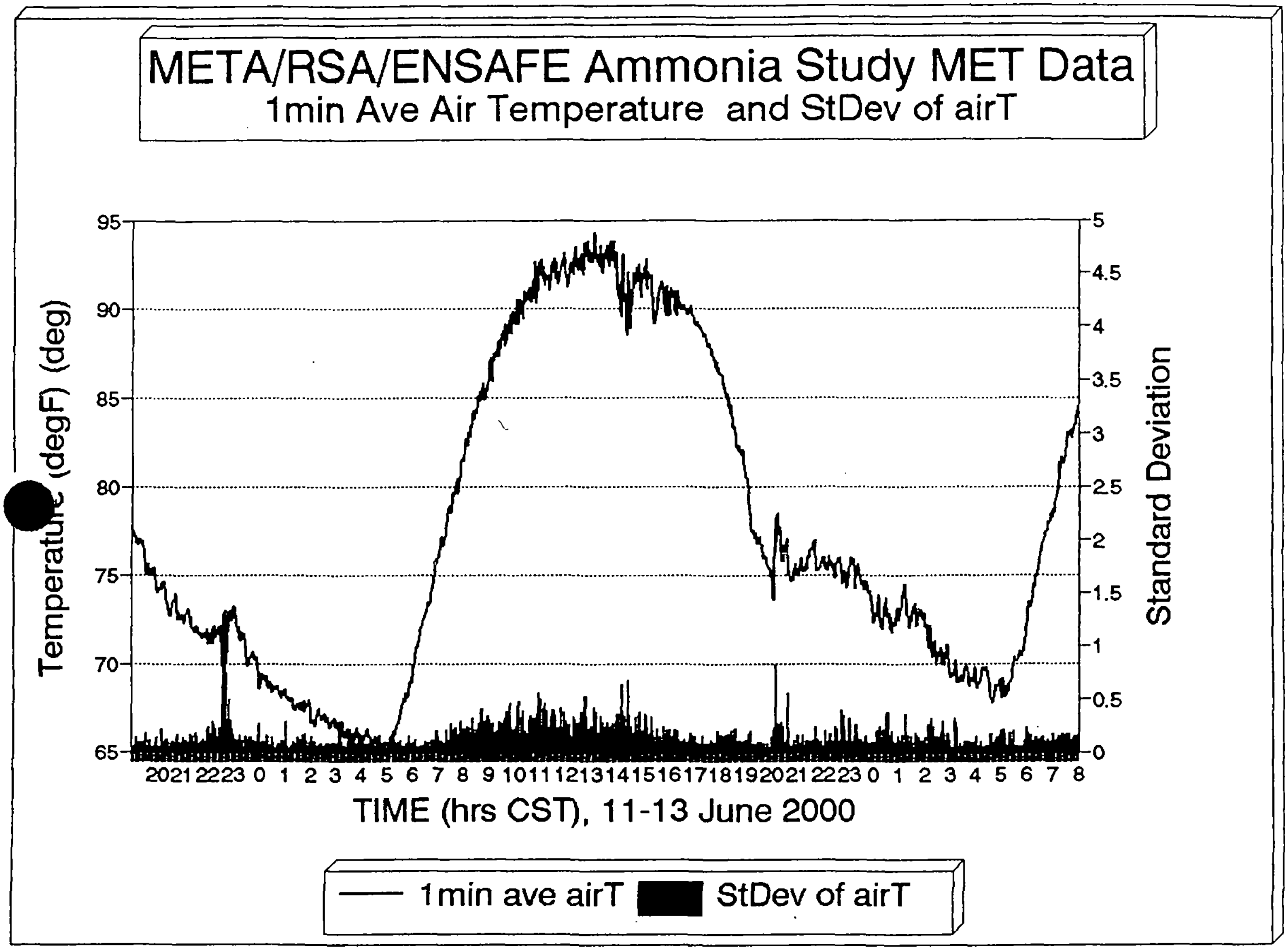
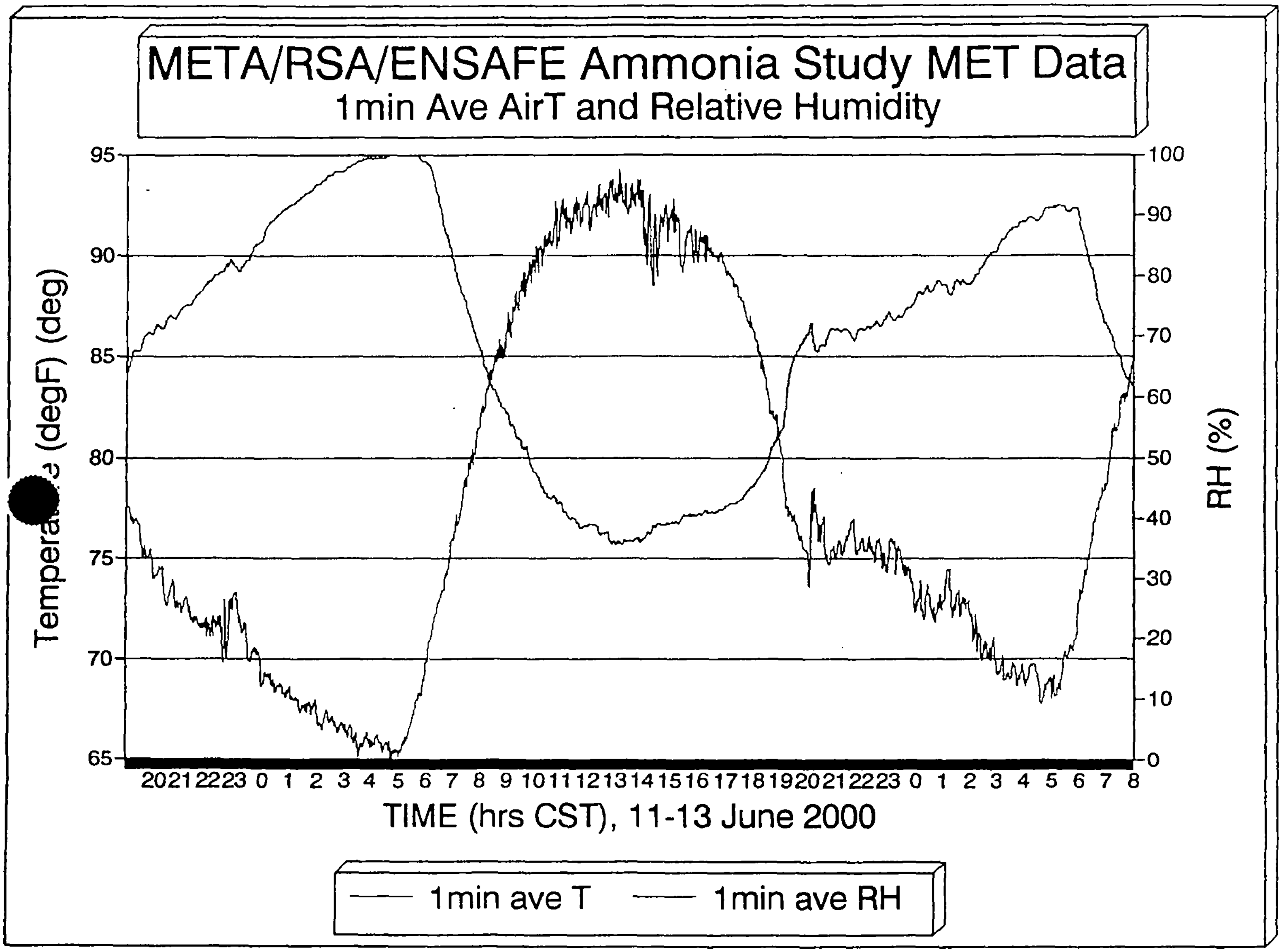
22
23
0
1
2
3
4
5
6
7
8
TIME (hrs CST), 11-13 June 2000
1min sigT



