Third Five-Year Review Report

for

Charles George Land Reclamation Trust Landfill Superfund Site

Tyngsborough,

Middlesex County, Massachusetts

June 2005

PREPARED BY:

United States Environmental Protection Agency
Region 1
Boston, Massachusetts

Approved by: Date:

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ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYM	DEFINITION
AAL	Allowable Ambient Limit
ACOE	Army Corps of Engineers
ARAR	Applicable or Relevant and Appropriate Requirement
AVS-SEM	Acid Volatile Sulfides - Simultaneously Extracted Metals
AWQC	Ambient Water Quality Criteria
BACT	Best Available Control Technology
BOD	Biological Oxygen Demand
BOH	Board of Health
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, 42 USC §§ 9601 *et seq.*
CFR	Code of Federal Regulations
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
COPC	Contaminant of Potential Concern
cPAHs	Carcinogenic Polyaromatic Hydrocarbons
CWA	Clean Water Act
DEP	Massachusetts Department of Environmental Protection
DEQE	Massachusetts Department of Environmental Quality Engineering
EO	Executive Order
EPA	Environmental Protection Agency (U.S. EPA - Region 1)
ERA	Ecological Risk Assessment
ESAT	Environmental Services Assistance Team
ESD	Explanation of Significant Differences
FS	Feasibility Study
HDPE	High Density Polyethylene
HQ	Hazard Quotient
ICs	Institutional Controls
LEL	Lower Explosive Limit

ACRONYM	DEFINITION
LRWU	Lowell Regional Water Utility
LTRA	Long-term Response Action
MADEP	Massachusetts Department of Environmental Protection
M&E	Metcalf & Eddy
MCLs	Maximum Contaminant Levels
MCLGs	Maximum Contaminant Level Goals
MMCL	Massachusetts Maximum Contaminant Level
MEPA	Massachusetts Environmental Policy Act
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan, 40 CFR Part 300
NPL	National Priorities List
O&M	Operation and Maintenance
ORSG	Office of Research and Standards Guideline
OU	Operable Unit
PAHs	Polycyclic Aromatic Hydrocarbons, also known as Polyaromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PRP	Potentially Responsible Party
RAC	Response Action Contract
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 *et seq.*
RfD	Reference Dose
RI	Remedial Investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SF	Slope Factor
SVOCs	Semivolatile Organic Compounds
TBC	To Be Considered
THF	Tetrahydrofuran
TLV	Threshold Limit Value
TRC	TRC Environmental Corporation

ACRONYM	DEFINITION
TSS	Total Suspended Solids
TTO	Total Toxic Organics
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

This five-year review report was prepared for the Charles George Land Reclamation Trust Landfill Superfund Site located at the corner of Dunstable Road and Cummings Road in Tyngsborough, Middlesex County, Massachusetts. The Site is a 70-acre mixed industrial, municipal, and hazardous waste landfill located approximately one mile southwest of the town center of Tyngsborough, Massachusetts (Figure 1). From the late 1950s until 1967, it was a small municipal dump. In 1967, the landfill was expanded to its present size and began accepting both household and industrial wastes, including drummed and bulk chemicals containing volatile organic compounds (VOCs) and metal sludges. The State of Massachusetts ordered closure of the landfill in 1983 and the Site was listed on the National Priorities List (NPL) that same year. Samples from private wells near the Site were collected and found to contain VOCs and metals. Benzene, tetrahydrofuran, arsenic, 1,4-dioxane, and 2-butanone are representative of the contaminants detected in the groundwater.

The Site is being addressed in five stages: initial actions and four long-term remedial phases or operable units (OUs). In response to the 1983 discovery of contaminated well water in nearby residential wells, the EPA took the initial action of improving an above-ground pipeline that was supplying residents with a temporary alternative water supply. Other initial actions taken in 1983 and 1984 included the installation of a security fence and 12 gas vents at the landfill, and regrading of the landfill to cover exposed refuse.

The initial actions addressed the immediate threats posed by the Site. EPA then initiated long-term remedial phases and subdivided the effort into four operable units. Operable Unit 1 (OU1) refers to the provision of a permanent alternative water supply for areas affected by the contaminated groundwater plume from the Site. Operable Unit 2 (OU2, Source Control) involves control of the contamination source to reduce off-site migration of contaminants (*i.e.*, capping of the landfill and collection of the leachate and landfill gas with interim treatment). Operable Unit 3 (OU3) addresses contaminated groundwater migration, permanent treatment of landfill gas and excavation of contaminated sediments in Dunstable Brook and Operable Unit 4 (OU4) addresses leachate treatment.

Construction complete status was attained for the entire Site in September 1998. The landfill cap, landfill gas collection/destruction system, and southwest groundwater collection trench (OU2 and OU3) are in the operation and maintenance (O&M) phase, and the groundwater/leachate collection system (OU3 and OU4) is in the long-term response action (LTRA) phase.

This is the third five-year review for the Site. The five-year review is required because hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. This five-year review concluded that the remedy is functioning as designed and continues to be protective of human health. The protectiveness of the remedy with respect to ecological receptors is currently undergoing re-evaluation by EPA. A re-examination of surface water and sediment data conducted in 2000 indicated that additional sampling and analysis of water bodies in the vicinity of the Site would be needed to obtain greater certainty that impacts to these water bodies are not present. In order for the remedy to remain protective in the long term, enforceable institutional controls to prevent installation and use of private drinking water wells near the Site are required. Institutional controls to prevent future disturbance of the landfill cap are also needed. The owner/operator is required to implement these on-site controls under a recent consent decree with EPA. A re-establishment of the groundwater monitoring program is recommended to obtain data to demonstrate continued protectiveness and support decisions regarding possible future remedial alternatives for the groundwater extraction system.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Charles George Land Reclamation Trust Landfill		
EPA ID *(from WasteLAN)*: MAD003809266		
Region: I	**State:** MA	**City/County:** Tyngsborough/Middlesex

SITE STATUS	
NPL status: ☒ Final ☐ Deleted ☐ Other (specify) ____	
Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete	
Multiple OUs?* ☒ YES ☐ NO	**Construction completion date:** 9 /25/1998
Has site been put into reuse? ☐ YES ☒ NO	

REVIEW STATUS	
Lead agency: ☒EPA ☐ State ☐ Tribe ☐ Other Federal Agency ____	
Author name: Elaine Stanley	
Author title: Remedial Project Manager	**Author affiliation:** EPA Region I
Review period:** 3/05/05 - 6/28/05	
Date(s) of site inspection: 3/17/2005	
Type of review: ☐ Post-SARA ☒ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion	
Review number: ☐1 (first) ☐ 2 (second) ☒ 3 (third) ☐ Other (specify) ____	
Triggering action: ☐ Actual RA Onsite Construction at OU #____ ☐ Actual RA Start at OU#____ ☐ Construction Completion ☒ Previous Five-Year Review Report ☐ Other (specify) ____	
Triggering action date *(from WasteLAN)*: 3/22/2000	
Due date *(five years after triggering action date)*: 6/28/2005	

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

Five-Year Review Summary Form, cont'd.

Issues:

(1) Potential risk to ecological receptors has not been fully assessed in accordance with current guidelines. Additional surface water and sediment sampling is planned.

(2) Groundwater institutional controls need review to determine if they are sufficiently protective and legally enforceable. Institutional controls are needed to prevent future disturbance of the landfill cap.

(3) Groundwater monitoring was last performed in April 2001.

Recommendations and Follow-up Actions:

(1) Evaluate existing surface water and sediment data and determine the potential need for further surface water, sediment, toxicity testing, and/or fish tissue sampling, and examine the need to conduct Ecological Risk Assessment.

(2) Identify any necessary off-site institutional controls and develop, implement, monitor and enforce these controls. Conduct risk evaluation for non-potable water uses.

(3) Establish groundwater monitoring program and evaluate extraction system effectiveness.

Protectiveness Statement(s):

OU1: The remedy for OU1 currently protects human health and the environment because all areas known to have been impacted by the contaminated groundwater plume have received an alternative water supply under OU1 (the original alternative supply) or OU3/OU4 (extensions to the original water supply lines). However, in order for this portion of the remedy to be protective in the long-term, follow-up actions need to be taken, in the form of a review of institutional controls restricting groundwater use to determine if they are sufficiently protective and legally enforceable.

OU2: The remedy for OU2 is protective in the short-term; however, in order for the remedy to be protective in the long-term, follow-up actions need to be taken. Although access to the landfill is currently strictly controlled by EPA and MADEP, formal institutional controls are needed to prevent future disturbance of the cap. The owner/operator is required to implement these on-site controls under a recent consent decree with EPA. Also, there remains a need for additional surface water and sediment sampling in water bodies in the Site vicinity to determine whether the Site may have impacted ecological receptors.

OU3 and OU4: The remedy for OU3 and OU4 is protective in the short-term; however, in order for the remedy to be protective in the long-term, follow-up actions need to be taken. Long-term protectiveness will be achieved once the extraction system reaches MCLs in the groundwater. In the interim, institutional controls are needed to prevent exposure to contaminants.

Comprehensive Protectiveness Statement: Because the remedial actions at all OUs are protective in the short-term, the remedy is currently protective of human health and the environment. However, in order for the remedy to be protective in the long-term, the following follow-up actions are needed:

- The owner/operator must establish enforceable institutional controls to prevent disturbance of the landfill cap. Establishment of enforceable institutional controls to prevent installation of drinking water wells near the Site until MCLs are attained is also needed.
- Risk evaluation of non-potable groundwater uses (e.g. irrigation wells) is recommended to see if such uses should also be restricted.
- Establishment of new groundwater monitoring program
- Evaluate existing surface water and sediment data and determine the potential need for further surface water and sediment sampling to determine whether the Site may have impacted ecological receptors.

SECTION 1.0
INTRODUCTION

This five-year review report is for the remedial actions conducted and on-going at the Charles George Land Reclamation Trust Landfill Superfund Site (Figures 1 and 2). The purpose of this five-year review is to determine whether the remedies for the Site are protective of human health and the environment. The methods, findings, and conclusions of this review are documented in this five-year review report. In addition, five-year review reports identify issues found during the review, if any, and present recommendations to address them.

EPA Region I has conducted this five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP). Section 121(c) of CERCLA 42 USC § 9621(c) states:

> *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 years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

> *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 exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The Charles George Land Reclamation Trust Landfill Superfund Site consists of four operable units. Operable Unit 1 (OU1) refers to the provision of an alternative water supply for areas affected by the contaminated groundwater plume from the Site. Operable Unit 2 (OU2, Source Control) involves control of the contamination source to reduce off-site migration of contaminants (*i.e.*, capping of the landfill and collection of the leachate and landfill gas and interim treatment of gas). Operable Unit 3 (OU3) addresses contaminated groundwater migration, permanent treatment for landfill gas and excavation of contaminated sediments in Dunstable Brook and Operable Unit 4 (OU4) addresses leachate treatment.

This is the third five-year review for the Charles George Land Reclamation Trust Landfill Superfund Site. This review is required by statute because the selected remedy will, upon completion, leave hazardous substances, pollutants, or contaminants on Site above levels that allow for unlimited use and unrestricted exposure. The trigger for this statutory review is the signature date of the previous Five-Year Review report on March 22, 2000.

SECTION 2.0
SITE CHRONOLOGY

The chronology of the Site is included in Table 1.

Table 1: Chronology of Site Events	
Event	**Date**
Site is operated as a municipal dump	Late 1950s until 1967
New owner expands landfill and accepts both household and industrial wastes	1967 to 1976
Hazardous wastes accepted, including drummed and bulk chemicals containing VOCs and metal sludges	1973 to 1975
EPA proposes site for listing on National Priorities List (NPL)	October 23, 1981
Bedrock wells serving Cannongate Condominium found to be contaminated and shut down by the State. State installs temporary water line and orders closure of landfill.	July 1982
Four private bedrock wells serving homes adjacent to condominiums also found to be contaminated	May 1983
EPA issues Notice to Charles George Land Reclamation Trust requesting cooperation in cleanup	May 1983
Final listing date on the NPL	September 8,1983
EPA undertakes emergency remedial actions including improvement to Cannongate temporary water line and landfill measures (fencing, soil cover, and gas vents)	August 1983 - March 1984
First Record of Decision (ROD) selecting extension of City of Lowell's water supply system to serve Cannongate area (OU1)	December 29,1983
Second ROD selecting landfill cap, gas collection/venting, and leachate collection (OU2)	July 11, 1985
Explanation of Significant Differences (ESD) to include an additional 24 residential tie-ins to the OU1 water line	May 1988
OU1 water line is activated	Fall 1988
Third ROD selecting long-term groundwater monitoring, incineration of landfill gas, contaminated groundwater extraction, leachate treatment, and excavation of Dunstable Brook sediments (OU3 and OU4)	September 29, 1988
Construction of landfill cap (OU2) completed	October 1990
Fifty-four Potentially Responsible Parties enter into Consent Decrees with EPA	1992

Table 1: Chronology of Site Events	
Event	**Date**
Construction of interim gas treatment flare and portion of groundwater extraction remedy completed	1993 -1994
Extraction well portion of groundwater remedy completed	1995
Leachate and groundwater temporary treatment system in operation	1991 to 1997
Contamination first discovered in monitoring wells on Notre Dame Academy property	October 1995
Contamination discovered in residential well water in Flint Pond neighborhood	August 1996
EPA evaluates alternatives for landfill gas treatment and selects enclosed flare to replace interim flare	1996
Existence of sanitary sewer connection near site is discovered, and evaluated as a replacement for on-site treatment of leachate and groundwater.	1996 - 1997
Completion of water line extension to Notre Dame Academy	July 1997
Lowell Regional Water Utility issues Industrial Discharge Permit allowing discharge of leachate and groundwater to sanitary sewer	January 1998
Construction for enclosed flare to replace interim flare is completed	April 1998
Completion of water line extension to Flint Pond neighborhood	June 1998
Dunstable Brook sediments sampled and risk re-calculated; results show sediment removal not necessary. Pump stations upgraded and O&M building constructed on site to support long-term O&M efforts.	1998
Construction of sewer line from site to Flint Corner Municipal Pump Station including two pump stations	September 1998
Construction complete status is attained for the Site	September 22, 1998
ESD issued to document changes to third ROD (additional water line extensions, selection of enclosed flare, elimination of Dunstable Brook sediment removal, and sanitary sewer extension for permanent leachate and groundwater disposal).	September 1999
Dorothy and Charles George settle all claims against them	March 2003
Completion of First Five-Year Review	August 31,1995
Completion of Second Five-Year Review	March 22, 2000

Table 1: Chronology of Site Events	
Event	**Date**
Completion of Third Five-Year Review	June 28, 2005

SECTION 3.0
BACKGROUND

3.1 PHYSICAL CHARACTERISTICS AND LAND AND RESOURCE USE

The Charles George Land Reclamation Trust Landfill Superfund Site (the Site) is a 70-acre mixed industrial, municipal, and hazardous waste landfill located approximately one mile southwest of the town center of Tyngsborough, Massachusetts (Figure 1). The Site is bordered to the east by U.S. Route 3, Flint Pond Marsh, and Flint Pond. Across Flint Pond, a neighborhood is located on the Pond's northern peninsula about one-half mile from the Site. The Academy of Notre Dame is on the eastern shore of Flint Pond. Dunstable Road and Dunstable Brook border the Site to the west and south, and the Cannongate Condominium complex is about 800 feet to the southeast. Blodgett Street forms the northwest border of the Site, eventually becoming Cummings Road.

Dunstable Brook flows in a southerly direction before turning east, then northeasterly, discharging into Flint Pond Marsh which in turn supplies Flint Pond. Flint Pond discharges to the Merrimack River.

Land use in the vicinity of the site is predominantly rural residential but also includes some light industry and seasonal livestock grazing. This area of town has experienced heavy residential development. In addition, adjacent to the northern border of the site a large commercial park with a build-out capacity of 18 buildings has been constructed. Drinking water in the area is supplied by local groundwater wells, by a water main installed as a result of the EPA's first Record of Decision (ROD) for the Site, and by water main extensions constructed by others. The public water supply is available to the area impacted by the Site, although some parties have chosen to remain with their private water supply wells. The water main is connected to the City of Lowell's system.

3.2 HISTORY OF CONTAMINATION

This section is excerpted from the site history discussion presented in the second ROD (USEPA, 1985). Waste disposal activity at the Site was initiated in the mid 1950's. During the period from 1955 until the land was purchased by Charles George Sr. in 1967, the Site was operated as a municipal dump. The Site continued as a municipal dump following acquisition by Charles George Sr. in 1967, and the Charles George Land Reclamation Trust (Charles George Sr. and Dorothy George, Trustees) in 1971. In 1973, the Trust was issued a permit by the State to handle hazardous wastes in addition to municipal and domestic refuse. Disposal of hazardous wastes and substances primarily in the form of drummed and bulk chemicals containing volatile organic compounds (VOCs) and toxic metal sludges continued from January 1973 to at least June 1976.

In 1982, the Tyngsborough Board of Health suspended the assignment of the Trust's land as a landfill. At approximately the same time, the Massachusetts Department of Environmental Quality Engineering (DEQE, now known as Department of Environmental Protection or DEP) ordered the closing of two wells serving the Cannongate Condominiums because of VOC contamination in the well water. The DEQE installed an above-ground water line from the North Chelmsford Water District to the condominiums to provide a temporary solution to the water shortage created by the loss of the wells. The water line froze and was subsequently dismantled in December 1982.

3.3 INITIAL RESPONSE

EPA's involvement at the Site began with groundwater testing conducted by EPA contractor Ecology and Environment, Inc. during 1981 and 1982. The site was proposed for the National Priorities List (NPL) on October 23, 1981, and finalized on the NPL in September 1983. In September 1983 EPA also allocated funds for a removal action at the Site to replace the DEQE's temporary water line with another temporary but insulated water line. Other removal work included construction of a security fence along the northwestern entrance to the landfill, regrading and placement of soil cover over exposed refuse, and installation of twelve gas vents. A remedial investigation and feasibility study (RI/FS) were also begun in September 1983. The basis for the removal action was documented in the first ROD issued on December 29, 1983.

3.4 BASIS FOR TAKING ACTION AT THE SITE

The initial action taken at the Site under the first ROD (ROD I, 1983) was based on the discovery of contamination in water from the wells that supplied the Cannongate Condominium complex to the south of the Site. The contaminants found included methyl ethyl ketone, acetone, toluene, benzene, methyl isobutyl ketone, trichloroethene, and 1,1-dichloroethane. Sampling of other private wells near the condominiums also began to show contamination. The first ROD extended a water line to affected residences to provide water from a neighboring town.