META/RSA/ENSAFE Ammonia Study MET Data

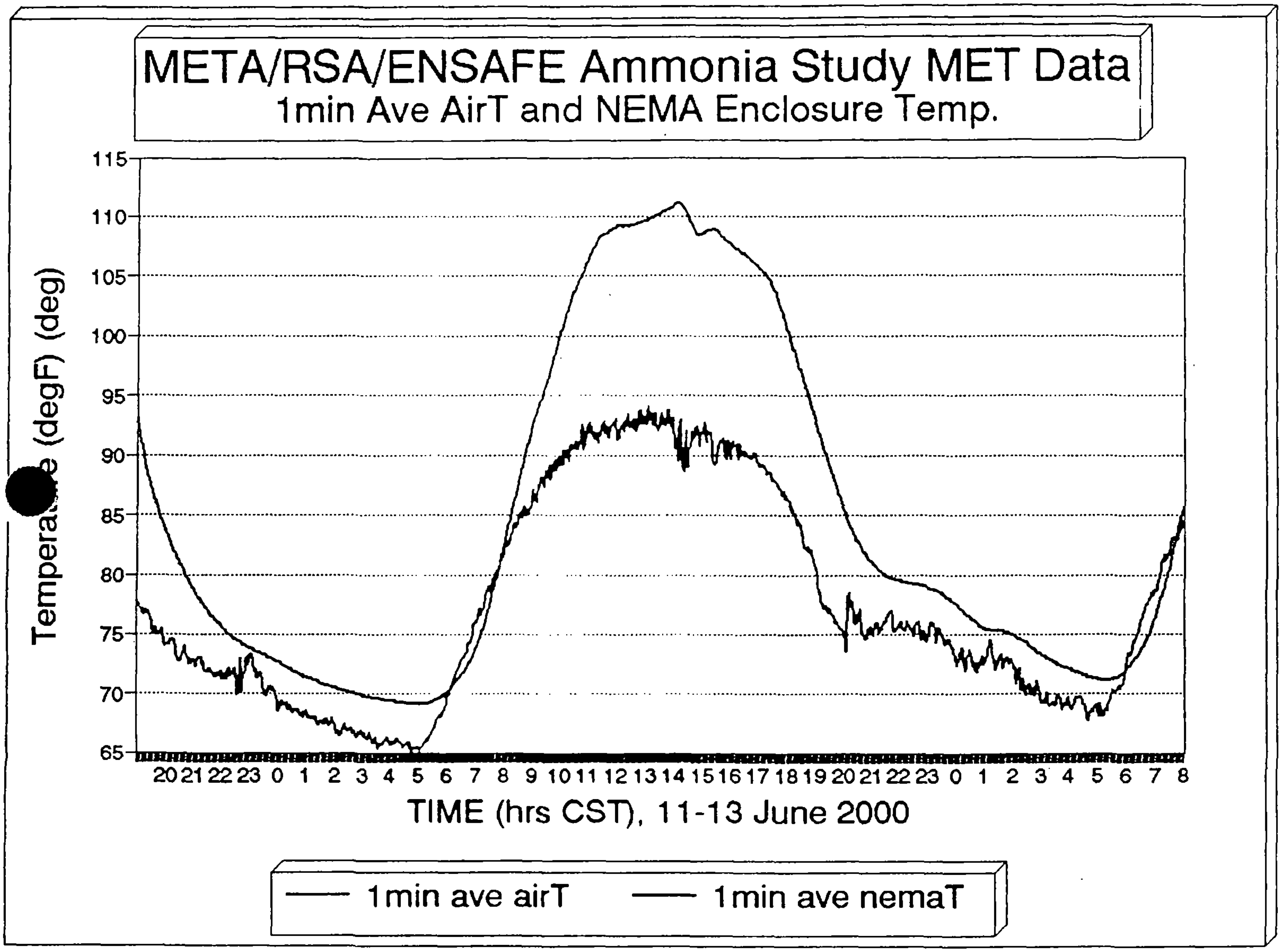
1min Ave Wind Speed and Max Gust


META/RSA/ENSAFE Ammonia Study MET Data
1min Ave Air Temperature and StDev of airT
Temperature (degF) (deg)
95
90
85
80
75
70
65
Standard Deviation
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
20 21 22 23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0 1 2 3 4 5 6 7 8
TIME (hrs CST), 11-13 June 2000
1min ave airT
StDev of airT



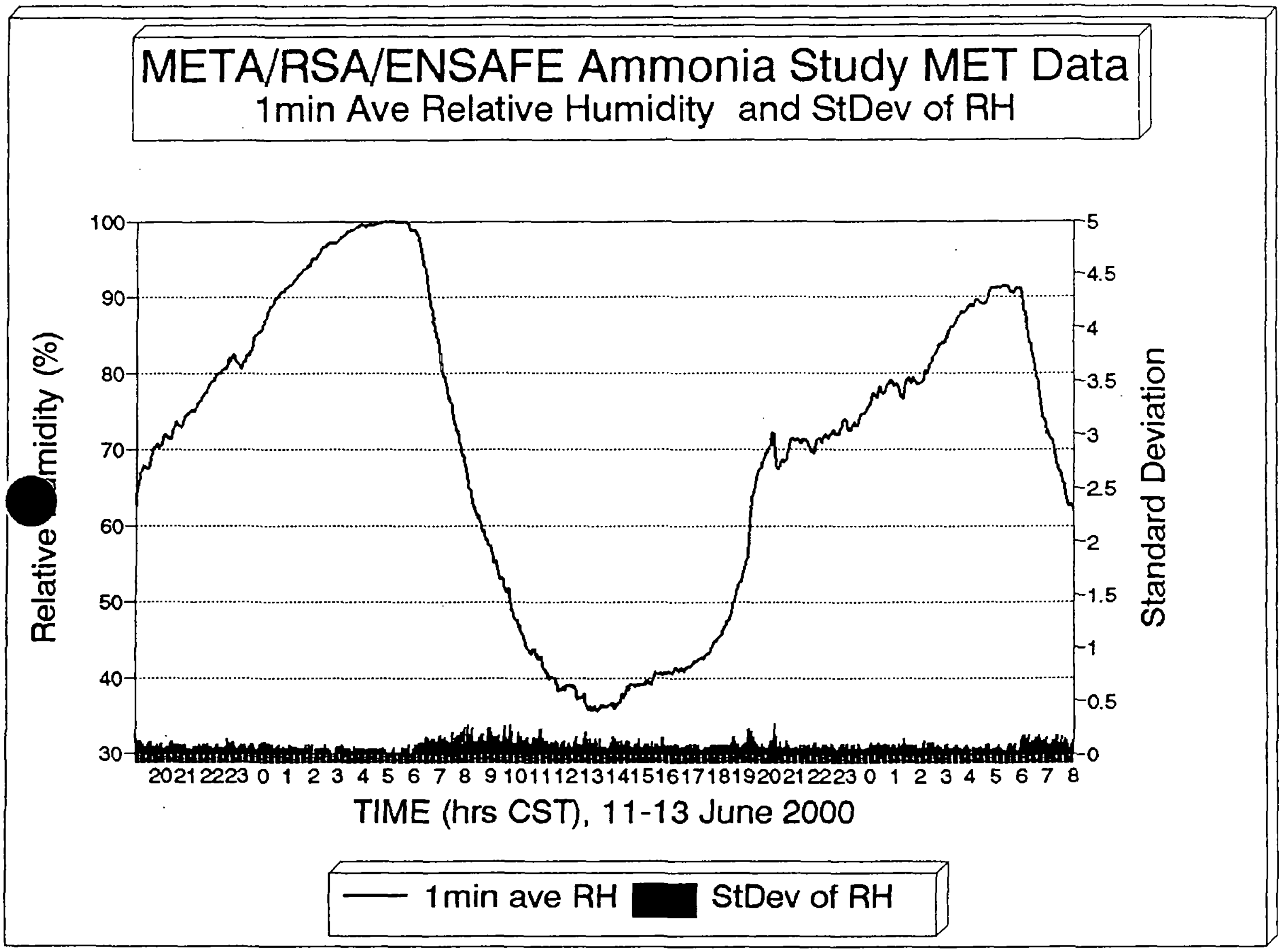
META/RSA/ENSAFE Ammonia Study MET Data

1min Ave AirT and Relative Humidity



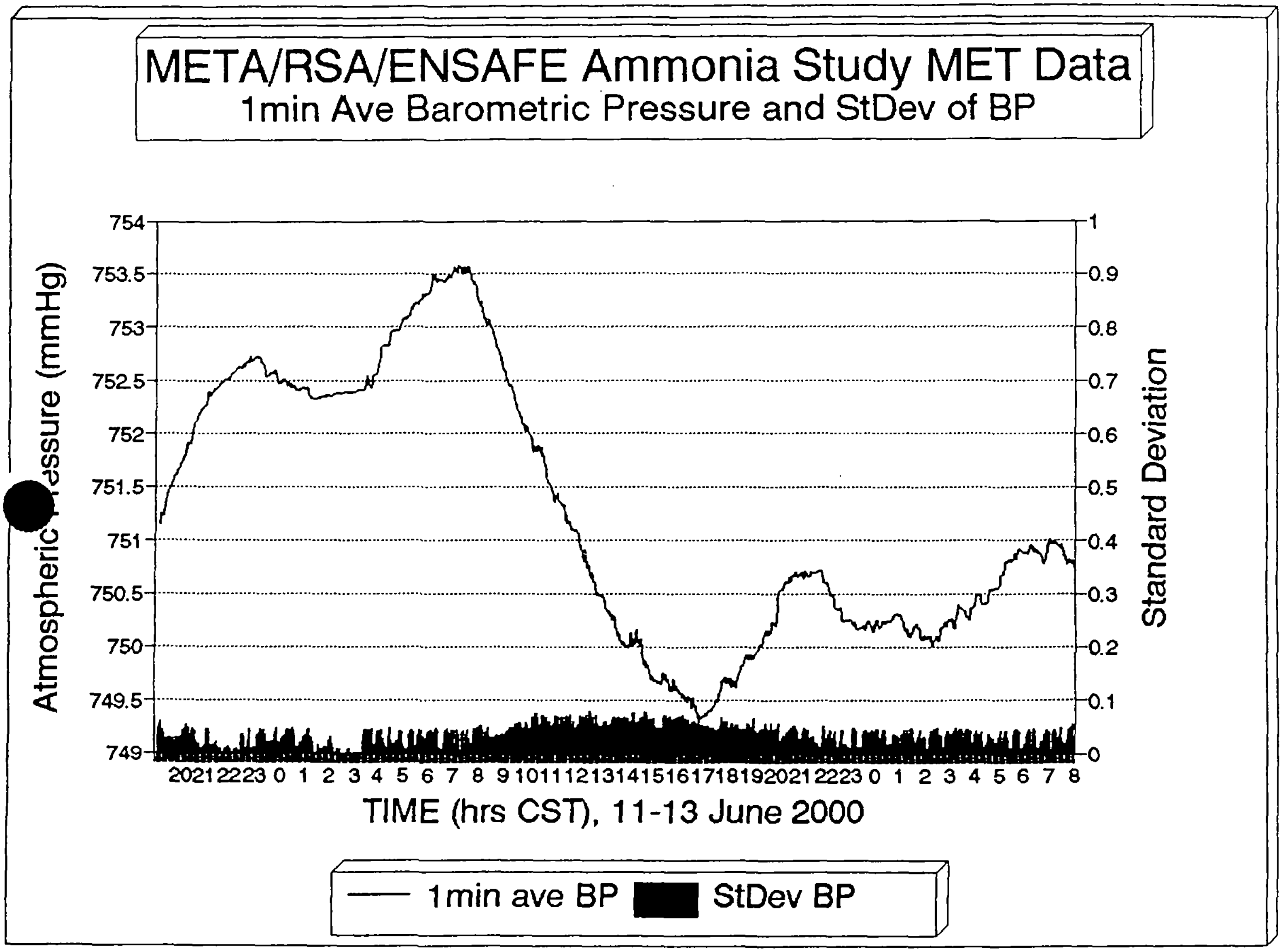
META/RSA/ENSAFE Ammonia Study MET Data

1min Ave AirT and NEMA Enclosure Temp.



META/RSA/ENSAFE Ammonia Study MET Data

1min Ave Relative Humidity and StDev of RH



META/RSA/ENSAFE Ammonia Study MET Data

1min Ave Barometric Pressure and StDev of BP

APPENDIX B

CALIBRATION REPORT FOR METEOROLOGICAL EQUIPMENT

June 2000

INSTRUMENT CALIBRATION TEST REPORT

FOR

META PORTABLE METEOROLOGICAL TOWER

Prepared by

MET ASSOCIATES

FOR:

REMOTE SENSING AIR INC.

(ENSAFE PROGRAM)

Prepared by:

Timothy L. Waldron
MET Associates
34 Deborah Dr.
St. Peters, MO. 63376
(636) 240-1561

1.0 TEST PROCEDURES

The audit/calibration work tasks and procedures are designed to meet and satisfy the operational and documentation requirements of DOE and EPA. All audit procedures are in accordance with the requirements described in Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, (EPA-600/4-82-060, August 1989).

The QA objectives for the ENSAFE meteorological measurements are assumed from the EPA recommendations contained in On-Site Meteorological Program Guidance for Regulatory Modeling Applications, EPA-450/4-87-013, June 1987. These objectives are reproduced as figure 1.

Complete calibration testing is performed after the system has been fully assembled at the META warehouse (bench testing)and then most tests are repeated after deployment for the project (field testing). Both sets of tests are performed with the same instruments, cables, dataloggers, software, and modems. A brief report is issued containing all primary results.

Equipment used during META audit and calibration programs include the following:

Lietz high precision siting compass
David White Level Transit
Certified variable-speed Synchronous Motor
NIST certified thermometers
Constant temperature water baths
R.M. Young 18310 Torque Disk
R.M. Young 18330 Torque Gauge
Qualimetrics 60103 Precipitation Calibrator
Digital Volt Meter (DVM)
Climatronics Linearity test fixture
Additional equipment as deemed necessary
Two-Channel portable radios
Camera for site documentation
Certified power aspirated psychrometer
Hygrometrix standard humidity calibration cells
Calibrated digital barometer

1.1 Establishment of True North Reference

True North is determined by META using the Solar Noon tower shadow projection technique at the site when possible. True Solar Noon is calculated to the nearest second using standard astronomical tables. A colored marker stake is established for the tower North/South projection line. The field value of magnetic declination is also determined and compared to that value determined, via modem, from the USGS Branch of Global Seismology and Geomagnetism to identify any

FIGURE 1 (from EPA)

Recommended System Accuracy and Resolutions

Meteorological Variable	System Accuracy	Measurement Resolution
Wind Speed (horizontal & vertical)	±(0.2 m/s + 5% of observed)	0.1 m/s
Wind Direction (azimuth & elevation)	± 5 degrees	1 degree
Ambient Temperature	± 0.5°C	0.1°C
Vertical Temperature Difference	± 0.1°C	0.02°C
Dew Point Temperature	± 1.5°C	0.1°C
Precipitation	± 10% of observed	0.3 mm
Pressure	± 3 mb (0.3 kPa)	0.5 mb
Radiation	± 5% of observed	10 W/m^2
Time	± 5 minutes	-------

local effects on magnetic north. The True North marker is also used to establish a True East/West Reference marker for the site, which identifies the datum line for transit placement for aligning the anemometer cross-arm assembly.

1.2 Performance Audit Procedures

The tower performance audit consists of instrument tests, data reviews, and assessment of the instrument operating environments. It is important that all audit test data be acquired through the data acquisition system (DAS) rather than an alternate or duplicate system.

Upon arrival at established site locations, each variable is observed for reasonableness in the real-time and the latest average values. Next the appropriate audit manipulations are performed on each sensor as described in the following sections, and the CR10/computer outputs are recorded and compared to the audit input values. If the EPA audit criteria limits are exceeded, troubleshooting is conducted to determine the cause of the discrepancy and the sensor is repaired if possible. All sensors so serviced are then re-audited. At the conclusion of the site audit, all instrument values are again checked for reasonableness.

The following sections briefly describe some of the instrument audit checks which are performed.

1.2.1 Check of Sensor Heights

During the site audit, each instrument exposure height above ground will be measured with a standard tape measure whenever possible. These values are compared to those stated in the QA Plan and/or Monitoring Plan where applicable.

1.2.2 WIND DIRECTION

1.2.2.1 Vane Orientation

Accurate alignment of the wind sensor is critical to any meteorological field measurements. The ENSAFE met tower, by virtue of being a portable tripod model, allowed more direct documentation of wind vane orientation than tilt-down towers. The vane orientation was determined (after completion of the tasks for determination of the reference marker as described above) by measuring and recording (via a transit) the cross-arm assembly orientation angle before any adjustments are made on the tripod. Any orientation error is recorded. A complete set of linearity tests (described in the next section) were performed on the sensor with error values determined for each 30 degrees of compass. The additive effect of these two error values (orientation and linearity) will provide the ENSAFE "as found" value for wind direction total error. Tolerances are 2° for vane orientation and 3° for mechanical linearity, for a total tolerance of 5° for directional error, in accordance with EPA specifications.