The basis for the second ROD (ROD II, 1985) was the poor condition of the abandoned landfill (lack of soil cover, exposed refuse, and leachate breakouts) that was allowing contaminants to migrate via surface runoff, groundwater passing through the waste, and gaseous emissions. Identified receptors included flora and fauna as well as humans coming into contact with surface waters and wetlands surrounding the Site. Landfill leachate and eroded contaminated soils were cited as having impacted the surrounding surface waters and wetlands. The potential migration of leachate to the bedrock aquifer was also cited as a concern. VOCs were detected in air samples from landfill vents and the surrounding environment, indicating that landfill gas control was also needed.

The third ROD (ROD III, 1988), addressing groundwater, leachate and sediment contamination, was based on a Site-wide Remedial Investigation and risk assessment (Ebasco, 1988). The contaminants listed below are those listed in the third ROD and are a representative subset of the contaminants identified at the Site that were selected for quantitative evaluation in the 1988 risk assessment.

Groundwater and Leachate

Acetone
Benzene
Benzoic acid
2-Butanone
1,1-Dichloroethene
Ethylbenzene
4-Methyl-2-pentanone
4-Methylphenol
2-Methylphenol
Phenol
Toluene
Trichloroethene
Arsenic
Cadmium
Chromium
Copper
Mercury

Air

Benzene
Bromoform
Bromomethane
Carbon Disulfide
Carbon Tetrachloride
Chlorobenzene
Chloroform
Chrysene
1,2-Dichloroethane
1,1-Dichloroethene
Methylene chloride
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
1,1,2-Trichloroethane
Trichloroethene
Vinyl Chloride
Xylenes

Sediment

Polycyclic Aromatic Hydrocarbons (PAHs)
Arsenic
Cadmium

The risk assessment (Ebasco, 1988) estimated human health risks and hazards that exceed the EPA risk management criteria from the following:

- Exposure to groundwater via ingestion during domestic use
- Exposure to airborne emissions from the venting system via inhalation of ambient air
- Exposure to sediments in Dunstable Brook via dermal exposure to carcinogenic PAHs

In 1998, sediments in Dunstable Brook were sampled and analyzed for PAHs and the human health risk and hazard from contact with the sediments (residential scenario) was reassessed. This reassessment was done because of changes in toxicity information and risk assessment practice that had occurred since the 1988 risk assessment was performed. Also, the 1998 results had showed decreased concentrations relative to the data used to support the third ROD. The 1998 reassessment concluded that the risk and hazard from exposure to Dunstable Brook sediments met EPA's risk management criteria. This reassessment formed the basis for the decision described in the 1999 Explanation of Significant Differences to eliminate removal of Dunstable Brook sediments from the OU3 remedy.

SECTION 4.0
REMEDIAL ACTIONS

4.1 REMEDY SELECTION

The Site was subdivided into four operable units (OUs) for the purpose of investigation, remedy selection and remediation. Three Records of Decision have been issued, as follows:

- ROD I. Provide an alternative water supply (OU1).
- ROD II. Control the contamination source (OU2) to reduce off-site migration of contaminants (*i.e.*, cap the landfill and collect the leachate and landfill gas).
- ROD III. Provide treatment of groundwater, leachate and landfill gas and provide removal of Dunstable Brook sediments as the selected source removal remedy. ROD III covered both management of contaminated groundwater migration (OU3) and leachate treatment (OU4).

4.1.1 Operable Unit 1

ROD I, issued in December 1983, provided a permanent drinking water supply to local groundwater users by extending an existing water supply system (OU1). In early studies, local groundwater wells were found to contain volatile organic compounds associated with the site. The remedy minimized exposure and, therefore, provided a measure of protectiveness to human health. ROD I established as an objective a new water main to provide an uncontaminated alternative water service to the residents of the Cannongate Condominium complex and surrounding area. The ROD specifically stated:

- Mitigate and minimize danger to and provide adequate protection of public health and welfare from ingestion of contaminated drinking water.

To meet this objective, the 1983 ROD selected the extension of an existing (Lowell's) water supply system to Cannongate Condominiums. Residential well water users along Dunstable Road up to Cannongate Road and along Cannongate Road were also tied into the waterline extension. An ESD was issued during the construction in 1988 to include these tie-ins, 24 in all.

4.1.2 Operable Unit 2

The final remedial action objectives selected in ROD II (1985) for addressing source control measures at the Site (OU2) are as follows:

- Abate additional impact to surrounding surface waters and wetlands.
- Minimize, to the extent possible, continued release to the groundwater.
- Control the emission of gases containing hazardous constituents to the surrounding residents.
- Minimize potential contamination of the water supplies and impacts on recreational uses around Flint Pond.

- Minimize potential exposure, via direct contact with leachate, to the surrounding public and wildlife.

- Secure the Site to eliminate unauthorized access.

- Comply with existing federal, state, and local laws.

- Ensure consistency with any off-site remedial alternatives which may be selected in the third ROD as required by CERCLA sec. 101(24).

ROD II provided a cap for the site including a synthetic membrane and soil cover, a surface water management system, a passive landfill gas venting system, and a leachate collection system (OU2). These measures minimized the migration of contaminants through the air and groundwater and, therefore, provided a measure of protectiveness to human health. The landfill cover minimized storm water infiltration which reduces leachate generation. From 1991 to 1997, leachate and groundwater were collected and pumped into a 3.5 million-gallon storage lagoon and at capacity, the wastewater was treated on-site in a temporary treatment facility. Treatment consisted of breakpoint chlorination, solids removal, and UV oxidation. The treated effluent was discharged to the eastern sedimentation pond with eventual discharge to Bridge Meadow Brook. Ambient Water Quality Criteria were met. Ten rounds of treatment were conducted, during which approximately 35 million gallons of wastewater were treated and discharged. The leachate collection system minimized impacts to off-site surface water and groundwater.

Construction of a synthetic landfill cap and appurtenant systems was begun in early 1989 and completed in October 1990. Included in the construction of the cap were a new shallow perimeter leachate toe-drain, two leachate pump stations with force mains flowing to the temporary leachate holding pond, a passive gas collection and venting system, and a surface water diversion and sedimentation system. The old leachate collection systems on the east and west sides of the landfill, which were installed by the former landfill operator, were connected to the pump stations.

4.1.3 Operable Units 3 and 4

The remedial action objectives selected in ROD III (1988) to address management of migration at the Site (OU3 and OU4) are as follows:

- Reduce potential future human health risks from ingesting benzene and arsenic in overburden groundwater southwest of the landfill.

- Reduce potential human health risks from benzene, arsenic, bis(2-ethylhexyl)phthalate, and trichloroethene in deep bedrock groundwater east of the landfill, with respect to use as a drinking water supply.

- Remediate shallow eastern groundwater to comply with Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and Resource Conservation and Recovery Act (RCRA) groundwater corrective action requirements (40 CFR 264.92-100).

- Reduce potential human health risks posed by bromoform and various carcinogenic contaminants in landfill vent emissions (primarily, 1,1-dichloroethene, 1,1,2,2-tetrachloroethane, vinyl chloride, methylene chloride, and carbon tetrachloride).

- Reduce potential human health risks from PAHs in sediments west of Dunstable Road, in the leachate drainageway to Dunstable Brook, as well as short reaches of Dunstable Brook itself.

ROD III completed the remedial actions via treatment of the media controlled during implementation of ROD II. Due to several investigations made subsequent to the issuance of ROD III, EPA modified four of the five remedies under the third ROD. These changes included extending the existing municipal water supply system, installation of an enclosed flare, determining that removal of sediments from Dunstable Brook would not be necessary, and construction of a sanitary sewer extension, which provides an alternate remedy for leachate and groundwater treatment and discharge. An ESD was issued by EPA in 1999 to address these changes (USEPA, 1999).

The southwest groundwater collection trench has been operating since October 1993, and the eastern groundwater extraction system has been operating since 1995. Contaminated groundwater from these two extraction systems is currently collected at the East and West Pump Stations, where citric acid and a biocide are added before the collected water is pumped to the effluent monitoring station near the site entrance. From there, it is piped to the Cummings Road Pumping Station for discharge to the Lowell Regional Water Utility (LRWU) for treatment and disposal. This discharge is regulated by the LRWU Industrial Discharge Permit for the Site. The residential well monitoring program started in 1989 was terminated in 1999 due partly to the now available municipal water supply near the landfill. In addition, certain residences in the Town of Dunstable near the site were sampled in the past but historic data has shown that due to groundwater flow direction and the lack of plume detection in the off-site southwest and west areas near the site, sampling of these residential wells is unnecessary.

The landfill gas collection and venting system included a passive, crushed stone, gas collection trench system under the cap liner which directed the landfill gas through 28 vents along the top of the landfill. Three existing monitoring wells (acting as gas vents) were connected to an active horizontal header pipeline that lies atop the landfill. Twelve pre-existing vents were capped off. Landfill gas is being routed to an enclosed flare, part of ROD III. The landfill gas collection system delivered landfill gas to an interim open flare (later replaced by the enclosed flare). The enclosed flare, provided under ROD III, thermally destroys contaminants carried in the gas and minimizes impacts to the air.

Landfill gas is currently being collected from an active gas extraction system of vents and header pipes via a blower, then treated via combustion in an enclosed flare.

The need for excavation of sediments from Dunstable Brook was re-evaluated as part of the first five-year review (M&E, 1995). Sediments that were to be dredged and placed under the landfill cap during cover construction remain in the brook. The decision to dredge the brook had been based on a risk assessment of contaminant levels using toxicity assumptions valid at the time ROD III was issued in 1988. In 1989, EPA revised the relative absorption factors for polycyclic aromatic hydrocarbons (PAHs), and in 1993, implemented the use of relative potency factors for carcinogenic PAHs (cPAHs). These changes were expected to result in decreased human health risk and hazard associated with exposure to sediments. Additional sediment data and a re-evaluation of relative absorption factors were presented in the first Five-Year Report (M&E, 1995). New risk calculations were not performed at that time, and EPA determined that more data was needed before dredging the brook. In 1998, EPA re-sampled brook sediments, re-evaluated the human health risks posed by cPAHs and determined that the concentrations of cPAHs are within the acceptable range of risk. This information was presented in the second five-year review report

(M&E, 2000) to support the decision not to dredge the brook.

The ROD called for on-site treatment of groundwater and leachate with on-site discharge into the aquifer or off-site surface water discharge. During pre-design activities in preparation for concept design of the permanent treatment plant for OU4, it was discovered that a sanitary sewer was constructed during the summer of 1996 approximately one or so miles from the site. EPA determined that the Site wastewater would meet the LRWU's pretreatment requirements. Directing the discharge to the LRWU is more cost effective, more environmentally protective and more reliable than the on-site treatment plant specified in the ROD (USEPA, 1999).

4.2 REMEDY IMPLEMENTATION

This section presents additional information regarding the remedial actions conducted or being conducted at the site in accordance with the ROD objectives mentioned in Section 4.1. Figure 2 presents a site plan.

4.2.1 OU1 Remedy Implementation

A water line, providing an alternate water supply to serve the Cannongate area, was completed and activated in the fall of 1988. This waterline, which was constructed under ROD I and is OU1, is now owned and operated by the Tyngsborough Water District (TWD). Since 1988, the municipal water line has been extended (not by EPA) along Westford Road to the Westec Industrial Park. Under ROD III, EPA extended the line from the Westec location on Westford Road to Middlesex Road, to the Academy of Notre Dame, then up Middlesex Road to Kendall Road and finally to Flint and Upton Roads. This extension is part of OU3 and was also turned over to the TWD in 1998. The waterline in Dunstable Road was extended by others from the Cannongate Road/Dunstable Road EPA terminus, up Redgate Road, and also extended up Dunstable Road to Blogett/Cummings Road to the commercial park constructed north of the site. In 1998, EPA tied the Site into this system.

4.2.2 OU2, OU3, and OU4 Remedy Implementation: Source Control and Management of Migration

ROD II provided for source control by selecting a synthetic membrane cap with surface water diversion, off-gas collection and passive venting (now superseded by ROD III), and leachate seep collection. Construction of this cap and other remedial systems described above were completed in October of 1990. ROD III includes management of migration systems, control of groundwater and leachate, and groundwater/leachate disposal. MADEP has O&M responsibilities for OU2, which constitutes the cap, surface water diversion system, the leachate collection system and the grounds within the fence (including the fence). MADEP also has O&M responsibilities for the gas collection and the enclosed flare systems and the southwest groundwater extraction trench. MADEP took over the financial responsibility for the southwest trench in September 2004 and fully funds these O&M responsibilities. EPA maintains O&M responsibilities for the remaining on-site leachate and groundwater collection and discharge systems until September 2009 when that will be transferred to MADEP.

Landfill Cap, Leachate Collection, Groundwater Collection, and Treatment Systems. Construction of the synthetic landfill cap and appurtenant systems was begun in early 1989 and completed in October 1990. Included in the construction of the cap were a new shallow perimeter leachate toe-drain, two leachate pump stations with force mains flowing to a temporary leachate holding pond, a passive gas collection and venting system, and a surface water diversion and sedimentation system. The old leachate collection systems on the east and west sides of the landfill, which were installed by the former landfill operator, were connected into pump stations.

The southwest groundwater extraction trench was completed and became operational in December 1993. It includes five wells that vary in depth from about 24 to 45 feet. The eastern groundwater extraction well field was completed in July 1995.

The eastern groundwater extraction system originally consisted of four extraction wells: CDM-1, CDM-2, CDM-3, and PW-1A. CDM-1 and CDM-2 had low yields and low concentrations of contaminants. CDM-2, which was open to both the overburden and shallow bedrock, was taken off line in 1996; it was suspected that the groundwater in the shallow bedrock in that area was not contaminated. More recently, CDM-1 was also taken off line. In 1997, a new extraction well, WES-1, was constructed near CDM-2. WES-1 is open to the overburden only and has a higher yield than CDM-2.

The first five-year review (M&E, 1995) identified many problems with the leachate/groundwater collection systems. Among the problems encountered were:

- Pump failure due to iron bacteria build-up resulting in pump motor burnout.

- Lack of pump station access due to limited space and a hazardous atmosphere within the manhole caused by landfill gas (e.g., hydrogen sulfide) infiltration.

- Equipment corrosion also due to hydrogen sulfide infiltration.

These problems were addressed by redesigning the leachate and groundwater collection and pumping systems.

Since January 1998, citric acid and biocide have been added to the collected leachate and groundwater to prevent iron biofouling of the discharge pipelines. Chemical addition occurs at both the East and West Pump Stations, from which the water is pumped to the effluent monitoring station prior to discharge to the LRWU via the Cummings Road Pump Station and its associated combined force main/gravity sewer located on Dunstable Road. EPA extended the Westford Road sewer line to the Site in 1998. The extension includes two off-site pump stations, two force main sections, and the remaining are gravity-fed sections. The EPA sewer line discharges to a pump station built by others located at the corner of Westford Road and Dunstable Road (*a.k.a.* Flint's Corner). At this time, EPA also constructed an Operations and Maintenance Building which houses equipment and vehicle storage, a wet laboratory, and an office. The extraction and discharge systems are monitored with a Supervisory Control And Data Acquisition (SCADA) system available in the building that also provides for remote access.

Landfill Gas Collection and Treatment System. A landfill gas collection and an interim open flare gas destruction system was constructed and became operational in 1994. During that year, landfill gas was characterized to determine the most appropriate destruction technology to meet the target cleanup levels established in ROD III. An enclosed flare system was determined to be the preferred alternative. Construction involved replacing the open flare stack with an enclosed flare stack. Some upgrading of the system was necessary, particularly the instrumentation and control panels, but most of the original system was utilized, including the flare building. This construction was completed in April 1998.

Landfill gas is collected via a system of 29 gas extraction vents and three existing groundwater monitoring wells (acting as gas vents) connected to an active horizontal header pipeline that lies atop the landfill. The pipeline is connected to a vacuum blower and enclosed flare for thermal treatment. There is no perimeter landfill gas collection system in place at the landfill.

The landfill gas vents are not extraction wells but are shallow structures that connect to the gas venting layer located directly beneath the HDPE geomembrane. Not all of the passive vents were connected to the header pipe system; those passive vents that were not connected to the gas extraction system were capped off and are no longer functional.

Monitoring Systems. A groundwater monitoring well network exists at the landfill. Semiannual inspection and monitoring of this network was performed by TRC Environmental Corporation from April 1999 through April 2001 under the EPA Response Action Contract. The monitoring included water level measurements in all wells and sampling of 12 key wells (with one “floating” well). Monitoring was also previously done by TRC from October 1992 through July 1996 under the ARCS Program. A review of the groundwater monitoring data is presented in Section 6.3 and the monitoring wells sampled by TRC are shown on Figure 3.

Monitoring of collected leachate/groundwater occurs at the effluent monitoring station located behind the O&M Building. By permit with LRWU, continuous monitoring of pH, temperature and flow rate (gallons per minute) occurs at the station along with collection of composite samples (via a refrigerated “ISCO” sampling unit) and grab samples.

Monitoring of landfill gas occurs at both the individual gas vents on top of the landfill as well as the flare/blower station. Sample taps are in place at each gas vent for collection of samples using hand-held instruments. Each vent also includes a pressure gauge to measure small changes in static pressure (either positive or negative) to allow adjustment to extraction rates from each vent, but these were generally not operational and have not been found to be useful for this Site. Automated monitoring at the flare/blower station involves the following parameters: flare temperature, landfill gas flow rate, vacuum pressure of the extracted landfill gas and oxygen concentration of the extracted gas.

Although there are no permanent perimeter monitoring wells for measuring methane or landfill gas in the vadose zone, the MADEP has monitored the soil gas using multiple, temporary, surficial probes installed by EPA in 1997. In general, gas migration has not been an issue at the Site in the past due to the lack of sensitive receptors such as nearby structures or buildings, and due to concentrations below action levels or non-detection of monitored parameters in these wells.

4.3 OPERATION AND MAINTENANCE

This section discusses the operation and maintenance (O&M) of the remedy at the Charles George Landfill.

4.3.1 Remedy Operation and Maintenance Program

O&M responsibilities are divided between the state (MADEP) and the EPA (via the Army Corps of Engineers). MADEP oversees the O&M of the landfill cap and grounds within the fence, surface water diversion system, Site security, southwest groundwater extraction trench, gas collection system, and the enclosed flare system (i.e., OU2 and OU3). The Army Corps is responsible for O&M of the east groundwater extraction system and discharge systems (i.e., OU4 east and west pump stations and effluent monitoring station). Since November 1999, the MADEP has subcontracted Clean Harbors to perform O&M activities related to OU2, OU3 and the southwest groundwater extraction trench. Nobis Engineering, Inc. conducts O&M of OU4 on behalf of the Army Corps of Engineers.