1.2.2.2 Sensor Linearity

The wind sensor's ability to accurately measure winds from any direction is tested by mounting a Climatronics vane angle calibration fixture on the vane shaft. The unit provides accurate positioning of the vane shaft for each 30° of the azimuthal circle. The vane is positioned at each 30° increment and the directional values are read from the CR10/computer display. The tests are performed in both clockwise and counterclockwise rotation of the calibration fixture to compensate for any mechanical ▒play▒ in the test fixture. Expected values are recorded and compared to those indicated from the data logger. The sensor linearity is considered satisfactory if each of the differences is less than 3°.

1.2.2.3 Starting Threshold Torque

The wind vane's starting threshold torque is measured using an R.M. Young model 18330 torque gauge. The gauge is applied at a point on the vane shaft 10 cm from the center of rotation and a constant force is applied. The test is repeated 6-8 times, beginning at different points of azimuth, and different directions of rotation. The audit result is considered satisfactory if the maximum measured threshold starting torque is 20 gram-centimeters (META goal of 10 gm cm) or less.

1.2.3 HORIZONTAL WIND SPEED

1.2.3.1 Sensor Calibration

The sensor is audited by removing the propeller and applying a constant rate of rotation in a clockwise direction to the anemometer shaft using the synchronous motors. This is done by connecting the motor shaft to the anemometer shaft using a non-rigid, no-slip connector. Using the anemometer specifications, rpm is converted to wind speed output values over one or two minutes. The tests are completed at 0, 300, 600, and 1000 rpm, which results in a four point calibration check. The audit results are considered satisfactory if the results are within 0.45 mph +5% of the audit value.

1.2.3.2 Starting Threshold Torque

The anemometer shaft starting threshold torque is measured using an R.M. Young Model 18310 Torque Disc. The torque disk fits directly on the anemometer shaft. The force is applied by weights attached to the disc at the precise distance from the center of rotation. The test is done by placing the anemometer in a horizontal position, turning the disc so that the weight is on a 9 o'clock or 3 o'clock position, and releasing the disc. The audit result is considered satisfactory if the disc moves freely and turns the weight to the 6 o'clock position (recorded as a 90° response). The disc is normally calibrated to provide a torque of 0.6 gram-centimeters (gm-cm). The test is repeated at 90° intervals.

1.2.4 TEMPERATURE

The temperature sensor is audited by co-location at three points with an NIST (NBS) traceable thermometer in constant temperature water baths. The tests are conducted in the following approximate temperature ranges: 32-33°F, 65-75°F, and near 90°F. The equilibrated thermometer reading is corrected to true temperature and is compared to the data logger/computer output. The audit results are considered satisfactory if the difference between the two is ±0.9°F or less at all three points tested. In addition, the aspirator motor is checked for proper operation.

1.2.5 RELATIVE HUMIDITY

The relative humidity sensor is checked by co-location with a power aspirated ASSMAN psychrometer with traceable wet and dry bulb thermometers. For low exposures (<3m) on tilt-down towers the co-location test is performed with the tower remaining in the upright position to avoid strong moisture gradients which are frequently encountered nearer the surface. The intakes for the two measurement systems are coincidal and the psychrometer is shielded from solar radiation when appropriate. When the two thermometer readings from the psychrometer have stabilized, the readings are noted from them and from the station sensor via the computer display screen. The wet and dry bulb temperatures are then used with standard reduction tables to calculate the relative humidity. The audit is considered satisfactory if the difference between values is less than 5% RH.

An "informal audit" for the high end of the scale is performed on the RH sensor whenever heavy fog is documented at the site. The difference from 100% is carefully tracked.

In addition to the power psychrometer tests, in-situ calibrations, utilizing standard (traceable) saturated salt solutions, may be performed as part of a trouble shooting exercise. This procedure requires that the sensor be carefully introduced into a sealed solution container and allowed to equilibrate with the artificial atmosphere. Because the process may take 1-3 hours per test point, this procedure is usually only used when the power psychrometer tests, or the sensor history, indicate a need for further confirmations.

A complete set of standard humidity cells (Hygrometrix, Model HMX-CK, validation kit, 8 standard humidity cells) can be used for the audit.

1.2.6 BAROMETRIC PRESSURE

The barometric pressure sensor usually cannot be tested per se but the data value is checked against local pressure reduced to sea level using atmospheric reduction techniques. The audit result is considered satisfactory if the data logger output is within ±0.6 mb (2.25 mm Hg) of the audit values. The sensor is may also be checked periodically against a calibrated digital barometer.

1.2.7 DERIVED QUANTITIES

All derived quantities (e.g., sigma theta,) are checked in the field as well as reviewed and compared during the data review. During the audit, sigma-theta calculations are checked by using the synchronous motor and vane angle calibration fixture simultaneously. The wind direction vane is held in one position for ½ of a measurement period (both 2 minute and 15 test periods are used) and quickly locked into a different position for the remainder of the period while the wind speed unit remains under constant rotation (600 rpm). Both positional values are recorded and an expected audit value for sigma-theta is calculated for comparison. Both the Yamartino and the Campbell algorithms are checked.

2.0 Test Results

All calibration tests showed acceptable results for all system components. The test results for both pre-deployment (8 June 2000 bench tests) testing and testing at the time of deployment (in the field on 11 June 2000) are shown on the following 4 page attachment and summarized briefly below.

Horizontal Wind Direction: Linearity, starting torque values, and alignment checks were all satisfactory for the wind vane.

Horizontal Wind Speed: Starting torque acceptable with a slight sensor imbalance judged not to affect starting torque values. Rotational test results were excellent for all speeds.

Sigma-Theta: The sigma-theta calculations were verified with the normal slightly higher Yamartino algorithm values and slightly lower Campbell algorithm values.

Temperature: Ambient temperatures were tested in 3 constant temperature water baths with similar satisfactory results for both the pre-deployment and deployment testing. The maximum error observed was 0.25 degF.

Barometric Pressure: Atmospheric pressure testing showed the unit to be within specifications with a scaling error of around 0.33%. Both tests showed similar results indicating that further processing refinement could be undertaken to remove the small, but acceptable, bias in the data.

Relative Humidity: Both test sets indicated accurate RH measurements were being obtained.

In addition, all acquired data were QC'd using statistical and graphical display software. No bias or persistent problems were observed in the data base.

STATION: ENSAFE CALIBRATION TESTS MET ASSOCIATES

DATE: 6/8/2000 - Bench Tests
DATE: *6/11/2000 - Field Tests*
Auditor: Tim Waldron

HORIZONTAL WIND DIRECTION

	SERIAL as found	Number as left
Crossarm Assembly	3405	3405
Wind Vane	1291	1291
Wind Cups	1157	1157

SENSOR HEIGHT

Stated:	2.00	m
Measured	2.01	m
DIFF:	0.01	m
	PASS	

ALIGNMENT

STATION ORIENTATION Reference	270.00	deg		
Initial Magnetic Audit Value:	270.00	deg		(QAmax = 2 deg
Declination Adjustment:	-1.50	deg		
Initial Corrected (True) Orientation:	268.50	deg		
Initial Error:	-1.50	deg	**PASS**	(initial)
Final Magnetic Audit Value:	270.00	deg		
Final Corrected (True) Orientation:	268.50	deg		
Final Error	-1.50	deg	**PASS**	(final)

		initial unit	new unit
	cw	4	n/a
	ccw	4	n/a
WIND VANE	cw	6	n/a
STARTING TORQUE	ccw	6	n/a
QAmax = 20 gmcm	cw	4	n/a
	ccw	4	n/a
	cw	4	n/a
	ccw	4	n/a
	AVERAGE	4.50	n/a
	MAX	6	n/a
	QA STATUS	**PASS**	**n/a**

(QAmax = 20 gmcm)

	DATALOGGER VALUES				Vane Linearity Error	TOTAL Orient. ERROR
(S/N 3405)	ANGLE SET	CCW	CW	AVG.		
	0	0.19	0.24	0.22	0.22	n/a
	30	29.10	29.68	29.39	-0.61	n/a
INITIAL (Bench)	60	58.83	59.45	59.14	-0.86	n/a
WIND VANE	90	88.79	89.42	89.11	-0.89	n/a
LINEARITY	120	118.56	119.23	118.90	-1.10	n/a
	150	148.29	149.01	148.65	-1.35	n/a
QAmax	180	178.06	178.83	178.45	-1.56	n/a
3 deg Linearity	210	208.07	208.79	208.43	-1.57	n/a
5 deg Total	240	238.04	238.76	238.40	-1.60	n/a
	270	268.39	269.20	268.80	-1.21	n/a
Total = Linearity Error	300	298.97	299.69	299.33	-0.67	n/a
+ Orientation Error	330	329.80	330.38	330.09	0.09	n/a
		AVERAGE ERROR =			-0.93	n/a
		MAX ERROR =			1.60	n/a
		QA STATUS =			**PASS**	**n/a**