4.3.2 MADEP Responsibilities

Clean Harbors, on behalf of the MADEP, conducts Semi-Annual (twice per year) landfill security and maintenance inspections, along with weekly inspections of the perimeter fence, southwest groundwater extraction trench, and enclosed flare system. Clean Harbors also performs quarterly sampling of both the landfill gas collection system and 19 soil gas probes. Soil gas probe locations are shown in Attachment 4.

Semi-Annual landfill security and maintenance inspections consist of a complete walkover of the landfill cap inspecting for significant subsidence, bulging or evidence of deterioration. The inspections include observation of the roadways, perimeter fence, soil and gravel cover, drainage features, observation ports, and toe-drain clean outs. During these inspections, woody growth is removed from the cap and near cap drainage structures as necessary. A five-page “Landfill/Security/Site Maintenance” inspection checklist is used by Clean Harbors to document observations from the Semi-Annual inspection. Findings of the Semi-Annual inspection are reported to MADEP in a Semi-Annual Status Report prepared by Clean Harbors. The Semi-Annual Status Report also summarizes observations and maintenance activities related to the quarterly sampling of soil gas probes and gas collection system sample ports, as well as weekly inspections of the flare and southwest groundwater extraction trench.

Monitoring of landfill gas is accomplished through the sampling of 22 gas extraction points (former gas vents), two new sample ports that were installed in the gas collection header pipes, and three monitoring wells (JLF1, JLF1A and JLF2) that were tied into the gas collection system. Monitoring at the gas extraction points is performed using Landtech Model GA-90 handheld instruments outfitted with hydrogen sulfide (H_2S) pods. Parameters measured during the quarterly gas sampling consist of oxygen (O_2), carbon dioxide (CO_2), H_2S, methane (CH_4), temperature, and pressure (vent suction). Monitored parameters and details concerning gas system maintenance are recorded for each sample location on “Gas Collection System Inspection Checklists”, which are included in Clean Harbors Semi-Annual Status Report to MADEP.

Each vent also includes a pressure gauge to measure small changes in static pressure (either positive or negative) and valves to allow adjustment to extraction rates from each vent. However, MADEP reported that in the past the valves were generally not operational and previous attempts to spatially “balance” different vent flow rates have not proven useful.

On a weekly basis, Clean Harbors performs routine monitoring and maintenance at the flare/blower station. Monitoring includes measuring gas quality and flow rate, blower speed, pressure set point, flare high temperature, landfill gas pressure, nitrogen pressure, and extracted gas oxygen concentration. Automated monitoring at the flare/blower station displays flare temperature, landfill gas flow rate, vacuum pressure of the extracted landfill gas and oxygen concentration of the extracted gas. Based on review of the O&M data, the oxygen sensor is a high maintenance item that frequently requires replacement. Observations from the weekly flare inspections are recorded on weekly “Flare Inspection Checklists”, which are included in Clean Harbors Semi-Annual Status Reports to MADEP.

Soil gas has been monitored since 1998 using multiple shallow probes that were installed near the perimeter of the Site in 1997 (55 temporary probes, total) as part of prior landfill gas migration studies. The current soil gas monitoring program consists of quarterly sampling of twenty (reduced to nineteen in 2004 due to destruction of one soil gas probe) select probes (locations described in section 6.3 Data Review). Again, monitoring is accomplished with the use of a Landtech Model GA-90 handheld instrument that measures O_2, CO_2, H_2S, and CH_4. VOCs are also measured qualitatively at each probe using a Thermo 580B photoionization detector. Monitored parameters and details concerning probe maintenance are recorded on “Soil Gas Probe Monitoring Results” worksheets, which are included in Clean Harbors Semi-Annual Status Reports to MADEP.

Weekly inspection activities performed by Clean Harbors at the Southwest groundwater extraction system include ambient air monitoring in pump manholes, inspection of pumps, floats, hoses, and support cables in each of the pump wells, and recording the number of pumps operating and each pump’s operating amperage. Air quality parameters monitored in the pump manholes consist of % lower explosive limit (LEL) of explosive gas, O_2, CO_2, and H_2S. Details concerning extraction pump and trench maintenance are recorded on weekly “Southwest Groundwater Collection Trench” worksheets, which are included in Clean Harbors Semi-Annual Status Report to MADEP.

4.3.3 EPA/Army Corps Responsibilities

The Army Corps of Engineers, on behalf of the EPA, performs weekly site visits and monitoring of collected leachate and groundwater prior to discharge to the off-site sewer system. Weekly site visits include inspection and routine maintenance of the east extraction wells and East and West Pump Stations. Monitoring of collected leachate/groundwater occurs at the effluent monitoring station located behind the Operations Building. This station receives the discharge from the East and West Pump Stations and the leachate collection system prior to discharging to the Lowell Regional Wastewater Utility (LRWU). In accordance with the LRWU Industrial Sewer User Permit, continuous monitoring of pH, temperature and flow rate (gallons per minute) occurs at the station. The permit also requires the collection of quarterly composite samples (via a refrigerated “ISCO” sampling unit) and grab samples of discharge water at the Effluent Monitoring Station. Prior to 2004, weekly sampling was required as part of the permit but the frequency was dropped to quarterly in 2004. The composite samples are collected by the automated sampler on a flow-weighted basis. Prior to summer 2004, the sampler collected time-weighted composite samples (i.e., over a 24-hour period). As required by the permit, the water samples are analyzed for biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), Total Toxic Organics (TTO), total cyanide, acidity, and metals (arsenic, antimony, beryllium, total chromium, copper, lead, nickel, selenium, thallium and zinc). These responsibilities will be transferred to MADEP in September 2009 when the LTRA period ends and O&M phase begins for OU4.

SECTION 5.0
PROGRESS SINCE LAST FIVE YEAR REVIEW

This is the third five-year review for the Site. This section presents the recommendations made in the second five year review, followed by a summary of efforts since 2000 to address the recommendations.

5.1 RECOMMENDATIONS FROM SECOND FIVE YEAR REVIEW

The recommendations from the second five year review were directed towards O&M and monitoring activities and are presented below by category.

5.1.1 Landfill Cap Operation and Maintenance

- Investigate the causes of landfill bare spots and provide appropriate vegetative cover by means of soil testing for appropriate analytical parameters, provide appropriate vegetative support soil by means of fertilizer applications, addition of organic content and reseeding.

- Monitor low-spot areas on the top of the landfill during or immediately after rain events to check if water is ponding. If necessary, conduct remedial activities to eliminate those areas where extensive ponding occurs.

- Eliminate all woody shrub and tree plant growth within areas of the HDPE geomembrane capped portion of the site to prevent damage to the liner. In areas with extensive woody growth, inspect and repair the liner as necessary after removal of the growth.

- Eliminate, control, or minimize woody plant growth within sedimentation basins as well as along the perimeter security fence to avoid long-term damage to these structures.

- Re-establish appropriate benchmarks at the Site boundary to replace those that have been damaged or destroyed.

- Continue to conduct either an aerial or ground survey of the landfill to evaluate conditions for future five-year inspections.

The progress made towards addressing landfill O&M recommendations is discussed in Section 5.2.1.

5.1.2 Monitoring

Recommendations were made in the second five-year review regarding monitoring of soil gas, landfill gas, the enclosed flare, and groundwater as follows:

Soil Gas and Landfill Gas

- Install permanent vadose zone, gas monitoring wells along the landfill's northern boundary where off-site development and construction is planned. Conduct testing for explosive gases (e.g.

methane) to confirm compliance with the landfill gas migration ARAR at the site property boundary.

- In the event that off-site landfill gas migration or off-site landfill odors become a concern, conduct appropriate field testing, design assessments and remedial actions to improve the efficiency of the landfill gas collection system.

Enclosed Flare

- Obtain sufficiently low detection limits during future enclosed flare stack testing events to demonstrate compliance with the ROD III target cleanup level for 1,1-dichloroethene.

- Conduct mathematical modeling using the flare stack testing conducted-to-date to demonstrate compliance with the federal NAAQS and Massachusetts AALs.

Groundwater

- Expand the semi-annual groundwater monitoring program to demonstrate compliance with the Remedial Action Objectives of ROD III.

5.2 PROGRESS SINCE LAST FIVE YEAR REVIEW

Progress in addressing the O&M and monitoring issues noted in the last five year review is summarized below. Further details regarding O&M activities are presented in Section 6.4.

5.2.1 Landfill Cap Operation and Maintenance

MADEP oversees the O&M of the landfill cap and grounds within the fence, surface water diversion system, Site security, southwest groundwater extraction trench, gas collection system, and the enclosed flare system (i.e., OU2 and OU3). Since November 1999, the MADEP has subcontracted Clean Harbors to perform O&M activities related to OU2, OU3 and the southwest groundwater extraction trench.

Clean Harbors conducts Semi-Annual (twice per year) landfill security and maintenance inspections, along with weekly inspections of the perimeter fence, southwest groundwater extraction trench, and enclosed flare system. Specific inspections to address bare spots and ponding as recommended in the last five year review were not conducted, but the landfill cap is reportedly in good condition, and the semi-annual inspections serve to identify and correct problems. A detailed inspection of the cap could not be conducted during this five year review because of snow cover.

The semi-annual landfill security and maintenance inspections consist of a complete walkover of the landfill cap inspecting for significant subsidence, bulging or evidence of deterioration. The inspections include observation of the roadways, perimeter fence, soil and gravel cover, drainage features, observation ports, and toe-drain clean outs. During these inspections, woody growth is removed from the cap and near cap drainage structures as necessary. A five-page “Landfill/Security/Site Maintenance” inspection checklist is used by Clean Harbors to document observations from the Semi-Annual inspection.

Findings of the Semi-Annual inspection are reported to MADEP in a Semi-Annual Status Report prepared by Clean Harbors.

The landfill cap is mowed twice per year (spring and fall). A commercial herbicide (i.e., "Roundup" or similar weed control product) is applied to the rock cover portions of the cap and detention basins once per year. MADEP and Clean Harbors reported that the herbicide program has been successful in limiting woody vegetative growth in the stone, rip rap and drainage areas.

Two survey monuments were noted during the 2000 five year review as being shown on as-built drawings from 1992, but they could not be field-located at that time. It was suspected that one of them had been damaged during water and sewer line construction along Blodgett Street. The other, at the junction of Blodgett Street and Dunstable Road, could not be located and no other information was available regarding it. This led to the recommendation that benchmarks be re-established at the site. The two old monuments are also shown on more recent record drawings (1997) provided by the Army Corps for this five-year review. No attempt was made to field-locate monuments during this five-year review. If site surveying is found to be needed in the future, survey benchmarks may need to be re-established at that time.

5.2.2 Progress in Monitoring

Soil Gas and Landfill Gas

Clean Harbors performs quarterly sampling of both the landfill gas collection system and perimeter soil gas probes. Soil gas has been monitored since 1998 using multiple shallow probes that were installed near the perimeter of the Site in 1997 (55 temporary probes, total) as part of prior landfill gas migration studies. Their locations are shown in Attachment 4. Permanent probes have not been installed. The current soil gas monitoring program consists of quarterly sampling of twenty (reduced to nineteen in 2004 due to destruction of one soil gas probe) select probes (locations described in section 6.3 Data Review). Monitoring is accomplished with the use of a Landtech Model GA-90 handheld instrument that measures oxygen (O_2), carbon dioxide (CO_2), hydrogen sulfide (H_2S), and methane (CH_4). VOCs are also measured qualitatively at each probe using a Thermo 580B photoionization detector. Monitored parameters and details concerning probe maintenance are recorded on "Soil Gas Probe Monitoring Results" worksheets, which are included in Clean Harbors Semi-Annual Status Reports to MADEP.

Monitoring of landfill gas is accomplished through the sampling of 22 gas extraction points (former gas vents), two new sample ports that were installed in the gas collection header pipes, and three monitoring wells (JLF1, JLF1A and JLF2) that were tied into the gas collection system. Monitoring at the gas extraction points is performed using the Landtech Model GA-90 handheld instrument. Parameters measured during the quarterly gas sampling consist of O_2, CO_2, H_2S, methane, temperature, and pressure (vent suction). Monitored parameters and details concerning gas system maintenance are recorded for each sample location on "Gas Collection System Inspection Checklists", which are included in Clean Harbors Semi-Annual Status Reports to MADEP.

Only minor, infrequent odors have been detected by O&M personnel on the south side of the landfill, and concentrations of methane have been below 25% of the LEL at the gas probes currently being monitored. Since new office buildings have recently been constructed adjacent to the landfill, an evaluation of the current soil gas monitoring program is recommended to verify that the extent of landfill gas is fully characterized, especially to the north of the landfill.

Clean Harbors technicians have noted that oxygen intrusion into the gas collection system has been an ongoing problem and may be attributed to the configuration of the landfill gas vents, which are seated within the cover layer but do not fully penetrate the wastes. Pressure testing and video inspection of the system completed in 2003 did not identify any large leaks in the system that would account for the high levels of oxygen. This investigation did find, however, that a possible source of oxygen infiltration may be occurring where the leachate toe drain is connected to the main header just north of the flare building.

Enclosed Flare

Enclosed flare stack testing for VOCs was most recently conducted in 1999. The results were evaluated by comparing detected concentrations and reporting limits to the ROD III cleanup levels for landfill vent emissions. The reporting limit for 1,1-dichloroethene slightly exceeded the cleanup level (5.2 ppbv compared to a cleanup level of 3.15 ppbv). For all other target VOCs, detected concentrations or reporting limits were below cleanup levels. Benzene was the only VOC detected, and the concentrations were well below the cleanup level. No dispersion modeling was conducted to estimate an ambient air concentration for benzene from the stack concentration.

MADEP plans to conduct stack testing again in 2005. During the planning for the testing, the possibility of obtaining lower reporting limits for 1,1-dichlorothene should be discussed with the laboratory. To evaluate compliance with Massachusetts Allowable Ambient Limits (AALs), a mathematical dispersion model may also be run that uses the stack testing results (should any compounds be detected) to estimate concentrations in ambient air. The ambient air concentration estimates would then be compared to the Massachusetts AALs.

Groundwater

Groundwater monitoring was most recently conducted in April 2001. EPA plans to re-establish a groundwater monitoring program in 2005, in conjunction with the surface water and sediment monitoring recommended in an EPA memorandum (Tyler, 2000; see Section 7.2.2).

SECTION 6.0
FIVE-YEAR REVIEW PROCESS

This section describes the activities performed during the five-year review process and provides a summary of findings.

6.1 COMMUNITY NOTIFICATION AND INVOLVEMENT

Community involvement was high leading up to the issuance of ROD III and thereafter during construction. Construction completion was attained in 1998. Since the last five-year review in 2000, no community concerns have been voiced to the EPA, and EPA and MADEP have not seen a need to hold formal community information sessions. EPA and MADEP held informal informational meetings up until 1999. Last summer, a citizen contacted EPA and expressed a desire to have another meeting. EPA indicated that follow up with this citizen will be made.

6.2 DOCUMENT REVIEW

This five-year review consisted of a review of relevant documents for the Site. See Attachment 2 for a list of documents that were reviewed.

6.3 DATA REVIEW

6.3.1 Groundwater Data Review

EPA RAC team contractor TRC reviewed groundwater analytical data collected during this five year review period and compared that data to historical data in order to evaluate whether the cleanup objectives of ROD III are being met. The review included analytical data for groundwater samples collected from Site monitoring wells in 1994, 1995, 1996, 1999, 2000, and 2001 and extraction wells WES-1, PW1-A, CDM-3, MH-2 and MH-4 in February 2002. Monitoring well locations are shown on Figure 3. Groundwater samples from Site monitoring wells have not been collected since April of 2001. Tables 2 and 3 summarize the volatile organic compounds (VOCs) and inorganic compounds detected in monitoring well samples that exceeded the Maximum Contaminant Levels (MCLs) in effect in 2001. In general the number of wells with VOC exceedances decreased between 1994 and 2001 while the number of wells with exceedances of inorganic compounds remained relatively constant. Arsenic was the most commonly detected inorganic compound from year to year that exceeded the MCL.