	DATALOGGER VALUES				Vane Linearity Error	TOTAL Orient. ERROR
(S/N 3405)	ANGLE SET	CCW	CW	AVG.		
	0	0.29	0.43	0.36	0.36	-1.14
	30	29.61	29.85	29.73	-0.27	-1.77
FINAL (FIELD)	60	59.67	59.45	59.56	-0.44	-1.94
WIND VANE	90	89.35	89.35	89.35	-0.65	-2.15
LINEARITY	120	119.19	119.24	119.22	-0.78	-2.28
	150	148.85	149.04	148.95	-1.06	-2.56
QAmax	180	178.79	178.79	178.79	-1.21	-2.71
3 deg Linearity	210	208.64	208.78	208.71	-1.29	-2.79
5 deg Total	240	238.58	238.77	238.68	-1.32	-2.82
	270	269.00	269.10	269.05	-0.95	-2.45
Total = Linearity Error	300	299.62	299.62	299.62	-0.38	-1.88
+ Orientation Error	330	330.33	330.33	330.33	0.33	-1.17
		AVERAGE ERROR =			-0.64	-2.14
		MAX ERROR =			1.32	2.82
		QA STATUS =			**PASS**	**PASS**

	DATALOGGER VALUES				Linearity Error	TOTAL ERROR
	ANGLE SET	CCW	CW	AVG.		
	0	n/a	n/a	n/a	n/a	n/a
	30	n/a	n/a	n/a	n/a	n/a
REPLACEMENT	60	n/a	n/a	n/a	n/a	n/a
WIND VANE	90	n/a	n/a	n/a	n/a	n/a
LINEARITY	120	n/a	n/a	n/a	n/a	n/a
	150	n/a	n/a	n/a	n/a	n/a
QAmax	180	n/a	n/a	n/a	n/a	n/a
3 deg Linearity	210	n/a	n/a	n/a	n/a	n/a
5 deg Total	240	n/a	n/a	n/a	n/a	n/a
	270	n/a	n/a	n/a	n/a	n/a
Total = Linearity Error	300	n/a	n/a	n/a	n/a	n/a
+ Orientation Error	330	n/a	n/a	n/a	n/a	n/a
		AVERAGE ERROR =			n/a	n/a
		MAX ERROR =			n/a	n/a
		QA STATUS =			**n/a**	**n/a**

HORIZONTAL WIND SPEED

	S/N	**3405**	**3405**	
	direction	(initial)	(final)	
	cw	90	90	
	cw	90	90	
WIND SPEED	cw	90	90	
STARTING TORQUE	cw	70	90	
QAmin = 80 deg	ccw			
	ccw			
	ccw			
	ccw			
	AVERAGE	85.00	90.00	
	MIN	70	90	
	MIN 90deg	FAIL	PASS	judged ok
	AVE 80deg	PASS	PASS	slight imbalance

STATION: ENSAFE
HORIZONTAL WIND SPEED (con't)

INITIAL (Bench) WIND SPEED ROTATIONAL TESTS

(Initial Unit, S/N 3405)

INPUT & Acquired Values

Time Period (CST)	Test Rotation	Expecte Value (mph)	CR10 Value	CR10 stdevWS
1846-1847	0	0.50	0.50	0.02
1850-1852	124	6.40	6.40	0.18
1858-1900	332	19.73	19.69	0.43
1902-1904	626	30.52	30.74	0.23
1906-1908	1000	48.46	48.84	0.07

Error Analysis

Test Rotation	**Error (MPH)**	Max Allowed Error	**QASTAT**
0	**0.00**	0.48	**PASS**
124	**0.00**	0.77	**PASS**
332	**-0.04**	1.44	**PASS**
626	**0.22**	1.98	**PASS**
1000	**0.38**	2.87	**PASS**

FINAL (FIELD) WIND SPEED ROTATIONAL TESTS

(Initial Unit, S/N 3405)

INPUT & Acquired Values

Time Period (CST)	Test Rotation	Expecte Value (mph)	CR10 Value	CR10 stdevWS
1654-1655	0	0.50	0.50	0.00
1700-1701	125.6	6.52	6.57	0.16
1702-1703	317.7	15.74	15.73	0.11
1704-1705	615	30.00	29.99	0.10
1706-1707	1000	48.46	48.47	0.07

Error Analysis

Test Rotation	**Error (MPH)**	Max Allowed Error	**QASTAT**
0	**0.00**	0.48	**PASS**
125.6	**0.05**	0.78	**PASS**
317.7	**-0.01**	1.24	**PASS**
615	**-0.01**	1.95	**PASS**
1000	**0.01**	2.87	**PASS**

SIGMA-THETA

SIGMA-THETA (StDev of WD)	Bench Campbell S/N 3405	Bench Yamartino S/N 3405	Field Campbell S/N 3405	Field Yamartino S/N 3405
SET ANGLE (datalogger)	29.59	29.59	29.80	29.80
SET ANGLE (datalogger)	329.92	329.92	330.42	330.42
Indicated Wind Speed	48.84	48.84	48.47	48.47
EXPECTED AUDIT VALUE	29.83	29.83	29.69	29.69
SYSTEM VALUE	29.33	30.23	29.29	30.19
(QAmax=1deg) ERROR	-0.50	0.40	-0.40	0.50
	PASS	PASS	PASS	PASS

TEMPERATURE

Serial #:	52X5
Standard Height:	2.00 m
Measured Height:	1.78 m
Difference:	-0.22 m
(Tolerance = .5m) QASTAT:	PASS

BENCH

		AUDIT TEMP	SYSTEM OUTPUT	(degF) ERROR	QASTAT
WATER BATH TESTS	low	32.60	32.80	0.20	PASS
(Tolerance = 0.9 degF)	medium	66.70	66.45	-0.25	PASS
	high	87.05	87.15	0.10	PASS

Field

		AUDIT TEMP	SYSTEM OUTPUT	(degF) ERROR	QASTAT
WATER BATH TESTS	low	32.20	32.30	0.10	PASS
(Tolerance = 0.9 degF)	medium	67.90	67.71	-0.19	PASS
	high	81.65	81.74	0.09	PASS

BAROMETRIC PRESSURE

		Bench		Field
ATMOS. PRESSURE	AUDIT PRESSURE:	748.66	mmHg	753.32
	STATION VALUE:	746.21	mmHg	750.96
	ABS DIFFERENCE:	-2.45	mmHg	-2.36
	% DIFFERENCE:	-0.33%		-0.31%
	QASTAT:	PASS		PASS

RELATIVE HUMIDITY

Bench

		AUDIT	STATION	RH ERROR
RELATIVE HUMIDITY	Dry B Temp	30.50	31.33	
	Wet B Temp	21.50	-------	
	RH	44.87%	45.87	1.00%
			QASTAT:	PASS

Field

		AUDIT	STATION	RH ERROR
RELATIVE HUMIDITY	Dry B Temp	30.30	31.97	
	Wet B Temp	22.00	-------	
	RH	48.31%	46.54	-1.77%
			QASTAT:	PASS

4.8.2 Grading Adjacent to Ditch 3

The Design Plans depict grading modifications which were to be made in the area adjacent to Ditch 3. Based on the construction layout survey, several cuts were made in this area. Prior to excavating the material, several test pits were excavated, and a composite sample was collected and analyzed as described in Section 4.2.2. The analytical results were below the Performance Standards for topsoil. Following a review of possible uses for this material, including potential onsite and off-site placement locations, EnSafe proposed to place the material in the area from which it had been excavated. EnSafe proposed increasing the slope from the landfill toward Ditch 3, however, the grading intent of the Design Plans would be maintained (see F015 in Appendix C). The material was to be placed in one 8-inch thick lift, and compacted. Compaction would be verified by proof rolling. USEPA approved this use of the cut material, and the work was performed according to EnSafe's proposal to USEPA. Following the placement of this material, topsoil was placed, and fertilizer, seed, and mulch applied as discussed in Section 4.7.