Table 2: Summary of VOC Exceedances						
Year	**Sampling Event**	**Total # of Wells with Exceedences**	**Extraction Area**	**# of Wells with Exceedences**	**List of Wells Sampled by Event**	**Analytes in Exceedance of Standards ***
1994	April	4	East	4	E&E FIT2	1
					GEI-F2	1
					JSB-1	1, 6
					MW-5	1
	November	8	East	5	E&E FIT2	1, 3, 4
					GEI-F2	1, 3
					GWC-2	4
					MW-5	1, 4
					MW-6	4
			Southwest	3	GWC-2	4
					MW-8	4
					MW-8A	4
1995	April	4	East	4	E&E FIT2	1, 3
					GEI-F2	1, 3
					JSB-1	3, 6
					MW-5	1
	October	4	East	4	CDM-4	3, 6
					E&E FIT2	1, 3
					GEI-F2	1, 3
					MW-5	1
1996	April	9	East	7	CDM-5B	4
					CDM-5S	1, 3, 4, 5
					E&E FIT2	1
					GEI-F2	1, 3
					JSB-1	4
					MW-5	1, 4
					MW-5A	4
			Southwest	2	BF-10	4
					SW-1	2
1999	April	2	East	2	CDM-5S	1
					GEI-F2	1, 3
	October	2	East	2	CDM-5S	1
					GEI-F2	1, 3
2000	April	3	East	3	CDM-5S	1
					GEI-F2	1,7
					GWC-1	1
	October	2	East	2	CDM-5S	1
					GEI-F2	3
2001	April	2	East	2	GEI-F2	1, 3, 7
					CDM-5S	1

Notes:

* List of Analytes:

1. Benzene
2. Chlorobenzene
3. 1,2-Dichloroethane
4. Methylene Chloride
5. 1,1,2-Trichloroethane
6. Trichloroethene
7. Vinyl Chloride

VOC - Volatile organic compounds

Table 3: Summary of Inorganic Exceedances						
Year	**Sampling Event**	**Total # of Wells with Exceedences**	**Extraction Area**	**# of Wells with Exceedences**	**List of Wells Sampled by Event**	**Analytes in Exceedance of Standards ***
1994	April	8	East	4	E&E FIT2	8
					GEI-F2	8
					MW-5	8
					MW-5A	8, 15
			Southwest	3	GEI-11	14
					MW-9	15
					MW-9A	8
			Upgradient	1	MW-1A	14
	November	5	East	4	E&E FIT2	8
					GEI-F2	8, 11
					MW-5	8
					MW-5A	8
			Southwest	1	MW-9A	8
1995	April	5	East	4	E&E FIT2	8
					GEI-F2	8
					MW-5	8
					MW-5A	8
			Southwest	1	MW-9A	8
	October	8	East	6	CDM-4	8, 10, 12, 13, 15
					E&E FIT2	8
					GEI-F2	8
					MW-5	8
					MW-5A	8
					MW-6	9, 13, 14
			Southwest	2	MW-9	15
					MW-9A	8
1996	April	8	East	5	CDM-5S	8
					E&E FIT2	8
					GEI-F2	8
					MW-5	8
					MW-5A	8
			Southwest	2	MW-9	15
					MW-9A	8
			Upgradient	1	MW-1A	15

Notes:

* List of Analytes:

8. Arsenic	12. Lead
9. Cadmium	13. Nickel
10. Chromium	14. Silver
11. Cyanide	15. Thallium

Table 3 (cont.): Summary of Inorganic Exceedances						
Year	**Sampling Event**	**Total # of Wells with Exceedences**	**Extraction Area**	**# of wells with Exceedences**	**List of Wells Sampled by Event**	**Analytes in Exceedance of Standards ***
1999	April	6	East	5	CDM-5S	8
					E&E FIT2	8
					GEI-F2	8
					MW-5	8, 15
					MW-5A	8
			Southwest	1	MW-9A	8
	October	6	East	5	CDM-5S	8
					E&E FIT2	8, 14
					GEI-F2	8
					MW-5	8
					MW-5A	8
			Southwest	1	MW-9A	8
2000	April	11	East	7	CDM-5S	8
					E&E FIT2	8
					GEI-F2	8, 15
					GWC-1	8, 10, 13
					JSB-1	15
					MW-5	8
					MW-5A	8, 14
			Southwest	2	MW-9	15
					MW-9A	8, 15
			Upgradient	2	MW-1	15
					MW-1A	15
	October	13	East	9	CDM-4	15
					CDM-5B	15
					CDM-5S	8, 15
					E&E FIT2	8, 15
					GEI-F2	8, 15
					GWC-1	8, 15
					JSB-1	15
					MW-5	8, 15
					MW-5A	8, 15
			Southwest	4	BF-11	15
					GEI-11	15
					MW-9	15
					MW-9A	8, 15
2001	April	7	East	5	MW-5	8, 15
					GEI-F2	8, 12
					MW-5A	8, 15
					E&E FIT2	8
					CDM-5S	8
			Southwest	2	MW-8A	8
					BF-10	11

Notes:

* List of Analytes:

8. Arsenic	12. Lead
9. Cadmium	13. Nickel
10. Chromium	14. Silver
11. Cyanide	15. Thallium

A statistical analysis was performed to evaluate groundwater concentration trends at select monitoring wells for select contaminants. Monitoring wells MW-5, GEI-F2, E&E FIT2, CDM-5S, JSB-1, MW-8, and MW-8A were selected because the locations are representative of key portions of the plume where MCLs had been exceeded in the past. Benzene was selected for analysis because of its common occurrence at concentrations that exceed the MCL. The VOC contaminants 1,4-dioxane and tetrahydrofuran (THF) appear to be representative of the groundwater plume due to their common occurrence at relatively high concentrations. Therefore, 1,4-dioxane and THF concentration trends were also evaluated, even though there are no MCLs established. The downgradient extent of the plume is also likely to be defined by the presence of 1,4-dioxane and THF because of their relatively high solubility and mobility in groundwater. Details of the statistical analyses are presented in Attachment 3. In summary, the statistical analyses show statistically significant decreasing trends in the following wells:

Statistically Significant
Decreasing Concentration Trends

Contaminant	Monitoring Well
Tetrahydrofuran	E&E FIT2 (OB)
Benzene	MW-5 (BR)
	GEI-F2 (BR)
	E&E FIT2 (OB)
	CDM–5S (OB)
1,4-Dioxane	GEI-F2 (BR)

Line plots of the THF, benzene, and 1,4-dioxane data (Figures 4, 5, and 6a, 6b, and 6c) show the following :

- A pronounced decrease in THF, 1,4-dioxane and benzene to significantly lower levels is evident starting in April 1996 within bedrock well GEI-F2 and overburden well E&E FIT2. A similar decrease is evident at downgradient overburden well CDM-5S to lower concentrations in April 1999. The decrease appears to be related to the start of the eastern groundwater extraction system in July of 1995.

- The overburden and bedrock wells evaluated exhibit a decreasing trend in benzene concentrations between 1994 and 2001. It appears that benzene concentrations may have already been decreasing in some wells prior to July 1995. The data suggests that the decreasing trend accelerated shortly after the start of the eastern extraction system in July 1995 to consistently low levels starting in April 1999.

- The trend in 1,4-dioxane concentrations in all wells examined is episodic (fluctuates over a wide range of concentrations) but exhibits a general decrease with time that is likely related to the overall effect of the remedy to minimize the generation and migration of leachate and landfill-related contaminants.

Concentrations of contaminants that exceeded MCLs in the April 2001 groundwater samples are presented in Table 4 along with corresponding concentrations of 1,4-dioxane and THF. The analytical results for the extraction well samples collected in February 2002 are also included in Table 4 for comparison. One or more contaminants exceeded the MCL in six (MW-5, MW-5A, CDM-5S, GEI-F2, E&E FIT2, and MW-8A) of the monitoring wells sampled in April 2001. Only arsenic exceeded the MCL in all of the six monitoring wells identified above. Exceedances of VOCs were limited to monitoring wells in the immediate vicinity of the landfill, indicating the lateral extent of the contaminant plume is adequately characterized by the current monitoring well network.

The monitoring wells are grouped in Table 4 with nearby or upgradient extraction wells for comparison purposes. Concentrations of benzene, 1,4-dioxane, and arsenic were slightly higher in the 2002 samples collected from the eastern groundwater extraction system wells as compared to the 2001 samples collected from nearby monitoring wells. This suggests that leachate continues to impact this area and contaminant concentrations may be increasing. Additional groundwater monitoring is scheduled for 2005 to evaluate current conditions and this potential impact. No contaminants were detected above MCLs in the samples collected from the Southwest Extraction Trench (MH-2 and MH-4), which suggests that the landfill cap and leachate collection system are effectively minimizing the generation and migration of leachate in that part of the Site.

Although cleanup criteria have not yet been attained, the analytical data available for review suggest that the remedy is functioning as intended in the ROD to reduce contaminant concentrations within the points of compliance, and minimize the off-site migration of groundwater contaminants. The points of compliance include the area from the upgradient landfill boundary to the extraction wells. The sharp decrease in contaminant concentrations noted in the monitoring wells on the east side of the Site (MW-5, GEI-F2, E&E FIT2, CDM-5S, and JSB-1) appears to be related to the start of the eastern groundwater extraction system in July of 1995. Analytical data collected to date suggest that contaminant concentrations in monitoring wells located hydraulically downgradient of the eastern groundwater extraction system are attenuating as hypothesized in the ROD. The gradual decrease in 1,4-dioxane concentrations in MW-8 and MW-8A may also be related to the southwest groundwater extraction and leachate collection systems, however, concentrations vary significantly over time suggesting either a seasonal effect or changes in the overall effectiveness of the groundwater/leachate extraction systems to minimize contaminant migration. Further groundwater monitoring is required to evaluate contaminant concentration trends and the effectiveness of the remedy.

Table 4
Groundwater Contaminants Exceeding MCLs (ug/L)
in Monitoring wells (April 2001) and Extraction Wells (February 2002)
Charles George Landfill
Tyngsborough, Massachusetts

	MCL	04/04/01	04/04/01	4/4/2001	04/04/01	02/07/02	04/04/01	2/7/2002	2/7/2002	4/4/2001	2/8/2002	2/8/2002
Parameter	**ug/L**	**MW-5**	**MW-5A**	**CDM-5S**	**GEI-F2**	**WES-1***	**E&E FIT2**	**PW-1A***	**CDM-3***	**MW-8A**	**MH-2***	**MH-4***
1,2-Dichloroethane	5	10 U	10 U	3 J	**6** J	2.3	10 U	1.1	0.5 U	1 J	0.5 U	0.5 U
1,4-Dioxane	NA	10 U	100 U	400	150	1100	100 U	1800	970	460	100	630
Benzene	5	1 J	10 U	**21**	**5** J	**54**	10 U	**93**	**14**	1 J	0.5 U	1.2
Tetrahydrofuran (THF)	NA	10 U	50 U	50 U	50 U	23	50 U	110	46	50 U	15	8.8
Vinyl Chloride	2	10 U	10 U	10 U	**4** J	0.5 U	10 U	**2.7**	1.2	10 U	0.5 U	0.5 U
Arsenic	50	**91.7**	**116**	**297**	**111**	**141**	**71.6**	**217**	**107**	**143**	15	17
Lead	15	2.5 U	2.5 U	2.5 U	**23.2**	NS	4.6	NS	NS	2.5 U	NS	NS
Thallium	2	**4.2**	**5.1**	3.6 U	3.6 U	9.3 U	3.6 U	9.3 U	9.3 U	3.6 U	9.3 U	9.3 U

Notes:
J = Estimated quantity.
U = Not detected above reporting limit.
NS = Not analyzed during this sampling round
NA = Not applicable/Not available
* = Extraction Well
Bold and Underline results denotes exceedance of criteria.

6.3.2 Groundwater Elevations

Analysis of 2001 groundwater elevations and contours for the Site continue to illustrate an overburden and shallow bedrock recharge area north of the Site, with radial flow to the southwest, south, and east. The predominant flow in overburden and shallow bedrock continues to be to the southwest and east. Contours in overburden and shallow bedrock reflect a localized influence due to the operation of the southwest and eastern extraction systems.

6.3.3 Flare System Operation Records

The March 2000 to December 2003 weekly inspection logs prepared by Clean Harbors were reviewed to evaluate flare O&M activities. Figure 7 is a plot showing the percentage of Site visits for which the flare was found to be operational during each semiannual or quarterly reporting period. Weekly flare inspection logs indicate that overall, the flare has had no major operational or maintenance problems, but has had more down time than operating time since the last Five Year Review.

As seen in Figure 7, the percentage of time the flare was operational appears to have decreased steadily over the past five years, from approximately 35% during the first quarter of 2000, to approximately 21% for the most recent Semi-Annual Status Report during the first half of 2004. Clean Harbors technicians reported that the flare typically runs between eight (8) and 24 hours per week. Their weekly observations have indicated that most of the time when the flare is off, it is a result of automatic shutdown due to a low temperature alarm in the stack. This information indicates that the flare temperature decreases after several hours or days of burning, regularly causing the flare to be extinguished. This likely occurs at a point when the levels of collected methane gas become too low to fuel the flare, and the levels of oxygen in the system are too high. However, the flare control system does not measure methane, so there is no real-time verification of low methane levels triggering the flare shutdowns. Clean Harbors technicians responsible for O&M of the flare indicated that intrusion of oxygen into the gas collection system has been an ongoing problem since the start up of the enclosed flare in April 1998. This apparent intrusion was also a problem during operation of the open flare system.

Methane concentrations at the flare are monitored and recorded at the flare sample port on a semiannual basis. Methane concentrations are also measured within the gas collection system at several landfill gas header sample ports, but also on a semiannual basis. However, it should be noted that the flare was not operating immediately prior to the majority of the semiannual flare sample port and landfill header port sampling events. Therefore, methane measurements are not likely representative of full-scale operating conditions and are likely biased high due to build-up of gas in the system while the flare is not burning. Flare sample port methane concentrations were, on average, around 50 percent.

Based on the above information, the frequent shutdown of the flare indicates that the landfill may not be generating enough methane to keep the flare running as currently configured and that there may likely be O_2 infiltration into the header system at the toe drain connection. However, as discussed below, based on landfill gas monitoring performed in soil gas probes located around the perimeter of the landfill, it appears that landfill gas is being contained within the gas collection system and is not apparently migrating beyond the landfill cap.

6.3.4 Soil Gas Probe Data

Soil gas measurements of oxygen, carbon dioxide, hydrogen sulfide, methane, and VOCs are recorded on a quarterly basis at twenty (20) soil gas probes located near the perimeter of the Site and at the boundary of a downgradient development (i.e., "Cannongate"). Probe locations are shown on the figure in Attachment 4. The monitored probes are located as follows: (a) seven probes at the fenceline to the north of the leachate collection pond and landfill; (b) six probes at the fenceline northwest of the landfill, across from a residence at the corner of Cummings and Dunstable Roads; (c) two probes south of the landfill along the fenceline near the southwest sedimentation basin; and (d) five probes southeast of the landfill along the northern edge of the Cannongate development. One of the probes near the Cannongate development (SG-CG-31) was recently destroyed; therefore, soil gas sampling is currently performed at 19 gas probe locations. Measurements were taken using a Landtech GA-90 hand held instrument.

Soil gas probe data sheets are used by Clean Harbors to record quarterly soil gas results. Clean Harbors noted in the checklists used for the flare system in October and December 2002 that the flare was started manually one day prior to the soil gas probe measurements to ensure the flare was operating during soil gas measurement events.

Between March 2000 and December 2003, methane concentrations were non-detect for all 20 probes in thirteen (13) out of seventeen (17) soil gas probe monitoring events. For the four events in which methane was detected at the soil gas probes, detected concentrations were 0.8% (less than 25% of the LEL) and below. Hydrogen sulfide concentrations and VOCs were non-detect, with the exception of two sample events (March 2002 and June 2002). VOCs were detected during these events at concentrations below 2.5 parts per million in up to five probes. Problems were occasionally noted by Clean Harbors with some of the probes during sampling, namely due to water intrusion (e.g., SG-7, and the probes near Cannongate) or low gas flows (e.g., SG-20, SG-22, and the wells near the west detention/sedimentation basin.

The landfill gas monitoring data from 2000 to 2005 does not appear to indicate any issues with migration of landfill gas beyond the limits of the cap. No explosive concentrations of methane have been detected over the last five years. Therefore, the landfill cap and gas collection system appear to be functioning properly to limit the migration of landfill gas.

6.3.5 Gas Vent/Landfill Gas Collection System Monitoring Data

Landfill gas is sampled quarterly by Clean Harbors in a network of 22 gas collection system header ports or former gas vents, and three former monitoring wells that were tied into the gas collection system. During the period from March 2000 to March 2005, methane concentrations measured in the gas collection system have been generally constant, ranging from 30 to 75 percent. The lowest overall methane concentrations were detected during the March 19, 2003 sample event, in which methane levels at many wells dropped an average of 40 to 45%. O&M records did not indicate a reason for this drop in methane levels. Clean Harbors began pressure testing and video testing of the gas collection system in the second half of 2003, shortly after this sample event. Methane levels measured subsequent to the pressure testing (i.e., in 2004 and 2005) were consistent with historic levels measured in the gas collection system.

Comparison of flare inspection dates with gas vent sampling dates indicates that the flare was not running at the start of any of the gas vent sampling events. A Clean Harbors technician noted that the flare was down upon arrival on each date, and then was manually started at the onset of gas vent sampling activities. Therefore, landfill gas concentrations at the time of sampling are not representative of full-scale operating conditions, and are likely artificially high due to build up of methane in the gas collection system while the flare is not running.

Clean Harbors technicians noted that oxygen intrusion into the gas collection system has been an ongoing problem and may be attributed to the configuration of the landfill gas vents, which are seated within the cover layer but do not fully penetrate the wastes. Pressure testing and video inspection of the system completed in 2003 did not identify any large leaks in the system that would account for the high levels of oxygen.

6.3.6 Southwest Groundwater Extraction Trench Data

The five extraction pumps and associated instrumentation of the southwest extraction trench system are inspected weekly by Clean Harbors. Clean Harbors reported that the southwest extraction trench has operated without major issues. Each week, one pump is removed for inspection and cleaning if necessary. Fouling of the pumps, especially Pump #3, was the most frequent maintenance problem noted. Fouled pumps are soaked overnight (or longer if needed) in a cleaning solution (e.g., acetic acid) to remove build up. Other occasional maintenance issues include normal wear on the pumps and level sensors, and freezing of the pump discharge lines, often rendering one or more pumps out of service through the winter months. Based on review of southwest extraction system inspection checklists, it appears that from March 2000 to mid 2002, the system operated with an average of two (2) out of five pumps running at most times. Inspection checklists from mid 2002 to 2005, however, show that the average number of operating pumps has been around four (4) at most times, indicating that maintenance activities have become more successful in maintaining efficient operation of the system.

Over the past five years, no major problems have been reported with operation and maintenance of the southwest extraction system. Infrequent mechanical and electrical issues with the pumps and vaults are addressed in a timely manner. Weekly maintenance activities appear adequate to keep the systems operating.

6.3.7 Landfill Maintenance Inspections

A Semi-annual landfill security and maintenance inspection is performed twice per year, usually in June and December. According to MADEP maintenance records, the landfill cap is mowed twice per year (spring and fall). A commercial herbicide (i.e., “Roundup” or similar weed control product) is applied to the rock cover portions of the cap and detention basins once per year. MADEP and Clean Harbors reported that the herbicide program has been successful in limiting woody vegetative growth in the stone, rip rap and drainage areas, which was a recurring issue in the past, as noted in the previous Five Year Review.

Occasional repairs are made to the fence and gates surrounding the landfill as a result of fallen trees or vandalism, and missing warning signs are regularly replaced. MADEP reported that in the winter of 2004, repairs were made to the fence along Cummings Road as a result of damage from a vehicle slipping off the roadway. Overall, Clean Harbors reported few problems with the Site security fence or the warning signs posted along it in their weekly inspections from 2000 to 2005. Potholes and ruts are regularly observed and repaired on the perimeter roadway around the landfill. Some areas of potholes and possible wash-out were recently noted and may require repair in the spring of 2005 after the snow melt.

Other current maintenance issues include potential settlement of the overflow pipe in the West Detention and Sedimentation basin. The intake of this 18" diameter vertical standpipe is less than one foot from the bottom of the basin, and was currently iced-over on the northern half of the pipe. Clean Harbors planned to review as-built drawings for this drain pipe to determine the amount of settlement, if any, and identify repair options. Another issue with the West Detention and Sedimentation basin is an apparent loss of grade at Dunstable Road that caused sedimentation in the vicinity of the basin outfall and flooding of the basin out onto Dunstable Road. MADEP personnel reported that sediments in the ditch would need to be cleaned out in 2005 from the sedimentation basin outfall to the berm at Dunstable Road.

6.3.8 East and West Pump Stations (Army Corps of Engineers)

Army Corps personnel reported that the East Pump Station has been functioning as intended with no major maintenance issues over the past five years. However, one of the three pumps has been inoperable for over a year. To prevent iron biofouling in the discharge lines, a biocide (Redux B-T20®) and a 50% citric acid solution are added to the pump station discharge using an automated chemical feed system. Sampling of pump station influent or effluent is not performed.

According to Army Corps personnel, the West Pump Station has generally been without major maintenance issues over the past five years. In 2004, a repair was made to a leaking section of HDPE pipe coming from the West Pump Station wet well where it daylights into the pump station building. The leaking section was removed and spliced with a new piece of HDPE pipe. However, Army Corps personnel reported that the new section of pipe is leaking and that a more permanent repair would need to be made in 2005. Therefore, the pumps in the southwest groundwater extraction trench and the West Pump Station were shut down at the time of the March 17, 2005 Five Year Review inspection. Sampling of pump station influent or effluent is not required and was not performed.

Occasional leachate odor is reported at the West Pump Station. Army Corps personnel also reported that the pipes connecting the pump stations to the Effluent Monitoring Station are occasionally cleaned to remove iron buildup if the pressure in the force mains is high.

6.3.9 Effluent Monitoring Station

The Effluent Monitoring Station is inspected on a weekly basis. Sampling and testing of monitoring station discharge has been performed on a quarterly basis for the past year (2004), per the requirements of the existing Industrial Sewer discharge permit. Prior to 2004, sampling was performed monthly.

Based on a review of some of the maintenance records, the Effluent Monitoring Station appears to be in appropriate working order and has been operating without major maintenance issues over the past five years.

Monthly discharge rates for the Effluent Monitoring Station from 2000 to 2004, as summarized by the Army Corps, are plotted in Figure 8. As shown in Figure 8, the flow data does not indicate any significant changes in flow over this period, with the exception of regular seasonal fluctuations. The monthly discharge volume was typically between 600,000 and 1,000,000 gallons. The Industrial Sewer Discharge permit allows for a discharge flow of up to 86,400 gallons per day, or approximately 2,500,000 gallons per month. Thus, monthly discharge volumes are well below the limit allowed under the permit.

Sampling (grab samples) and analysis of the Effluent Monitoring Station discharge for Total Toxic Organics (TTO) has been performed since January 2000 on a monthly or quarterly schedule by the Army Corps in accordance with the requirements of the Industrial Sewer Discharge permit. TTO is a measurement of the total concentration of organic compounds considered toxic including 1,4-dioxane, acetone, and tetrahydrofuran. The TTO data shows some seasonal fluctuation with apparent peak concentrations often occurring in the winter and early spring months (i.e., December through April; see Figure 9). The data also shows that peak concentrations in 2002-2005 decreased from those measured during 2000-2001. The drop in peak TTO concentrations may be due to source reduction (landfill cap) and continued operation of the groundwater collection system.

6.4 SITE INSPECTION

An inspection of the Site was performed on March 17, 2005. Interview forms, photos, and the site inspection checklist are attached (Attachment 5). The following personnel were in attendance:

Name	Title and Affiliation
Elaine Stanley	RPM, EPA Region I
Barbara Weir	Project Manager, Metcalf and Eddy
Greg Mischel	Project Manager, TRC
Amy Stattel	Project Engineer, TRC
David Buckley	Project Manager, MADEP
David O'Connor	Project Engineer, Army Corps of Engineers
Jason Bierly	Remediation Eng., Clean Harbors (O&M Contractor to MADEP)
Douglas Murphy	O&M Technician, Clean Harbors (O&M Contractor to MADEP)
Jeff McCullough	Sr. Project Manager, Nobis Engineering, Inc. (O&M Contractor to ACOE)
Marc Bouvier	Project Scientist, Nobis Engineering, Inc. (O&M Contractor to ACOE)

Due to deep snow cover, the Site inspection consisted of a landfill cap reconnaissance based on limited observations from the perimeter access road and visual inspections of the above ground portions of the groundwater/leachate collection systems, and the landfill gas flare.

6.4.1 Landfill Cap

The landfill cap was inaccessible, and for the most part not visible, due to the snow cover. According to the O&M contractors in attendance during the inspection, the surface of the landfill cap is in good condition with no significant erosion, differential settlement, problems with vegetation growth, or evidence of slumping. Woody vegetation growth noted during the second five-year review is now controlled by applying an herbicide to the landfill side slopes covered by stone. The cap is mowed twice each year to control the growth of woody vegetation on the vegetated portions of the cap. The O&M contractors have observed animal burrows in the cap, particularly near the gas vent structures. There is currently no animal control program in place.

6.4.2 Drainage Structures and Sedimentation Basins

Snow cover prevented the inspection of the surfaces of the drainage structures and sedimentation basins. Woody vegetation, however, was observed in the off-cap sedimentation basins. The presence of woody vegetation and tree growth, if allowed to continue, could restrict access to the structures for maintenance and compromise the integrity of the basin sideslopes. The O&M contractor noted that the erosion had undermined the East Sedimentation Basin outlet structure (i.e. riser pipe and concrete foundation) causing water to bypass the riser pipe. The MADEP has tasked the O&M contractor with evaluating the extent of the damage and providing a cost estimate for repair in the near future. The top of the riser pipe of the Southwest Sedimentation basin discharge structure was observed to be only approximately two feet above the floor of the basin. It was speculated that the outlet structure may have settled. The O&M contractor will consult the as-built drawings and investigate if the drawings differ significantly from the current configuration. The Southwest Sedimentation Basin outlet structure will be repaired, if needed, in the near future.

According to the O&M contractor, excessive sediment has built up in the drainage swale along Dunstable Road from the West Sedimentation Basin to the concrete culvert near the West Pump Station Building. The sediment has reduced the flow capacity of the swale and the swale reportedly overflows periodically during rain storm events. The MADEP intends to have the sediments removed by the O&M contractor.

6.4.3 Leachate and Groundwater Collection Systems

The above ground portions of the leachate and groundwater collection systems were inspected including the extraction well vaults, the East Pump Station Building, the West Pump Station Building, the Operation and Maintenance Building and the Effluent Monitoring Station. In general the facilities appeared to be in good condition and in working order with the exception of the West Pump Station. At the time of the inspection, the Southwest Extraction Trench system had been deactivated due to a leaking HDPE pipe in the West Pump Station Building. The O&M contractor was evaluating options for repair during the Site inspection.

6.4.4 Landfill Gas Flare

The landfill gas flare building, equipment and controls appeared to be in good condition and in working order. The flare was not operating at the start of the inspection however. The control system data indicated that the flare had shut down due to low flare temperature and high oxygen content of the landfill gas. According to the O&M contractor, the flare is often found to be in this condition and restarted during weekly Site visits. The source of the oxygen is unknown at this time. Pressure testing of the accessible gas piping system in 2003 found no leaks. A small section of pipe immediately before the flare blower was unable to hold more than 9 psi of pressure. A condensate drain from the gas header pipe to the leachate collection system was implicated as a possible source of the leak/air intrusion. Another possibility is that the capacity of the blower exceeds the current gas generation rate of the landfill and the system is drawing air from the edges of the landfill cap. The flow rate of the system can not be lowered any further because the variable speed drive for the blower is currently at the lowest setting.

There is no data to suggest that the landfill gas system is not protective at this time. Only minor, infrequent odors have been detected by O&M personnel on the south side of the landfill, and concentrations of methane have been below 25% of the LEL at the gas probes currently being monitored. Since new office buildings have recently been constructed adjacent to the landfill, an evaluation of the current soil gas monitoring program is recommended to verify that the extent of landfill gas is fully characterized, especially to the north of the landfill.

6.4.5 Follow-Up Inspection

A follow-up inspection was performed on June 3, 2005 to inspect the portions of the landfill that were covered by snow during the March 17, 2005 inspection. The findings of the June 3, 2005 inspection are summarized below:

- Landfill Surface – The landfill surface was generally in good condition with no obvious signs of erosion, cracks, or holes. The vegetative cover, where present, was also in good condition. Several saplings were observed at the east end of the landfill. Only one was alive at the time of the inspection. The O&M contractor has been using a herbicide to control woody vegetation and it has been effective.

- An area of differential settlement was observed at the top of the landfill at the eastern end, at the end of the upper-most access road. The area of settlement was approximately 50 feet in diameter and one foot in depth. Water did not appear to be accumulating in the depression. There is no indication that there is any cap damage at this time.

- Perimeter ditches and off-site discharge – The perimeter ditches appeared to be in good condition with the exception of minor sedimentation and vegetative growth.

- Landfill access roads – The gravel roads on the landfill cap were generally in good condition.

6.5 INTERVIEWS

In accordance with the EPA guidance for five-year reviews (USEPA, 2001), several personnel involved with the operation and maintenance of the Site were interviewed. Telephone interviews were conducted with Joan Ferarri, Health Administrator for the Tyngsborough Board of Health on March 10, 2005, and Alan Curseaden, Superintendent of the Tyngsborough Sewer Commission on March 11, 2005. On-site interviews with the O&M personnel took place on March 17, 2005. The interview forms are attached (Attachment 5). Key points of discussion are provided below.

Interview with Ms. Ferrari:

- Ms. Ferrari was asked about the potential for someone to have installed a drinking water well in the vicinity of the Site. According to Ms. Ferrari, residents in the vicinity of the Site can not install a drinking water well without a permit from the Town. The Town is not granting permits if there is access to the public water line, and there is good coverage of the area around the Site with the water line for Tyngsborough. The water line does not extend into Dunstable. The Town did permit the installation of a well for irrigation purposes at the industrial park located to the north of the Site at 31 Progress Avenue. The irrigation well was installed on August 1, 2002.

- Ms. Ferrari noticed orange staining on Dunstable Road in front of the West Pump Station this past winter. The staining appeared to be caused by water from the Site.

- Ms. Ferrari does not believe that there is any additional evidence of visible contamination (i.e. leachate) on the west side of the Site near Route 3.

Interview with Mr. Curseaden:

- Odors have been noticed coming from the wet well at the Cummings Road Pump Station.

- Iron bacteria growth has been observed on the walls of the Cummings Road Pump Station wet well. Mr. Curseaden was concerned that the iron bacteria may also be growing in, and clogging the sewer pipe downstream.

- Seeps near the West Pump Station on Dunstable Road sometimes flow over the road. (Note: this problem was also discussed during the site inspection and is scheduled for correction - see Section 6.4.2).

Interview with O&M Contractors:

- According to the O&M Contractors the Site is in good condition and only routine maintenance is required to operate the components of the remedy.

- Current maintenance issues are discussed in detail in Section 6.4 of this report.

- The landfill cap appears to be in good condition with no signs of slumping, erosion or differential settlement.

- Site security has been maintained to prevent public access to the Site with only two minor instances of unauthorized entry. The instances included a breach of the fence by unknown persons, and a single instance of several adolescents removing the fence to gain access with an all-terrain vehicle. The fence was repaired and the gate was modified to prevent removal.

SECTION 7.0
TECHNICAL ASSESSMENT

This section discusses the technical assessment of the remedy and provides answers to the three questions posed in the EPA guidance for five-year reviews (USEPA, 2001).

7.1 QUESTION A: IS THE REMEDY FUNCTIONING AS INTENDED BY THE DECISION DOCUMENTS?

The review of documents, ARARs, and risk assumptions indicates that the remedy was constructed and is being operated in accordance with the RODs and ESDs, and is currently protective. Additional surface water and sediment sampling and re-evaluation of ecological risks was recommended by EPA (Tyler, 2000) to reduce uncertainty regarding possible ecological impacts to water bodies in the vicinity of the Site (see Section 7.2.2).

7.2 QUESTION B: ARE THE EXPOSURE ASSUMPTIONS, TOXICITY DATA, CLEANUP LEVELS, AND REMEDIAL ACTION OBJECTIVES (RAOs) USED AT THE TIME OF REMEDY SELECTION STILL VALID?

7.2.1 Review of Human Health Risk Assessments and Toxicity Factors Serving as the Basis for the Remedy

Risk Assessment Review

The 1988 risk assessment (Ebasco, 1988) focused on the evaluation of future off-site risks and hazards to human receptors after the placement of the synthetic cap over the landfill. Direct contact exposures at the landfill surface were not evaluated but presumed to result in hazard and risk in excess of EPA risk management criteria. Exposure pathways quantitatively evaluated in 1988 included ingestion of groundwater by area residents, incidental ingestion and dermal contact with surface water and dermal contact with sediment in impacted surface water bodies (e.g., Flint Pond), the ingestion of fish from Flint Pond, and the inhalation of airborne contaminants emanating from the landfill.

The risk assessment (Ebasco, 1988) estimated human health risks and hazards that exceed EPA risk management criteria from the following exposures:

- Groundwater via ingestion during domestic use
- Airborne emissions from the venting system via inhalation of ambient air
- Sediments in Dunstable Brook via dermal exposure to carcinogenic PAHs

In 1998, sediments in Dunstable Brook were sampled and analyzed for PAHs and the human health risk and hazard from contact with the sediments (ingestion and dermal contact for a residential scenario) was reassessed. This reassessment was done because of changes in toxicity information and risk assessment practice that had occurred since the 1988 risk assessment was performed. Also, the 1998 sediment results had showed decreased concentrations relative to the data used to support the third ROD. The 1998 reassessment concluded that the risk and hazard from ingestion and dermal contact exposure to Dunstable Brook sediments met EPA's risk management criteria, and that no further remedial action was necessary.

In this five-year review, exposures to contaminants in groundwater, ambient air, and sediment are qualitatively reassessed to determine potential impacts to remedy protectiveness. The reassessment consists of a review of toxicity information that served as the basis for conclusions regarding compliance with EPA risk management criteria, and a review of exposure pathways and exposure assumptions applicable to the Site. As appropriate, medium-specific concentrations detected during recent sampling events have been compared to pathway-specific risk-based criteria to further evaluate remedy protectiveness.

Changes in Toxicity

Table 5 presents a summary of the changes in toxicity values (oral reference doses and oral cancer slope factors) for compounds selected as Contaminants of Potential Concern (COPCs) as identified in the 1988 risk assessment. Updated toxicity information was obtained from the *Integrated Risk Information System* (IRIS; USEPA, 2005) and other current EPA sources (e.g., the Superfund Technical Support Center). Toxicity values for sediment contaminants evaluated in the 1998 risk evaluation have also been listed.

For some contaminants, changes in toxicity values (reference doses and oral slope factors) between 1988 and 2005 have been minimal. In general, toxicity values used in the 1988 risk assessment were more conservative than toxicity values recommended for use in 2005. Changes in toxicity values to more conservative values for some groundwater COPCs (e.g., benzene, trichloroethene, and vinyl chloride) would not affect remedy protectiveness since cleanup levels for groundwater are based on federal Maximum Contaminant Levels (MCLs). The only change between 1998 and 2005 toxicity values used in the sediment re-assessment is for arsenic. The oral slope factor for arsenic has been decreased slightly since 1998 which results in a decrease in the estimation of cancer risk associated with arsenic in residual sediment. Therefore, the conclusions of the 1998 risk evaluation, based on toxicity values, remain valid.

Institutional controls for groundwater should be implemented until groundwater cleanup levels are achieved, as demonstrated by a groundwater monitoring program. Fencing and cap integrity should also be maintained to minimize on-site exposures which have not been quantitatively estimated but presumed to be associated with risks and hazards above EPA risk management guidelines.

TABLE 5. COMPARISON OF 1988 AND 2005 ORAL REFERENCE DOSES AND ORAL CANCER SLOPE FACTORS FOR COMPOUNDS OF POTENTIAL CONCERN

Contaminant of Potential Concern	Oral Reference Dose (RfD) (mg/kg-day)		Oral Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$	
	1988	2005	1988	2005
2-Butanone	0.05	0.6	N/A	N/A
Benzoic Acid	N/A	4	N/A	N/A
Di-n-butylphthalate	0.1	0.1	N/A	N/A
4-Methylphenol	N/A	0.005	N/A	N/A
trans-1,2-Dichloroethene	N/A	0.02	N/A	N/A
Toluene	0.29	0.2	N/A	N/A
Arsenic (a)	N/A	0.0003	1.5	1.5
Benzene	N/A	0.004	0.052	0.055
Cadmium (food)	0.00029	0.001	N/A	N/A
Cadmium (water)	0.00029	0.0005	N/A	N/A
Chromium	0.005	0.003	N/A	N/A
Mercury	0.002	0.0003	N/A	N/A
Benzo(a)anthracene (b)	N/A	N/A	11.5	0.73
Chrysene (b)	N/A	N/A	11.5	0.0073
Benzo(b)fluoranthene (b)	N/A	N/A	11.5	0.73
Benzo(a)pyrene (b)	N/A	N/A	11.5	7.3
Indeno(1,2,3-cd)pyrene (b)	N/A	N/A	11.5	0.73
Dibenz(a,h)anthracene (b)	N/A	N/A	11.5	7.3
Trichloroethene	N/A	0.0003	0.011	0.4
bis(2-Ethylhexyl)phthalate	0.02	0.02	0.00068	0.014
Methylene chloride	N/A	0.06	0.0143	0.0075
1,2-Dichloroethane	N/A	0.02	0.035	0.091
Chloroform	N/A	0.01	0.081	N/A
1,1-Dichloroethene	N/A	0.05	1.16	N/A
1,1,2,2-Tetrachloroethane	N/A	N/A	0.2	0.2
Vinyl chloride	N/A	0.003	0.025	1.5
Carbon tetrachloride	N/A	0.0007	0.13	0.13
1,1,2-Trichloroethane	N/A	0.004	0.0573	0.057
Tetrachloroethene	N/A	0.01	0.0017	0.54
Chlorobenzene	0.0057	0.02	N/A	N/A
Xylenes	0.2	0.2	N/A	N/A
Bromomethane	0.0004	0.0014	N/A	N/A
Bromoform	0.02	0.02	N/A	0.0079
Carbon disulfide	0.1	0.1	N/A	N/A

N/A = Not Applicable or Not Available

(a) Arsenic oral slope factor used in 1998 sediment re-assessment was 1.75 $(mg/kg\text{-}day)^{-1}$.

(b) Oral slope factor (2005) for this compound is the same as that used for the 1998 re-sediment assessment.

Changes in Exposure Pathways/Assumptions

One pathway of potential concern that was not evaluated in the 1988 risk assessment was the vapor intrusion pathway. This pathway may be of concern at sites where shallow groundwater contaminated with VOCs exists in close proximity to occupied buildings. There are structures on Site for operation and maintenance of the remedy, and there are several residences downgradient of the Site. It was considered possible that volatile contaminants in shallow groundwater migrating from the Site could be impacting indoor air quality in nearby buildings. Therefore, April 2001 VOC data collected from monitoring wells across the Site (TRC, 2001) were evaluated for the vapor intrusion pathway. Detected concentrations were tabulated and compared to screening levels provided in Tables 2a, 2b, and 2c of the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA, 2001). The screening levels provided correspond to a 10^{-4}, 10^{-5}, or 10^{-6} cancer risk and/or a hazard quotient of 0.1. The results are presented in Table 6. Note that 1,4-dioxane is listed in the table because it was detected in the VOC analysis used. However, exposure to this compound is not a concern via the vapor intrusion pathway because of its relatively low volatility, with a Henry's Law constant of less than 1 x 10^{-5} atm m^3/mol.