4.8.3 HDPE Well Boot Seals

The Design Plans include a detail drawing which depicts HDPE monitoring well boot seals. According to the notation on the drawing, the seals were to be installed around several monitoring wells/piezometers. The seal construction involves the following:

- One foot of granular bentonite was to be placed above the clay cap around each well.

- The HDPE boot is to be welded to a 3-foot diameter circular piece of HDPE liner, and placed over the protective well cover/piezometer and bentonite.

- The HDPE boot is to be bonded to the protective well cover/piezometer with mastic, and then secured with a clamp.

The intent of this component of the design is to prevent water from infiltrating into the landfill cap through potential voids around the monitoring wells/piezometers located within the clay cap/clay fill area. The Contractor could not locate a mastic which would bond the HDPE material to the metal protective well boxes. Additionally, HDPE boots were not available in a small enough diameter to provide an adequate seal around the 1-inch diameter piezometers.

Alternatively, the Contractor attempted to place a neoprene sleeve between the protective well box and the HDPE boot, which was secured by a clamp. This application was unsuccessful due to the square shape of the protective well box and the round shape of the HDPE boot and the neoprene sleeve. Due to these problems, EnSafe re-evaluated the design of the HDPE boot seals, and determined the following:

- The clay around each well had been well-compacted with a hand-held mechanical tamper.

- The only potential void in the clay cap in the vicinity of each monitoring well was immediately adjacent to the well, therefore, placement of 1 foot of bentonite around each well would be sufficient to prevent infiltration.

- Installation of the HDPE boots as designed would potentially trap water between the HDPE liner and the bentonite seal.

USEPA agreed with the above-listed items, and approved a change in the Design Plans to eliminate the HDPE boot seals, and to only place 1 foot of bentonite around each monitoring well (see F014 in Appendix C). Topsoil was placed on top of the 1-foot thick layer of bentonite around each well as described in Section 4.7.

4.8.4 Aesthetic Modifications

Several modifications were made to the original Design Plans to improve the Brantley Landfill site aesthetically, as well as to improve the future accessibility of the site for O & M activities. These modifications are discussed below.

The Design Plans depict the modified north end landfill cap extending outside the original fenceline. To prevent damage to the cap, and to avoid penetrating the cap with fenceposts, the fenceline was extended outside the modified cap (see F010 in Appendix C).

According to notations on the Design Plans, the gravel access road which is located along the western boundary of the property, inside the fenceline, was to be improved following site activities. The improvement of this road included placing 8-inches of gravel along the entire road. Due to the minimal use that the roadway receives, and the fact that the original road crossed the newly constructed clay cap at the north end, EnSafe proposed to USEPA that the designated roadwork not be performed. USEPA agreed that as long as the site was accessible for O & M, no other improvements would be necessary (see F011 in Appendix C). EnSafe approved the use of No. 610 crusher run limestone (see documentation in Appendix J) to repair and improve the site entrance and parking area immediately inside the gate. Geotextile was placed beneath the limestone inside the gate area. No other road modifications were made.

Due to the raised elevation of the north end landfill cap in the vicinity of monitoring wells K-7S and K-7D, it was necessary to raise the well casings and the protective well boxes to allow the wells to be accessible (see F012 in Appendix C). The original well casing is stainless steel, and the extension casing is PVC pipe of the same diameter. A PVC coupling was placed between the original casing and the extension, and they were secured with sheet metal screws. The original protective well boxes were 4-inch square metal boxes. Six-inch square protective boxes were placed over the 4-inch boxes, and were set in concrete.

5.0 CONCLUSIONS

Based on a review of the tasks included on the Punch Lists, all tasks have been completed in accordance with the *Final Design Report* and/or the *CQAP*. All design modifications implemented throughout the course of the construction phase of the RA were documented and approved, when required, by USEPA. Furthermore, all design modifications were implemented to support the RD/RA objectives. Remaining tasks, as described in the RA Work Plan (June 1997), consist of the following:

- Air monitoring
- Groundwater monitoring
- Post-Remediation operation and maintenance

A one-time monitoring of air emissions will be conducted using open-path Fourier-transform infrared (FTIR) spectroscopy to confirm that ammonia emissions from the landfill to the ambient air have been effectively mitigated or eliminated by the RA construction activities and improvements. This sampling event will be performed when meteorological conditions are conducive to maximizing volatile emission rates. These conditions are defined as warm (temperatures greater than 70° F), sunny, and shortly after a moderate to heavy rainfall.

As stated in the ROD, quarterly groundwater monitoring shall be performed on all piezometers and monitoring wells for one to two years following construction activities. Following the first year of quarterly sampling, the analytical results will be reviewed to assess the need for a second year of quarterly groundwater data. Groundwater samples will be analyzed for the parameters required in the Revised Performance Standards.

The pond will be sampled twice for the same parameters as the groundwater. Upon the receipt of acceptable results, no further sampling will be required from the pond.

Post-remediation O & M on this site will be described in the Site Operations Maintenance Plan, which will be submitted to USEPA following this report. This plan will focus on the maintenance of the landfill cap, surface water management structures, and protection of the site.

Attachment D
Site Inspection Attendees List & Meeting Notes

Attachment D
Brantley Landfill Five-Year Review

Site Inspection Attendees List

Name	Organization	Phone Number	Date of Site Visit
Ginny Gray Davis	EnSafe Inc	513-621-7233	August 8, 2002
Ken Logsdon	KNREPC , DWM	502-564-6716	August 8, 2002
Robert Pugh	KNREPC, DWM	502-564-6716	August 8, 2002
Kevin D Conkright	Commonwealth Industries	270-733-1212 Ext 5	August 8, 2002
Roger Burden	Commonwealth Industries	270-733-1212 Ext 7	August 8, 2002
Damon Smith	Commonwealth Industries	270-733-1212 Ext 4	August 8, 2002
Sandra English	Commonwealth Industries	270-733-1212 Ext 1	August 8, 2002
Harold Taylor	USEPA Region IV	404-562-8791	April 22, 2002
Femi Akindele	USEPA Region IV	404-562-8809	April 22, 2002
Roger Burden	Commonwealth Industries	270-733-1212 Ext 7	April 22, 2002
Damon R Smith	Commonwealth Industries	270-733-1212 Ext 4	April 22, 2002

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: Brantley Landfill	**Date of inspection:** 3/8/02
Location and Region:	**EPA ID:** KY
Agency, office, or company leading the five-year review: EnSafe Inc. & CAC	**Weather/temperature:** Sunny; clear 39° F

Remedy Includes: (Check all that apply)

- ✓ Landfill cover/containment
- ✓ Access controls
- ✓ Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- Other____
- ✓ Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: ✓ Inspection team roster attached ✓ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Mr. Roger Burden (Name) Env. Services, CAC (Title) 03/08/02 (Date)
Interviewed [✓ at site] at office by phone Phone no. (270)
Problems, suggestions; Report attached ___________________________

2. **O&M staff** Mr. Kevin Conkright (Name) Mgr. Env. Services, CAC (Title) 03/08/02 (Date)
Interviewed [✓ at site] at office by phone Phone no. (270)
Problems, suggestions; Report attached ___________________________

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency KNREPC, Div. of Waste Mgmt.
Contact Mr. Ken Logsdon | PM | 8/8/02 | (502) 564-6716
Name | Title | Date | Phone no.
Problems; suggestions; Report attached

Agency KNREPC, Div. of Waste Mgmt.
Contact Mr. Robert Pugh | PM | 8/8/02 | (502) 564-6716
Name | Title | Date | Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name | Title | Date | Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name | Title | Date | Phone no.
Problems; suggestions; Report attached

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

O&M manual	[✓ Readily available]	[✓ Up to date]	N/A
As-built drawings	[✓ Readily available]	[✓ Up to date]	N/A
Maintenance logs	[✓ Readily available]	[✓ Up to date]	N/A

Remarks

EnSafe reviewed all the above and inspections 1998 1999, 2000 + 2001

2. **Site-Specific Health and Safety Plan** [✓ Readily available] Up to date N/A

Contingency plan/emergency response plan	Readily available	Up to date	[✓ N/A]

Remarks

3. **O&M and OSHA Training Records** [✓ Readily available] Up to date N/A

Remarks

4. **Permits and Service Agreements**

Air discharge permit	Readily available	Up to date	[✓ N/A]
Effluent discharge	Readily available	Up to date	[✓ N/A]
Waste disposal, POTW	Readily available	Up to date	[✓ N/A]
Other permits	Readily available	Up to date	[✓ N/A]

Remarks

5. **Gas Generation Records** Readily available Up to date [✓ N/A]

Remarks

6. **Settlement Monument Records** Readily available Up to date [✓ N/A]

Remarks

7. **Groundwater Monitoring Records** [✓ Readily available] Up to date N/A

Remarks

8. **Leachate Extraction Records** Readily available Up to date [✓ N/A]

Remarks

9. **Discharge Compliance Records**

Air	Readily available	Up to date	[✓ N/A]
Water (effluent)	Readily available	Up to date	[✓ N/A]

Remarks

10. **Daily Access/Security Logs** [✓ Readily available] [✓ Up to date] N/A

Remarks

Reviewed entire access log post construction.