There were no reported exceedances of the screening levels for the 10^{-4} risk level (Table 2a of the guidance). For TCE and 1,2-dichloropropane, the Contract Required Detection Limit (CRDL) of 10 ug/L is greater than the screening level. At one location (GEI-F2), concentrations of TCE and 1,2-dichloropropane were reported as estimated (J) below the CRDL. The estimated concentrations were below the screening levels of both TCE (5.3 ug/L) and 1,2-dichloropropane (3.5 ug/L). The sample from GEI-F2 exceeded the screening levels for 1,2-dichloroethane at the 10^{-6} risk level (6 ug/l in comparison to 5 ug/L), and vinyl chloride at the 10^{-5} and 10^{-6} levels (4 ug/L compared to 2.5 and 2.0 ug/L). This well is located near the eastern extraction wells just west of Route 3, and there are no occupied structures within 100 feet of this well. Therefore, the vapor intrusion pathway is considered incomplete and exposures to residents and Site workers via indoor air are likely to be negligible.

Evaluation methods and exposure assumptions applicable to the ambient air pathway have changed significantly since 1988. This pathway is currently evaluated using inhalation toxicity values rather than oral toxicity values, as done in 1988. A qualitative comparison of ambient air levels estimated in the 1988 risk assessment to risk-based ambient air preliminary remediation goals (PRGs) established by EPA Region 9 confirms the conclusions of the 1988 risk assessment (i.e., the ambient air pathway was associated with risks and hazards above EPA risk management guidelines). However, it is anticipated that current ambient air levels are less than those estimated in 1988 based on the installation, operation, and maintenance of the landfill gas collection system. Enclosed flare stack testing is scheduled by MADEP in 2005. The analytical results obtained during this testing should be evaluated to confirm that the remedy remains protective relative to the ambient air pathway.

Table 6: VOCs Detected in Groundwater (April 2001) Compared to Vapor Intrusion Screening Levels (ug/L)

	Vapor Intrusion Screening Levels (EPA, 2001 - Tables 2a, 2b, and 2c)			Southwest Extraction Area				East Extraction Area								
				Bedrock	Bedrock	Overburden	Overburden	Bedrock	Bedrock	Bedrock	Bedrock	Bedrock	Overburden	Overburden	Overburden	Overburden
	10^{-6}	10^{-5}	10^{-4}	04/04/01	04/04/01	4/4/2001	04/04/01	04/04/01	04/04/01	04/04/01	04/04/01	04/04/01	04/04/01	04/04/01	04/04/01	04/04/01
Parameter	risk level	risk level	risk level	**MW-8**	**GEI-10**	**MW-8A**	**BF-10**	**MW-5**	**MW-5 DUP**	**GEI-F2**	**JSB-1**	**CDM-5B**	**MW-5A**	**E&EFIT2**	**CDM-4**	**CDM-5S**
1,1-Dichloroethane	220	220	220	10 U	10 U	10 U	10 U	10 U	**1** J	**12**	10 U	**7** J	10 U	10 U	10 U	**3** J
1,2-Dichloroethane	5.0*	23	230	10 U	**2** J	**1** J	10 U	10 U	**1** J	**6** J	**2** J	**4** J	10 U	10 U	10 U	**3** J
1,2-Dichloropropane	3.5	3.5	3.5	10 U	10 U	10 U	10 U	10 U	10 U	**2** J	10 U	10 U	10 U	10 U	10 U	10 U
1,4-Dioxane	NA	NA	NA	**310**	100 U	**460**	100 U	10 U	10 U	**150**	100 U	100 U	100 U	100 U	100 U	**400**
Acetone	22,000	22,000	22,000	10 U	10 U	**3** J	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	**7** J
Benzene	5.0*	14	140	10 U	10 U	**1** J	10 U	**1** J	**1** J	**5** J	10 U	10 U	10 U	10 U	10 U	**21**
Chlorobenzene	39	39	39	10 U	10 U	**1** J	10 U	**6** J	**6** J	**5** J	10 U	**4** J	**2** J	**22**	10 U	**13**
Chloroethane	2,800	2,800	2,800	10 U	10 U	10 U	10 U	10 U	10 U	**17**	**4** J	**16**	10 U	**2** J	10 U	**19**
Methylene Chloride	58	580	5,800	10 U	10 U	10 U	10 U	10 U	10 U	**2** J	10 U	**2** J	10 U	10 U	10 U	10 U
Trichloroethene**	5.0*	5.0*	5.3	10 U	10 U	10 U	10 U	10 U	10 U	**2** J	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	2.0*	2.5	25	10 U	10 U	10 U	10 U	10 U	10 U	**4** J	10 U	10 U	10 U	10 U	10 U	10 U

Notes:

Bold and Underline results denotes detection
J = Estimated quantity.
U = Not detected above reporting limit.
NA = Not applicable. 1,4-Dioxane is not sufficiently volatile per EPA, 2001 because its Henry's Law constant is less than 1×10^{-5} atm m^3/mol.
Screening values for noncarcinogens adjusted to a hazard quotient of 0.1.

Notes from EPA Vapor Intrusion Guidance Screening Tables 2a, 2b, and 2c:

* The target groundwater concentration is the MCL.

** The target concentration for Trichloroethene (TCE) is based on the upper bound cancer slope factor identified in USEPA's draft risk assessment for TCE (EPA, 2001). The slope factor is based on state-of-the -art methodology, however the TCE assessment is still undergoing review. As a result, the slope factor and the target concentration values for TCE may be revised further.

Exposure assumptions used during the 1988 risk assessment for the groundwater ingestion pathway are consistent with or more conservative than values provided in the current EPA 1997 *Exposure Factors Handbook*. This is also true for the 1998 exposure assumptions used to evaluate the sediment exposure pathways. Additional pathways not evaluated in the 1988 risk assessment include dermal contact with and inhalation of groundwater contaminants during household water use (e.g., bathing and showering). However, as long as impacted groundwater is not used for household purposes (including ingestion), remedy protectiveness will be maintained. It should also be noted that the use of groundwater for non-potable purposes has not been quantitatively evaluated. An irrigation well has been installed to the north of the Site at 31 Progress Avenue. Because the groundwater flow direction at the Site is to the southwest, south, and east, it is unlikely that groundwater in the vicinity of this well is impacted by the Site. However, further non-potable private well installation within the vicinity of the Site should be restricted unless site-specific risk assessment indicates that the non-potable exposure pathways anticipated will not result in risks and hazards above EPA risk management criteria.

Summary and Conclusions

Toxicity information that served as the basis for conclusions regarding compliance with EPA risk management criteria have been re-evaluated to determine whether any changes in toxicity impact the protectiveness of the remedy along with any changes in exposure pathways or exposure assumptions. In addition, environmental data, available since the last five year review, have been qualitatively evaluated to determine whether exposure levels existing at the Site present a risk to current human receptors.

Based on the evaluation of changes in toxicity values, the decrease in the cancer toxicity value for arsenic results in a decrease in the estimation of cancer risk associated with arsenic in residual sediments. Exposure assumptions used to evaluate sediment risk and hazard in 1998 are consistent with or more conservative than current assumptions. Therefore, the conclusions of the 1998 risk evaluation for sediment remain valid.

Fencing and cap integrity should be maintained to minimize on-site direct contact soil exposures which have not been quantitatively estimated but presumed to be associated with risks and hazards above EPA risk management guidelines.

One pathway of potential concern that was not evaluated in the 1988 risk assessment was the vapor intrusion pathway. April 2001 VOC data collected from monitoring wells across the Site (TRC, 2001) were evaluated for the vapor intrusion pathway by a comparison to screening levels provided in the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA, 2001). The sample from GEI-F2 exceeded the screening levels for 1,2-dichloroethane and vinyl chloride. Because there are no occupied structures within 100 feet of this well, the vapor intrusion pathway is considered incomplete and exposures to residents and Site workers via indoor air are likely to be negligible.

For the ambient air pathway, a qualitative comparison of 1988 ambient air concentrations to Region 9 risk-based PRGs confirms the results of the 1988 risk assessment. It is anticipated that current ambient air levels are significantly less than those estimated in 1988 based on the installation, operation, and maintenance of the landfill gas collection system. However, analytical results obtained during 2005 stack testing should be evaluated to confirm that the remedy remains protective relative to the ambient air pathway.

Continued exceedances of MCLs indicate that completion of the drinking water ingestion pathway would present a risk to human receptors. Since groundwater from the Site is not currently used by area residents as a source of potable water, the drinking water exposure pathway is incomplete. Institutional controls preventing potable groundwater use should be implemented until groundwater cleanup levels (i.e., federal MCLs) are achieved, as demonstrated by a groundwater monitoring program. Non-potable private well installation within the vicinity of the Site should also be restricted unless site-specific risk assessment indicates that the non-potable exposure pathways anticipated will not result in risks and hazards above EPA risk management criteria. The implementation of comprehensive institutional controls, when complete, will provide long-term protectiveness for the Site remedy.

7.2.2 Review of Ecological Risk Assessments and Toxicity Factors Serving as the Basis for the Remedy

An ecological risk review for the Site was performed in 2000 by Lockheed Martin's Environmental Services Assistance Team (ESAT), as documented in a memorandum from the EPA's Office of Ecosystem Assessment (memorandum from Patti Lynne Tyler, Aquatic Biologist/Ecological Risk Assessor to Elaine Stanley, Remedial Project Manager, dated June 5, 2000). The review was initiated to summarize available data through 1999 and serve as a starting point for additional sampling and risk evaluation that EPA plans to perform for Dunstable Brook, Flint Pond, Flint Pond Marsh, and Bridge Meadow Brook.

The overall summary and conclusions from the ESAT report were as follows (quoted from ESAT, 2000):

> *The surface water of Flint Pond, Flint Pond Marsh, and Dunstable Brook had benchmark exceedances only for metals in 1999. These exceedances included overlaps in barium, copper, and manganese at all three sites, and individual exceedances for aluminum and iron at Flint Pond Marsh and Dunstable Brook. However, many of these exceedances also occurred in the upgradient background sample of Dunstable Brook, including aluminum, manganese, copper, and barium.*
>
> *Sediment samples from Flint Pond and Flint Pond Marsh showed a few less benchmark exceedances in 1999 compared to 1993, but as of 1999, 10 and 8 COPCs were still evident in these water bodies. Dunstable Brook showed less sediment contamination with only 3 COPCs, but it was not sampled in 1999 for recent comparison. The upgradient site on Dunstable Brook revealed extremely high levels of acetone in 1993 sediment samples, but no other organics were found above benchmarks. This site also showed the highest sediment concentrations of manganese, suggesting a source above the landfill for this and other metals. Bridge Meadow Brook showed only one COPC in sediments, but it was the farthest water body from the landfill and is diluted by the waters of Dunstable Brook.*
>
> *Toxicity tests run with 1993 sediment samples on* Hyallela azteca *and* Chironomus tentans *showed significant decreases in the survival rates of both species (but not growth) when tested from Dunstable Brook and an unnamed tributary compared with the upstream background sample.*

Fish tissue analysis for metals did not yield substantial increases in tissue levels in Flint Pond compared to a reference pond (Locust Pond).

Further monitoring of risk to fish and wildlife species is warranted since many of the benchmarks for surface water and sediment are still exceeded in recent 1999 samples.

Based on the ESAT report, the memorandum by P. Tyler concluded that "the presence of several COPCs in recent surface water and sediment indicates some remaining potential risk to benthic invertebrates, fish and wildlife and suggests a continued monitoring of surface waters and sediments at Dunstable Brook, Flint Pond and Flint Pond Marsh until there is greater confidence in evaluating the surface water and sediment concentrations associated with these areas." The memorandum went on to recommend surface water sampling for inorganics only, and sediment sampling for a full suite of analytes: VOCs, SVOCs, pesticides, PCBs, inorganics, total organic carbon, and Acid Volatile Sulfides-Simultaneously Extracted Metals (AVS-SEM). It was recommended that a background location be identified upstream of the landfill, and samples collected and analyzed to provide a comparison with locations potentially impacted by the landfill. It was suggested that additional toxicity testing might be needed in Flint Pond and Flint Pond Marsh, and that fish tissue analysis might also ultimately be indicated.

The activities recommended in the memorandum are being pursued by EPA with plans to perform additional sediment and surface water sampling in 2005. Although it is considered unlikely that there is an ongoing ecological impact of the capped landfill on water bodies in the vicinity, past impacts (prior to landfill capping and installation of the groundwater extraction and leachate collection systems) have not been conclusively ruled out.

7.2.3 ARARs Review

Review of Applicable or Relevant and Appropriate Requirements was performed to check the impact on the remedy due to changes in standards that were identified as ARARs in the three RODs and in the previous Five-Year Review Reports (1995, 2000), newly promulgated standards for chemicals of potential concern, and TBCs (to be considered) that may affect the protectiveness of the remedy. The results of the 2000 ARARs review, which was conducted consistent with the most recent five-year review guidance (USEPA, 2001), were used as a basis for this review. The tables in Attachment 6 provide the ARARs review. The review includes a determination of whether the regulation is currently ARAR or TBC and whether the requirements have been met. Most of the listed ARARs remain applicable or relevant and appropriate to the Site. Some of the listed ARARs address groundwater treatment and discharge to surface water, and these ARARs are no longer applicable because groundwater and leachate are instead discharged to the LRWU. Those that are still applicable or relevant and appropriate are being complied with.

ROD I. The basis for the 1983 ROD was developed prior to promulgation of the revised National Contingency Plan (40 CFR Part 300, March 1990) and prior to publication of the *CERCLA Compliance With Other Laws Manual: Parts I and II,* (OSWER Directives 9234.1-01 and 9234.1-02, respectively). The 1983 ROD set forth the Safe Drinking Water Act as an ARAR for the selected remedy.

ROD II. The basis for the 1985 ROD was developed prior to promulgation of the revised National Contingency Plan (40 CFR Part 300, March 1990). The 1985 ROD set forth the following ARARs for the selected remedy:

- Resource Conservation and Recovery Act (RCRA), 40 CFR Part 264
- Executive Order 11988 (Floodplain Management)
- Executive Order 11990 (Protection of Wetlands)
- Clean Water Act
- Clean Air Act
- Safe Drinking Water Act

Since the 1985 ROD was completed prior to promulgation of the revised NCP and prior to publication of the *CERCLA Compliance With Other Laws Manual: Parts I and II*, (OSWER Directive 9234.1-01 and 9234.1-02, respectively), the ROD does not provide detailed analysis of the applicability or relevance and appropriateness of each regulation.

ROD III. The 1988 ROD set forth the following ARARs for the selected remedy:

- Resource Conservation and Recovery Act (RCRA), 40 CFR Part 264
- Executive Order 11990 (Protection of Wetlands)
- Clean Water Act
- Clean Air Act
- Safe Drinking Water Act

Chemical-Specific ARARs. The current chemical-specific ARARs for groundwater are summarized in Table 2 of Attachment 6 and consist of Safe Drinking Water Act (SDWA) MCLs and Massachusetts MCLs (MMCLs). The federal MCL Goals (MCLGs) and Massachusetts Office of Research and Standards Guidelines (ORSGs) are also included in the table. These values are non-enforceable guidelines and are To Be Considered, whereas the SDWA MCLs and MMCLs are relevant and appropriate criteria.

The MCL for arsenic has changed since the RODs were promulgated, having been reduced from 50 ug/L to 10 ug/L. It will become enforceable for public drinking water systems on January 23, 2006. The target cleanup level for arsenic in groundwater in ROD III was established at 50 ug/L, the MCL in effect at that time. The MCLs for other groundwater contaminants for which there are target cleanup levels have not changed since ROD III. The change in the MCL for arsenic may need to be considered in decision-making about when the groundwater extraction system can be permanently shut down, if MCLs for other contaminants are reached, but arsenic still remains at concentrations above 10 ug/L. The evaluation of whether the 10 ug/L MCL is appropriate may need to include an evaluation of background concentrations of arsenic that might naturally be expected in the Site vicinity, if Site contamination were not present. The change in the arsenic MCL does not affect remedy protectiveness because public water is available in the area.

The MADEP Office of Research and Standards has established a guideline (ORSG, see Table 2 in Attachment 6) for 1,4-dioxane in drinking water of 3 ug/L. This guideline did not exist at the time of ROD III. It is a non-enforceable guideline that is not ARAR. This guideline is classified as To Be Considered in decision-making regarding shut down of the groundwater extraction system.

Location-Specific ARARs. The wetlands ARARs identified in the 1988 ROD still apply today to Flint

Pond, Dunstable Brook, and to scattered wetlands which border the Site. ROD II included a provision for the compensation of an anticipated loss of wetlands on the north side of the landfill with establishment of a larger wetlands to the south of the Site (ROD II, Consistency With Other Environmental Laws and Regulations Section). Wetland areas impacted by remedial actions were assessed in 1990. The Wetland Damage Assessment Report (HMM, 1990) stated that approximately 1.5 acres of wetlands were filled during capping activities and an additional 5 acres of wetlands were altered or otherwise damaged. This report also outlined general mitigation requirements and procedures. Based on a 1993 wetlands inspection, it appeared that the wetland mitigation proposed in the Wetland Damage Assessment Report had not been addressed since no replicated wetlands were observed and damage to other wetland areas persisted. As the Site exists today, and as documented in the Administrative Record, there are no remaining wetlands onsite and wetlands replacement is not physically possible (USEPA, 2000). As part of the cap remedy, three sedimentation basins were constructed to serve as surface water runoff discharge retention locations, and are considered to provide an environment similar to a wetland. These basins comprise 3 acres.

Action-Specific ARARs. Action-specific requirements identified in the 1988 ROD were presented for all alternatives evaluated. Treatment of landfill gas is accomplished through an enclosed gas flare. The enclosed flare meets MADEP's requirements for Best Available Control Technology (BACT). Calculations show that, without any treatment, total VOCs emitted would be less than 0.368 ton per year, far less than the 1 ton per year level that triggers additional Massachusetts Division of Air Quality Control facility requirements. Since landfill gas emissions are being treated, total VOCs are further reduced and, thus, these rules are neither applicable nor relevant and appropriate.