IV. O&M COSTS

1. **O&M Organization**

State in-house　　Contractor for State
PRP in-house　　Contractor for PRP
Federal Facility in-house　　Contractor for Federal Facility
Other____

2. **O&M Cost Records**

Readily available　　Up to date
Funding mechanism/agreement in place
Original O&M cost estimate________________　Breakdown attached

Total annual cost by year for review period if available

From________ To________ ____________ Breakdown attached
Date　Date　Total cost
From________ To________ ____________ Breakdown attached
Date　Date　Total cost
From________ To________ ____________ Breakdown attached
Date　Date　Total cost
From________ To________ ____________ Breakdown attached
Date　Date　Total cost
From________ To________ ____________ Breakdown attached
Date　Date　Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: ______________________________

V. ACCESS AND INSTITUTIONAL CONTROLS [✓ Applicable] N/A

A. Fencing

1. **Fencing damaged**　Location shown on site map　[✓ Gates secured]　N/A

Remarks____

B. Other Access Restrictions

1. **Signs and other security measures**　[✓ Location shown on site map]　N/A

Remarks Sign is clearly posted @ front gate.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented Yes [✓ No] N/A
Site conditions imply ICs not being fully enforced Yes [✓ No] N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ________
Frequency ________
Responsible party/agency ________
Contact ________ ________ ________ ________
Name Title Date Phone no.

Reporting is up-to-date [✓ Yes] No N/A
Reports are verified by the lead agency [✓ Yes] No N/A

Specific requirements in deed or decision documents have been met Yes [✓ No] N/A
Violations have been reported Yes No N/A
Other problems or suggestions: Report attached

Deed restrictions have not been completed to date.

2. **Adequacy** [✓ ICs are adequate] ICs are inadequate N/A
Remarks________

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
Remarks One incident has occurred in 1999 where batteries were stolen from O&M equipment parked overnight onsite.

2. **Land use changes on site** [✓ N/A]
Remarks________

3. **Land use changes off site** [✓ N/A]
Remarks________

VI. GENERAL SITE CONDITIONS

A. Roads Applicable [✓ N/A]

1. **Roads damaged** Location shown on site map Roads adequate N/A
Remarks Site roads were taken out during construction.

B. Other Site Conditions

Remarks

VII. LANDFILL COVERS [✓ Applicable] N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map [✓ Settlement not evident]
Areal extent____ Depth____
Remarks Landfill grade was still consistent w/ construction as-builts.

2. **Cracks** Location shown on site map [✓ Cracking not evident]
Lengths____ Widths____ Depths____
Remarks

3. **Erosion** Location shown on site map [✓ Erosion not evident]
Areal extent____ Depth____
Remarks

4. **Holes** Location shown on site map Holes not evident
Areal extent____ Depth____
Remarks Some very small holes noted off cap from burrowing animals. See photo log.

5. **Vegetative Cover** [✓ Grass] [✓ Cover properly established] No signs of stress
Trees/Shrubs (indicate size and locations on a diagram)
Remarks Some sign of stress in small discrete areas due to lack of rainfall. Reseeding plan in place for this fall.

6. **Alternative Cover (armored rock, concrete, etc.)** [✓ N/A]
Remarks

7. **Bulges** Location shown on site map [✓ Bulges not evident]
Areal extent____ Height____
Remarks

8. **Wet Areas/Water Damage** [✓ Wet areas/water damage not evident]
Wet areas ~~Location shown on site~~ map Areal extent__________
Ponding Location shown on site map Areal extent__________
Seeps Location shown on site map Areal extent__________
Soft subgrade Location shown on site map Areal extent__________
Remarks__________

9. **Slope Instability** Slides Location shown on site map [✓ No evidence of slope instability]
Areal extent__________
Remarks__________

B. Benches Applicable [✓ N/A]
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** Location shown on site map [✓ N/A or okay]
Remarks__________

2. **Bench Breached** Location shown on site map [✓ N/A or okay]
Remarks__________

3. **Bench Overtopped** Location shown on site map [✓ N/A or okay]
Remarks__________

C. Letdown Channels [✓ Applicable] N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Location shown on site map [✓ No evidence of settlement]
Areal extent__________ Depth__________
Remarks__________

2. **Material Degradation** Location shown on site map [✓ No evidence of degradation]
Material type__________ Areal extent__________
Remarks__________

3. **Erosion** Location shown on site map [✓ No evidence of erosion]
Areal extent__________ Depth__________
Remarks__________

4. **Undercutting** Location shown on site map [✓ No evidence of undercutting]
Areal extent______________ Depth____________
Remarks____

5. **Obstructions** Type______________________ [✓ No obstructions]
Location shown on site map Areal extent______________
Size____________
Remarks____

6. **Excessive Vegetative Growth** Type__________________
[✓ No evidence of excessive growth]
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent______________
Remarks____

D. Cover Penetrations [✓ Applicable] N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
[✓ N/A]
Remarks____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance [✓ N/A]
Remarks____

3. **Monitoring Wells** (within surface area of landfill)
[✓ Properly secured/locked] [✓ Functioning] [✓ Routinely sampled] Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks Outer casing deterioration @ well J125. Plan to replace underway.

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance [✓ N/A]
Remarks____

5. **Settlement Monuments** Located Routinely surveyed [✓ N/A]
Remarks____

E. Gas Collection and Treatment Applicable [✓ N/A]

1. **Gas Treatment Facilities**
Flaring Thermal destruction Collection for reuse
Good condition Needs Maintenance
Remarks____

2. **Gas Collection Wells, Manifolds and Piping**
Good condition Needs Maintenance
Remarks____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
Good condition Needs Maintenance [✓ N/A]
Remarks____

F. Cover Drainage Layer Applicable [✓ N/A]

1. **Outlet Pipes Inspected** Functioning [✓ N/A]
Remarks____

2. **Outlet Rock Inspected** Functioning [✓ N/A]
Remarks____

G. Detention/Sedimentation Ponds [✓ Applicable] N/A

1. **Siltation** Areal extent______________ Depth____________ N/A
Siltation not evident
Remarks____

2. **Erosion** Areal extent______________ Depth____________
[✓ Erosion not evident]
Remarks____

3. **Outlet Works** Functioning [✓ N/A]
Remarks____

4. **Dam** Functioning [✓ N/A]
Remarks____

H. Retaining Walls Applicable [✓ N/A]

1. **Deformations** Location shown on site map Deformation not evident
Horizontal displacement____________ Vertical displacement______________
Rotational displacement____________
Remarks____
____

2. **Degradation** Location shown on site map [✓ Degradation not evident]
Remarks____
____

I. Perimeter Ditches/Off-Site Discharge [✓ Applicable] N/A

1. **Siltation** Location shown on site map [✓ Siltation not evident]
Areal extent______________ Depth___________
Remarks____
____

2. **Vegetative Growth** Location shown on site map N/A
Vegetation does not impede flow
Areal extent______________ Type___________
Remarks____
____

3. **Erosion** Location shown on site map [✓ Erosion not evident]
Areal extent______________ Depth___________
Remarks____
____

4. **Discharge Structure** Functioning [✓ N/A]
Remarks____
____

VIII. VERTICAL BARRIER WALLS Applicable [✓ N/A]

1. **Settlement** Location shown on site map Settlement not evident
Areal extent______________ Depth___________
Remarks____
____

2. **Performance Monitoring** Type of monitoring__________________________
Performance not monitored
Frequency_____________________________ Evidence of breaching
Head differential_____________________________
Remarks____
____

IX. GROUNDWATER/SURFACE WATER REMEDIES

Applicable [✓ N/A]