7.3 QUESTION C: HAS ANY OTHER INFORMATION COME TO LIGHT THAT COULD CALL INTO QUESTION THE PROTECTIVENESS OF THE REMEDY?

During a telephone interview with the Health Administrator for the Tyngsborough Board of Health to support the five-year review (see Section 6.5), it was learned that an irrigation well has been installed to serve an industrial park located just north of the Site and south of Cummings Road. It is recommended that the potential effect of this irrigation well on the groundwater and leachate collection systems be evaluated. The irrigation well does not affect remedy protectiveness because the water will not be used for drinking and it is upgradient of the contaminated groundwater plume. However, its operation could potentially cause the extraction systems in place to be less effective than they currently are for controlling plume migration.

7.4 TECHNICAL ASSESSMENT SUMMARY

According to the data reviewed, the site inspection, and the interviews, the remedy is functioning as intended by the RODs, as modified by the 1999 ESD. There have been no changes in the physical conditions of the Site that would affect the protectiveness of the remedy.

Fencing and cap integrity should be maintained to minimize on-site direct contact soil exposures which have not been quantitatively estimated but presumed to be associated with risks and hazards above EPA risk management guidelines.

Based on the evaluation of changes in toxicity values and exposure assumptions, the conclusions of the

1998 human health risk re-evaluation for sediment remain valid.

One pathway of potential concern that was not evaluated in the 1988 risk assessment was the vapor intrusion pathway. April 2001 VOC data collected from monitoring wells across the Site (TRC, 2001) were evaluated for the vapor intrusion pathway by a comparison to screening levels provided in the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA, 2001). The sample from GEI-F2 exceeded the screening levels for 1,2-dichloroethane and vinyl chloride. Because there are no occupied structures within 100 feet of this well, the vapor intrusion pathway is considered incomplete and exposures to residents and Site workers via indoor air are likely to be negligible.

For the ambient air pathway, a qualitative comparison of 1988 ambient air concentrations to Region 9 risk-based PRGs confirms the results of the 1988 risk assessment. It is anticipated that current ambient air levels are significantly less than those estimated in 1988 based on the installation, operation, and maintenance of the landfill gas collection system. However, analytical results obtained during 2005 stack testing should be evaluated to confirm that the remedy remains protective relative to the ambient air pathway.

Continued exceedances of MCLs indicate that completion of the drinking water ingestion pathway would present a risk to human receptors. Since groundwater from the Site is not currently used by area residents as a source of potable water, the drinking water exposure pathway is incomplete. Institutional controls preventing potable groundwater use should be implemented until groundwater cleanup levels (i.e., federal MCLs) are achieved, as demonstrated by a groundwater monitoring program. Non-potable private well installation within the vicinity of the Site should also be restricted unless site-specific risk assessment indicates that the non-potable exposure pathways anticipated will not result in risks and hazards above EPA risk management criteria. The implementation of comprehensive institutional controls, when complete, will provide long-term protectiveness for the Site remedy.

Public water is available in the area and the town of Tyngsborough is not issuing permits for new drinking water wells in the Site vicinity. Hence, there is no current residential exposure to contaminated groundwater. However, it is not certain whether the town of Tyngsborough's permit process is a sufficient institutional control in the long term to prevent use of groundwater as drinking water.

There remains a need for additional surface water and sediment sampling in water bodies in the Site vicinity to more conclusively determine whether the Site has impacted ecological receptors, according to an EPA memorandum (Tyler, 2000). EPA is planning to conduct additional sampling in 2005.

Most of the ARARs identified in the RODs remain applicable or relevant and appropriate and either have been met or are being complied with. Some ARARs identified in ROD III are no longer ARAR because the OU3 remedy no longer includes discharge to a surface water body, since discharge is to the Lowell Regional Water Utility. It may be necessary to consider the change in the MCL for arsenic from 50 ug/L to 10 ug/L, and the Massachusetts ORSG for 1,4-dioxane (3 ug/L) in future decision-making regarding shut down of the groundwater extraction system. A resumption of groundwater monitoring is also needed to verify the continued effectiveness of the extraction system.

An evaluation of the new irrigation well north of the Site is recommended, to determine whether its operation might affect the effectiveness of the on-Site groundwater extraction and leachate collection systems.

SECTION 8.0
ISSUES

Based on the activities conducted during this five-year review, the issues identified in the following table have been noted.

Table 7: Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Issues That May Affect Future Protectiveness		
Potential risk to ecological receptors has not been fully assessed in accordance with current guidelines. Additional surface water and sediment sampling and data evaluation are needed.	N	Y
Groundwater institutional controls need review to determine if they are adequate to provide protectiveness in the long term and are legally enforceable. Institutional controls are needed to prevent future disturbance of the landfill cap.	N	Y
Risk evaluation of non-potable groundwater uses is needed (for example, irrigation wells), to determine whether such uses should be restricted along with potable uses.	N	Y
Groundwater monitoring was last performed in April 2001. An evaluation of monitoring requirements and resumption of monitoring is needed to confirm protectiveness and help assess when the extraction system can be shut down.	N	Y
O&M and Monitoring Issues		
New office buildings have been constructed just north of the Site landfill. The soil gas monitoring program in this area may need updating to verify that the extent of landfill gas is fully characterized.	N	N
The operational time of the flare has been decreasing during the past five years, possibly because the landfill is no longer generating enough methane to keep the flare running as currently configured.	N	N

Table 7: Issues		
Several maintenance needs were described by the O&M contractor during the Site inspection related to the sedimentation basin discharge structures, the drainage swale along Dunstable Road, and the West Pump Station piping.	N	N
Iron bacteria growth has been observed on the walls of the Cummings Road Pump Station wet well by the Superintendent of the Tyngsborough Sewer Commission. He is concerned that the iron bacteria may also be growing in, and clogging the sewer pipe downstream.	N	N

SECTION 9.0
RECOMMENDATIONS AND FOLLOW-UP ACTIONS

In response to the issues noted above, it is recommended that the actions listed in the following table be taken:

Table 8: Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness	
					Current	Future
Issues That May Affect Future Protectiveness						
Potential risk to ecological receptors has not been fully assessed in accordance with current guidelines. Additional surface water and sediment sampling and data evaluation are needed.	Resume surface water and sediment sampling; evaluate data and potential need for toxicity testing, fish tissue sampling, and Ecological Risk Assessment.	EPA	N/A	2006	N	Y
Groundwater institutional controls need review to determine if they are adequate to provide protectiveness in the long term and are legally enforceable. Institutional controls are needed to prevent future disturbance of the landfill cap.	Review controls and establish new ones as needed.	EPA and Responsible Party	EPA	2009	N	Y
Risk evaluation of non-potable groundwater uses is needed (for example, irrigation wells), to determine whether such uses should be restricted along with potable uses.	Evaluate potential risk from non-potable groundwater uses to determine if institutional controls should restrict non-potable uses along with potable uses.	EPA	N/A	2006	N	Y

Table 8: Recommendations and Follow-up Actions						
Issue	**Recommendations and Follow-up Actions**	**Party Responsible**	**Oversight Agency**	**Milestone Date**	**Affects Protectiveness**	
					Current	**Future**
Groundwater monitoring was last performed in April 2001.	Establish new groundwater monitoring program and evaluate extraction system effectiveness.	EPA	EPA	2006	N	Y
O&M and Monitoring Issues						
New office buildings have been constructed just north of the Site landfill. The soil gas monitoring program in this area may need updating to verify that the extent of landfill gas is fully characterized.	Review soil gas probe locations and condition; consider possible need for new probes in north area.	MADEP	EPA	2006	N	N
The operational time of the flare has been decreasing during the past five years, possibly because the landfill is no longer generating enough methane to keep the flare running as currently configured.	Evaluate options for reconfiguration that might improve time between shutdowns.	MADEP	EPA	2006	N	N
Several maintenance needs were described by the O&M contractors during the Site inspection related to the sedimentation basin discharge structures, the drainage swale along Dunstable Road, and the West Pump Station piping.	Obtain estimates for repairs and execute for: sedimentation basin discharge structures, West Pump station leaking pipe, and removal of sediment from swale to restore grade.	EPA and MADEP (depending on location of maintenance need)	N/A	2006	N	N

Table 8: Recommendations and Follow-up Actions						
Issue	**Recommendations and Follow-up Actions**	**Party Responsible**	**Oversight Agency**	**Milestone Date**	**Affects Protectiveness**	
					Current	**Future**
Iron bacteria growth has been observed on the walls of the Cummings Road Pump Station wet well by the Superintendent of the Tyngsborough Sewer Commission. He is concerned that the iron bacteria may also be growing in, and clogging the sewer pipe downstream.	Discuss observations further with the Town and investigate the problem.	EPA	NA	2006	N	N

SECTION 10.0
PROTECTIVENESS STATEMENTS

OU1

OU1 refers to the provision of an alternative water supply for areas originally found to have been affected by the contaminated groundwater plume from the Site. The remedy for OU1 currently protects human health and the environment because all areas known to have been impacted by the contaminated groundwater plume have received an alternative water supply under OU1 (the original alternative supply) or OU3/OU4 (extensions to the original water supply lines). However, in order for this portion of the remedy to be protective in the long-term, follow-up actions need to be taken. Specifically, it is necessary to evaluate the current institutional controls in place to prevent use of groundwater in the Site vicinity for drinking water, and possibly also consider restricting non-potable uses. The town of Tyngsborough Board of Health currently prevents potable use by not allowing installation of drinking water wells in areas that have access to public water. However, additional legally enforceable controls may also be necessary to attain protectiveness in the long-term.

OU2

OU2 (Source Control) involves control of the contamination source to reduce off-site migration of contaminants (*i.e.*, capping of the landfill and collection of the leachate and landfill gas). This operable unit also included the Remedial Action Objective of "abating additional impact to surrounding surface waters and wetlands." This portion of the remedy is protective in the short-term; however, in order for this portion of the remedy to be protective in the long-term, follow-up actions need to be taken. Although access to the landfill is currently strictly controlled by EPA and MADEP, formal institutional controls are needed to prevent future disturbance of the cap. The owner/operator is required to implement these on-site controls under a recent consent decree with EPA. Also, there remains a need for additional surface water and sediment sampling in water bodies in the Site vicinity to determine whether the Site may have impacted ecological receptors. EPA is planning to conduct additional sampling in 2005.

OU3 and OU4

OU3 addresses contaminated groundwater migration and OU4 addresses leachate treatment. Since contaminated groundwater and leachate are addressed together in ROD III by the construction of a groundwater/leachate collection system with discharge to the Lowell Regional Water Utility, these operable units are discussed together. The remedy for OU3 and OU4 is protective in the short-term; however, in order for this portion of the remedy to be protective in the long-term, follow-up actions need to be taken. Long-term protectiveness will be achieved once the extraction system reaches MCLs in the groundwater. In the interim, institutional controls are needed to prevent exposure to contaminants. The town of Tyngsborough Board of Health currently prevents installation of drinking water wells in areas that have access to public water. However, additional legally enforceable controls may also be necessary to attain protectiveness in the long-term. The owner/operator is required to implement on-site controls under a recent consent decree with EPA..

Comprehensive Protectiveness Statement

Because the remedial actions at all Operable Units are protective in the short-term, the remedy is currently protective of human health and the environment. However, in order for the remedy to be protective in the long-term, the following follow-up actions are needed:

- Establishment of enforceable institutional controls to prevent disturbance of the landfill cap
- Establishment of enforceable institutional controls to prevent installation of drinking water wells near the Site until MCLs are attained
- Risk evaluation of non-potable groundwater uses (for example, irrigation wells), to determine whether such uses should be restricted along with potable uses
- Re-establishment of groundwater monitoring program to allow evaluation of extraction system effectiveness
- Performance of additional surface water and sediment sampling in water bodies in the Site vicinity to determine whether the Site may have impacted ecological receptors

SECTION 11.0
NEXT REVIEW

Five-year reviews are done every five years at sites where contaminant levels remain at concentrations that prevent unlimited, unrestricted use of the Site. Since the remedy does not allow for unrestricted use of the Site, a follow-up five-year review will be required. The next five-year review for the Charles George Land Reclamation Trust Landfill Superfund Site should be conducted in 2010.

ATTACHMENT 1

FIGURES

Source: MassGIS, Commonwealth of Massachusetts
Executive Office of Environmental Affairs

METCALF & EDDY | AECOM

Figure 1.
SITE LOCATION MAP

Charles George Landfill
Tyngsborough, Massachusetts

G:\Projects\MASSACHUSETTS\TyngsboroughMaps\Locus.mxd

6	5	4	3	2	1

D	C	B	A

NUMBER	DATE	MADE BY	CHECKED	DESCRIPTIONS
REVISIONS				

M&E Metcalf & Eddy

REG. PROF. ENGR. XX PE NO. XXXXX DATE

REG. PROF. ENGR. XX PE NO. XXXXX DATE

DRAWN BY: C. BENZIGER

DEPT. CHECK: B. WEIR

PROJ. CHECK: <PROJ. CHECK>

SCALE: 1" = 120' (0, 120, 240, 360 FEET)

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

CHARLES GEORGE RECLAMATION TRUST LANDFILL SUPERFUND SITE
TYNGSBOROUGH, MASSACHUSETTS

FIGURE 2
SITE PLAN

CIVIL

APRIL, 2005

JOB 00100TYN

FILE NO.

CADD FILE CZTYN001.dwg

SHEET C-1

PATH/FILENAME: P:\00100TYN\C\CZTYN001.dwg
LAST UPDATE: March 29, 2005 @ 01:50:01 pm
PLOT DATE: March 29, 2005 @ 03:44:24 pm

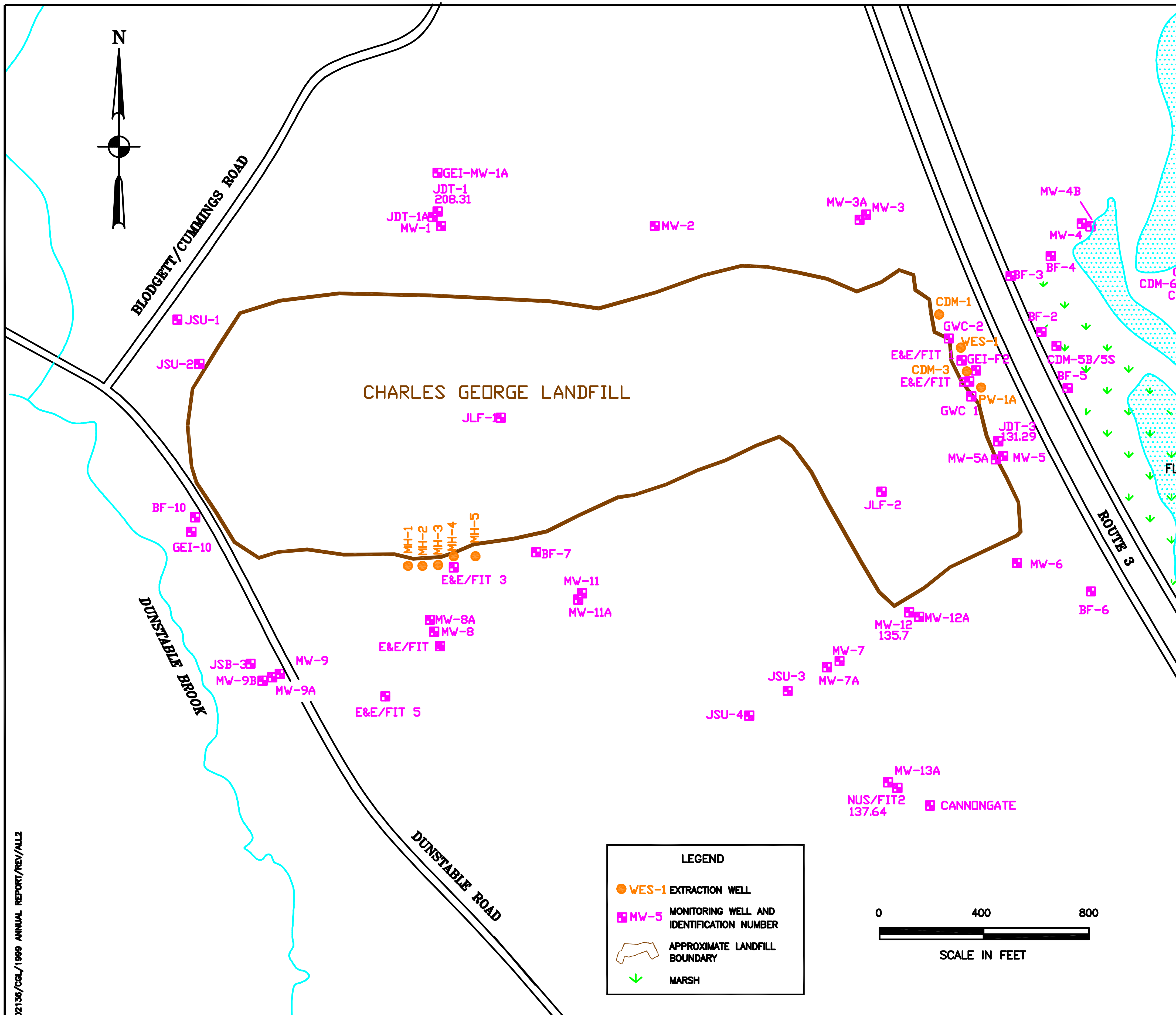


FIGURE 3

GROUND WATER MONITORING WELL LOCATIONS

CHARLES GEORGE LANDFILL
TYNGSBORO, MASSACHUSETTS

TRC
Boott Mills South
116 John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0530-17175

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACTOR NO.: 107061

M&E Metcalf & Eddy

Figure 4
THF Concentrations in Groundwater
East Extraction Area
Charles George Landfill, Tyngsboro, MA