A. Groundwater Extraction Wells, Pumps, and Pipelines

Applicable [✓ N/A]

1. **Pumps, Wellhead Plumbing, and Electrical**
Good condition All required wells properly operating Needs Maintenance [✓ N/A]
Remarks____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks____

3. **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks____

B. Surface Water Collection Structures, Pumps, and Pipelines

Applicable [✓ N/A]

1. **Collection Structures, Pumps, and Electrical**
Good condition Needs Maintenance
Remarks____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks____

3. **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks____

C. Treatment System   Applicable   [✓ N/A]

1. **Treatment Train** (Check components that apply)
   - Metals removal   Oil/water separation   Bioremediation
   - Air stripping   Carbon adsorbers
   - Filters______________________________
   - Additive (*e.g.*, chelation agent, flocculent)______________________________
   - Others______________________________
   - Good condition   Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually______________________________
   - Quantity of surface water treated annually______________________________
   - Remarks______________________________

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - [✓ N/A]   Good condition   Needs Maintenance
   - Remarks______________________________

3. **Tanks, Vaults, Storage Vessels**
   - [✓ N/A]   Good condition   Proper secondary containment   Needs Maintenance
   - Remarks______________________________

4. **Discharge Structure and Appurtenances**
   - [✓ N/A]   Good condition   Needs Maintenance
   - Remarks______________________________

5. **Treatment Building(s)**
   - [✓ N/A]   Good condition (esp. roof and doorways)   Needs repair
   - Chemicals and equipment properly stored
   - Remarks______________________________

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked   [✓ Functioning]   [✓ Routinely sampled]   [✓ Good condition]
   - All required wells located   Needs Maintenance   N/A
   - Remarks w/ exception of outer casing at J12S

D. Monitoring Data

1. Monitoring Data
   - [✓ Is routinely submitted on time]   [✓ Is of acceptable quality]

2. Monitoring data suggests:
   - Groundwater plume is effectively contained   Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

SAMPLE O&M INSPECTION SHEET

INSPECTION CHECKLIST

Date April 22, 2002

Weather Clear

Personnel onsite Roger Burden, chuck Kreca, Kevin Conright, Nat Peters, John Jent, Harold Taylor, Femi Akindele

Check yes or no as each task/condition is inspected. Note all observed conditions for which 'Yes' was marked. Attach additional pages if required.

Area	Conditions	YES	NO
Fenceline Inspection	Damage, unlocked gates, areas in need of other repairs		✓
North End Cap	Erosion		✓
	Stressed Vegetation		✓
	Odors		✓
Interior Area	Erosion		✓
	Stressed Vegetation		✓
	Odors		✓
Ditch 1, 2, and/or 3	Erosion		✓
	Ponding		✓
	Straw Bales - silt buildup, damaged		✓
	Riprap - dislocated, silt buildup		✓
Southern Slope	Erosion		✓
	Stressed Vegetation	✓	
	Riprap - displaced, silt buildup		✓
Site Entrance	Gravel road in need of repair		✓
Cleared Western Area	Erosion		✓
	Stressed Vegetation		✓
Site Wide	Any other conditions noted		✓

Comments:

1820hrs. Arrived at Site,

Walked Site + review for areas.

identified on Inspection checklist.

Found. Area on South and on western

slope with this vegetation.

* See Attached map.

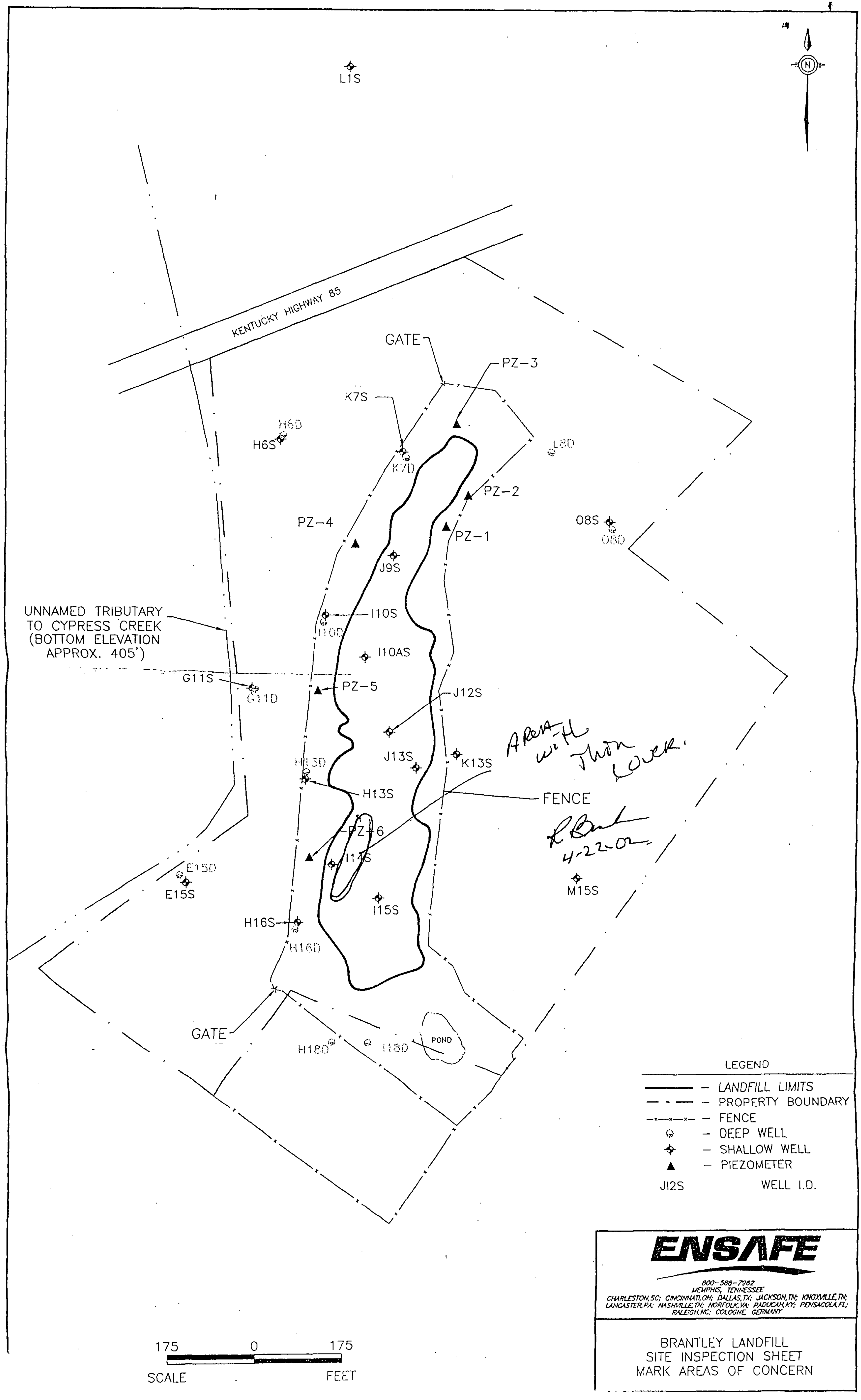
1855hrs... Depart from Site

Problems/Solutions:

Plans Are to Re-seed this Area

with A Notch Drill. This will be

Less invasive.



AREA with thin cover.

4-22-02

ENSAFE

800-588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY

BRANTLEY LANDFILL
SITE INSPECTION SHEET
MARK AREAS OF CONCERN

Attachment E
Site Inspection Photos

Superfund Five Year Review Report
Brantley Landfill

Photograph 1 — Entrance gate to Site. Contact numbers for emergencies/information provided.

Photograph 2 — Groundwater investigation-derived waste tank along northern fence line.

Photograph 3 — View of landfill facing south (inside property boundary).

Photograph 4 — Protective outer casing corrosion at groundwater monitoring well location J12S.

Photograph 5 — Area to be reseeded in Fall 2002.

Photograph 6 — Bare area to be reseeded in Fall 2002.

Photograph 7 — Area to be reseeded on southern slope of the landfill in Fall 2002.

Photograph 8 — Stormwater retention basin at southern end of landfill.

Photograph 9 — Southern slope of landfill. Wastewater treatment plant at left of picture.

Photograph 10 — Southwestern construction gate and site fence.

Photograph 11 — Northern perimeter of landfill. Monitoring well ___ at right of picture.

Photograph 12 — Western perimeter fencing at site facing North.