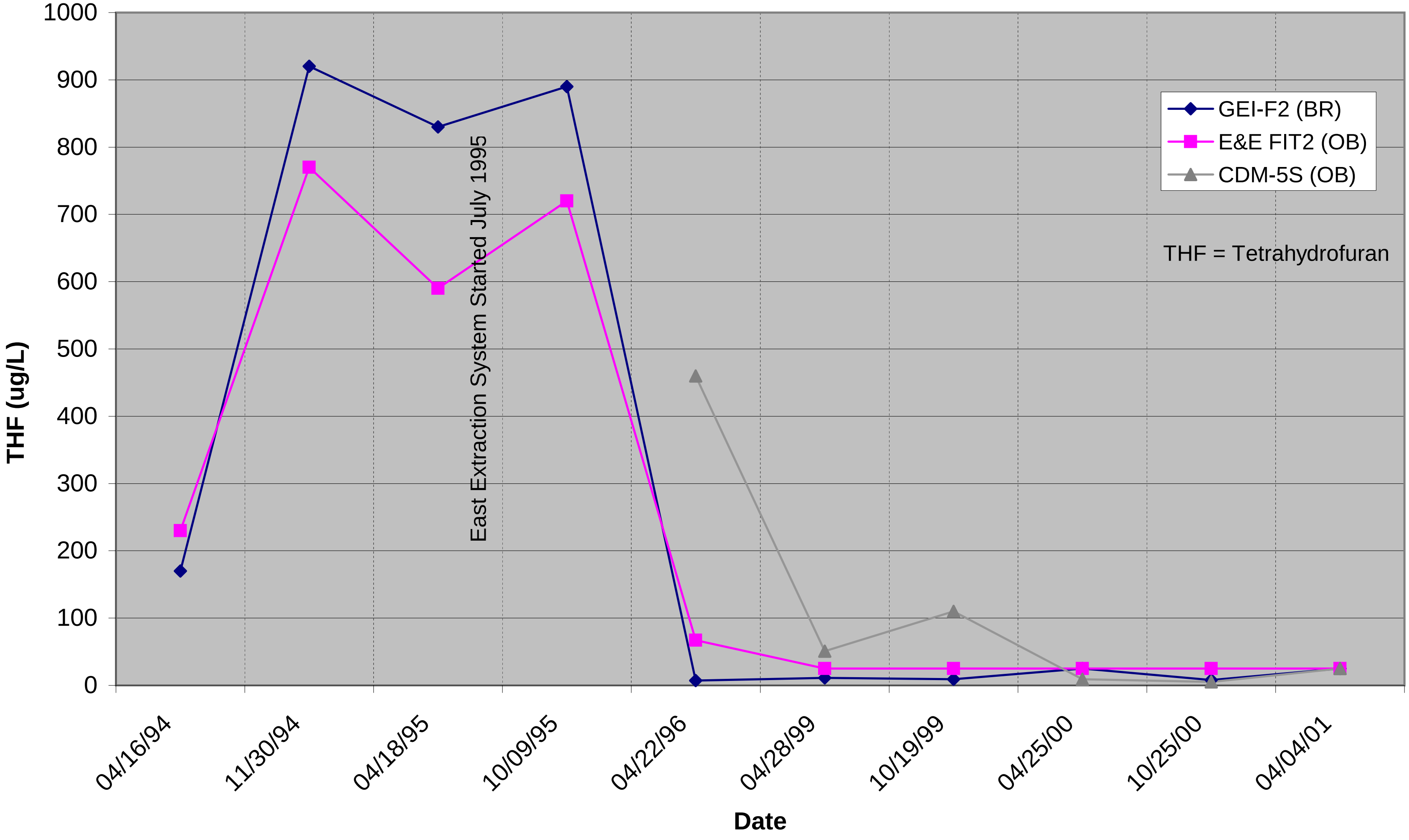


Figure 5
Benzene Concentrations in Groundwater
East Extraction Area
Charles George Landfill, Tyngsboro, MA

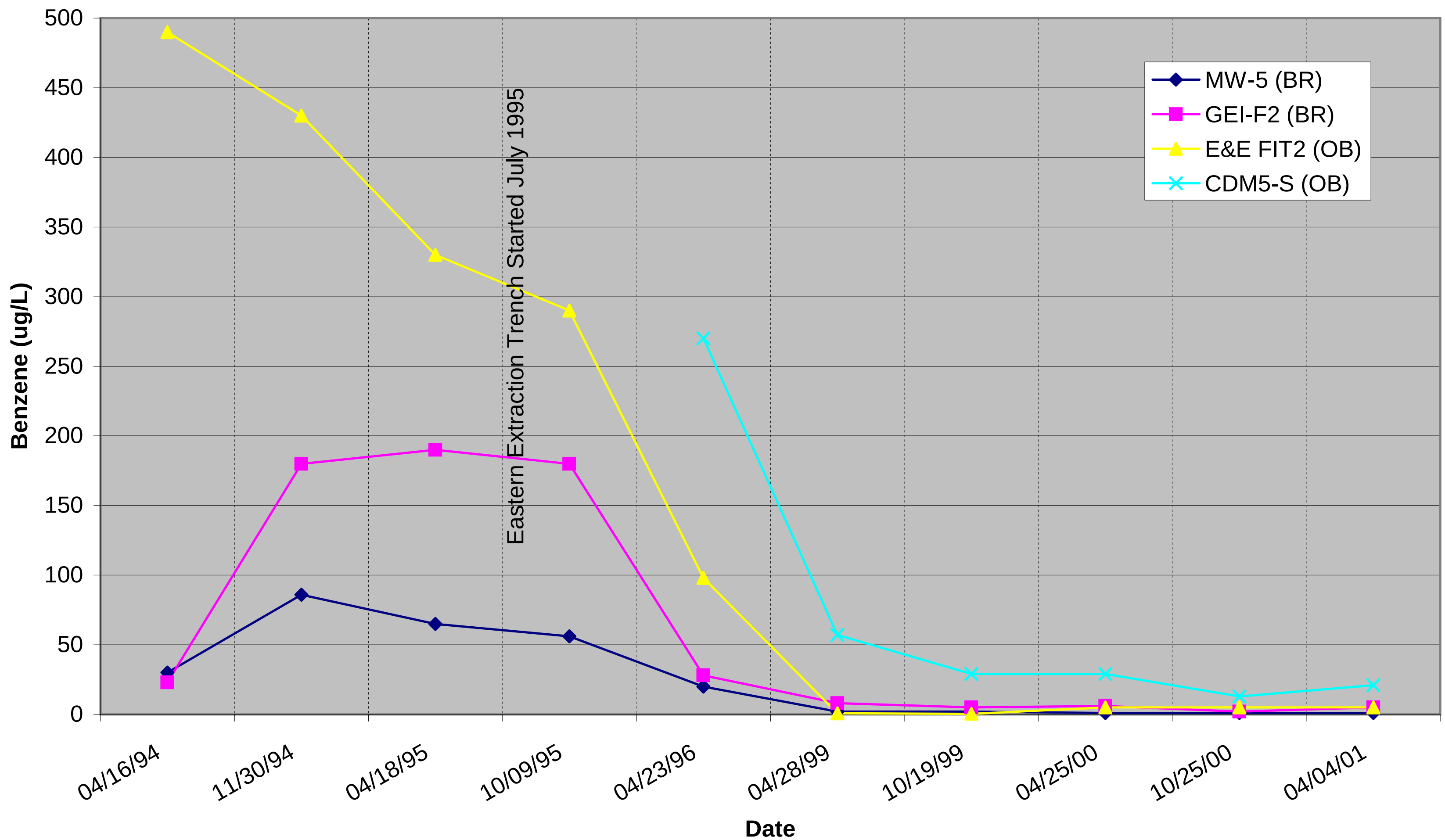


Figure 6a
1,4-Dioxane Concentrations in Groundwater
East Extraction Area within Point of Compliance
Charles George Landfill, Tyngsboro, MA

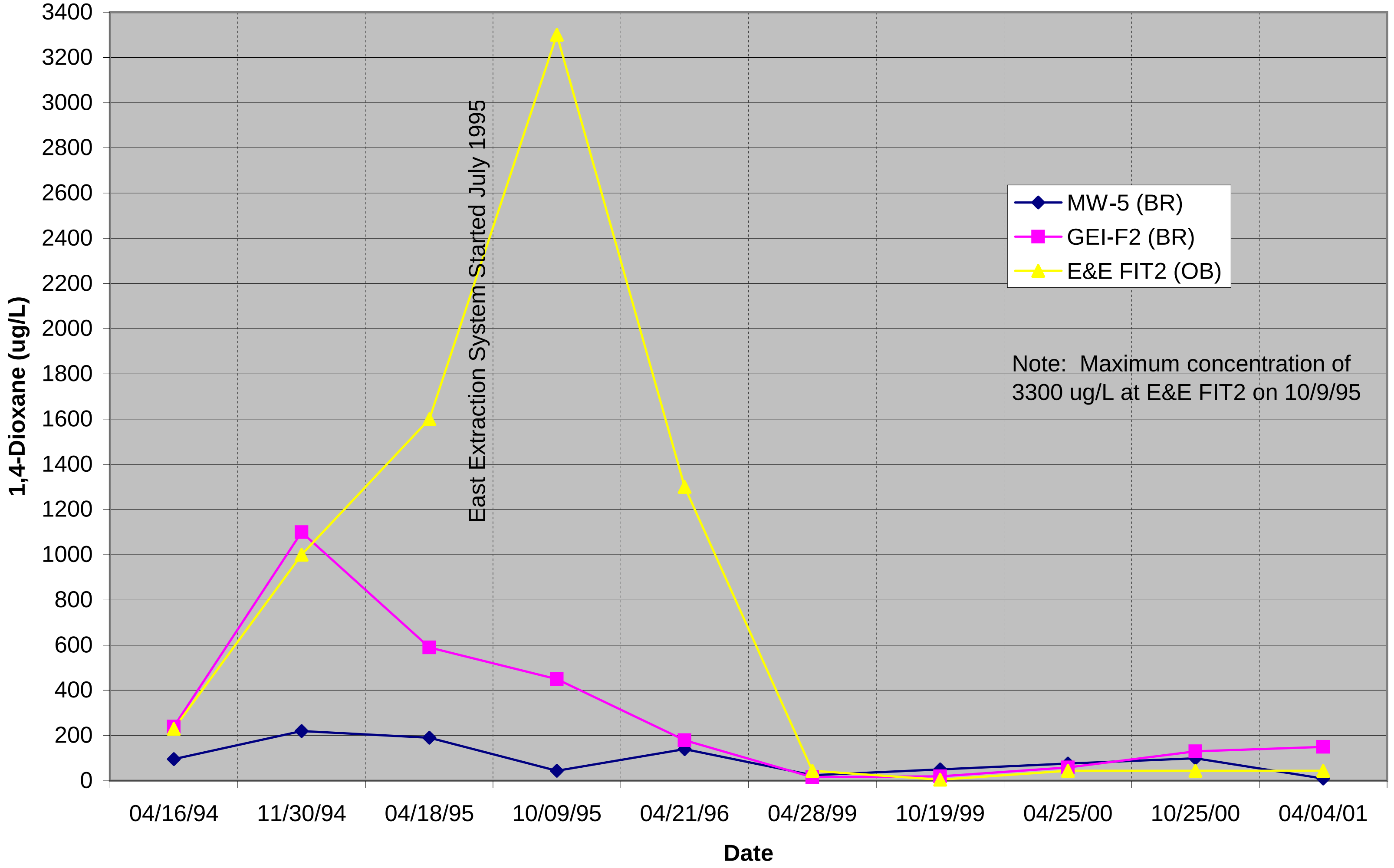


Figure 6b
1,4-Dioxane Concentrations in Groundwater
Downgradient of East Extraction Area
Charles George Landfill, Tyngsboro, MA

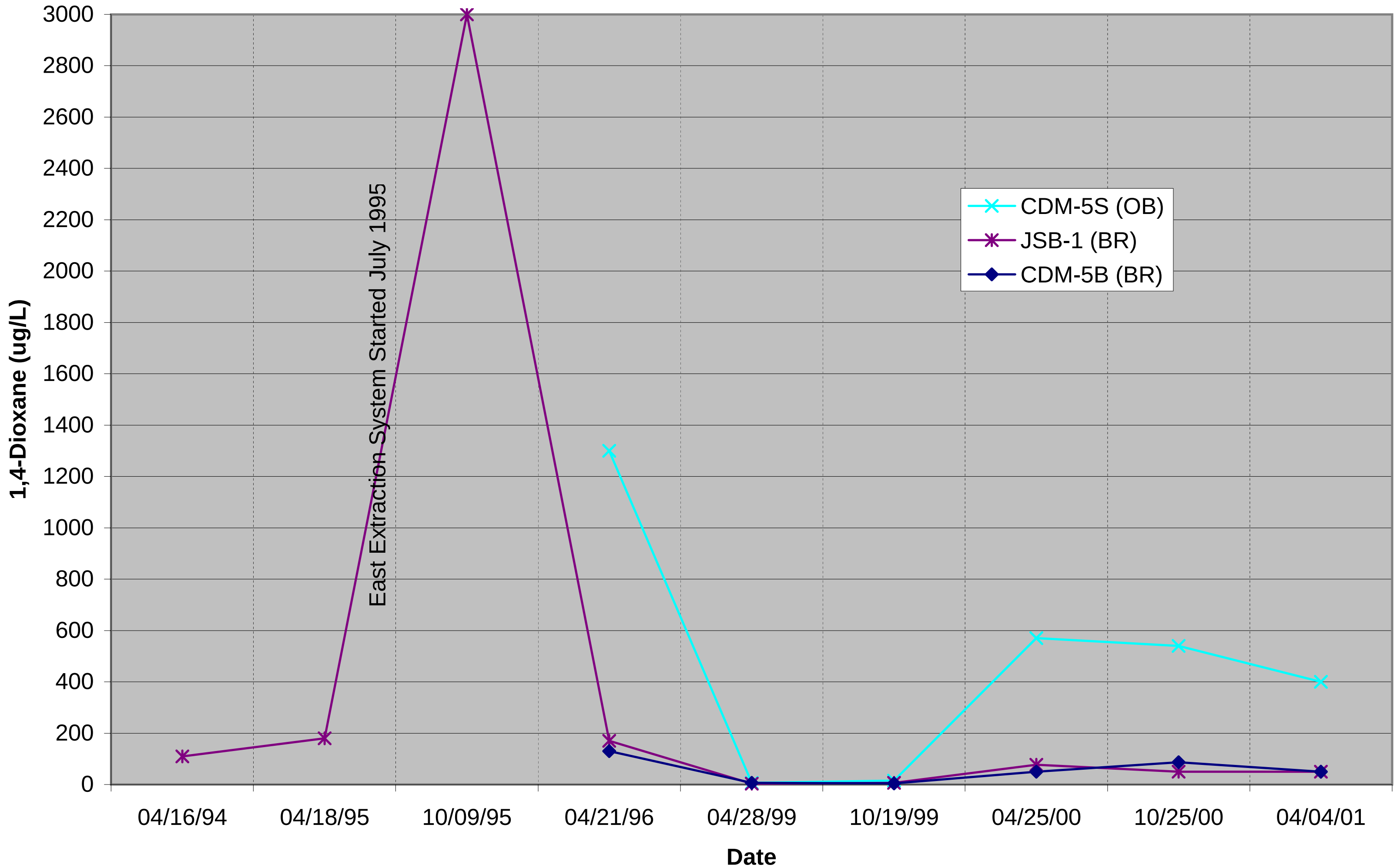


Figure 6c
1,4-Dioxane Concentrations in Groundwater
Southwest Extraction Area
Charles George Landfill, Tyngsboro, MA

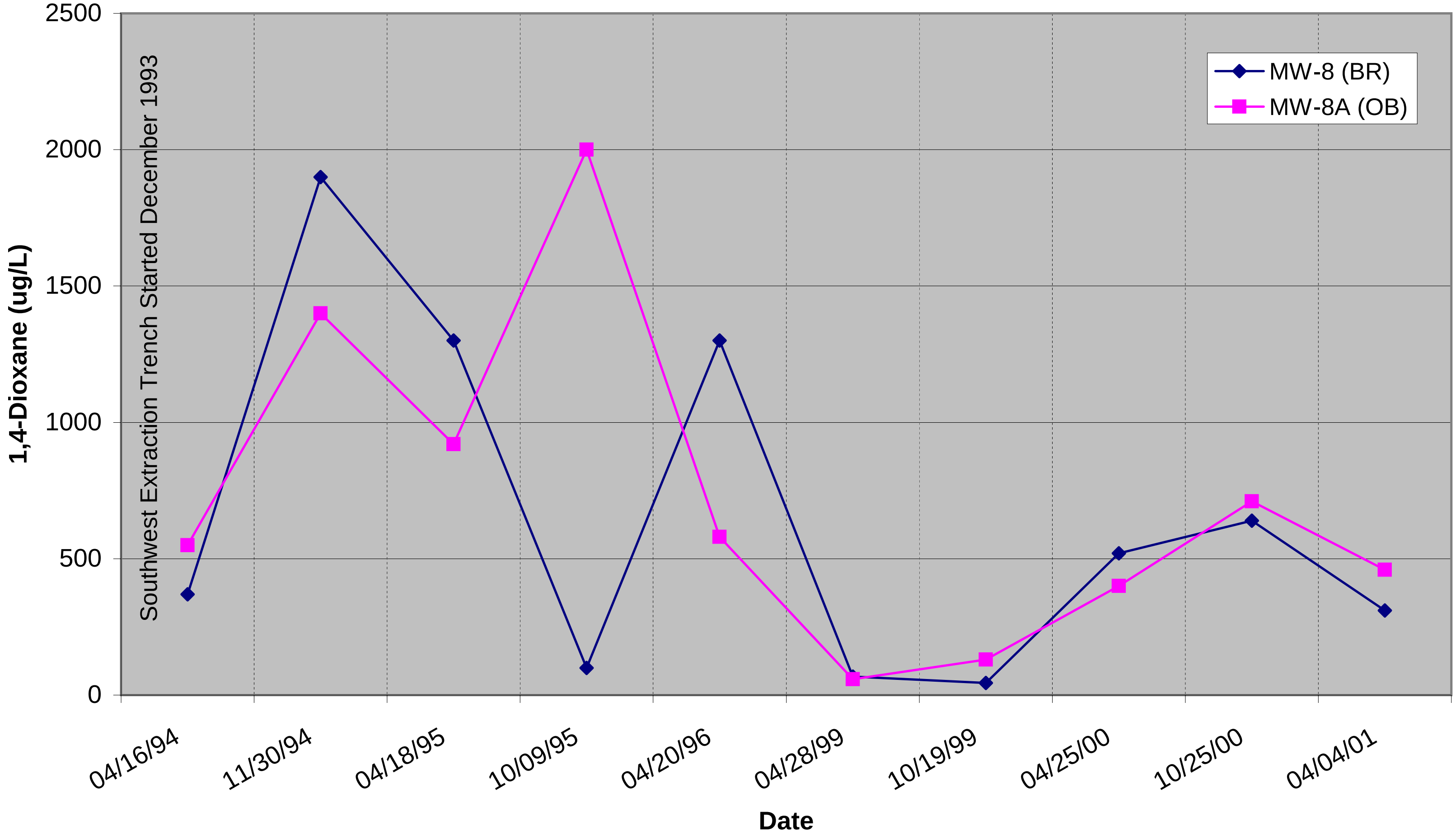


Figure 7
Landfill Gas Flare
Percent Operational During Monitoring Period

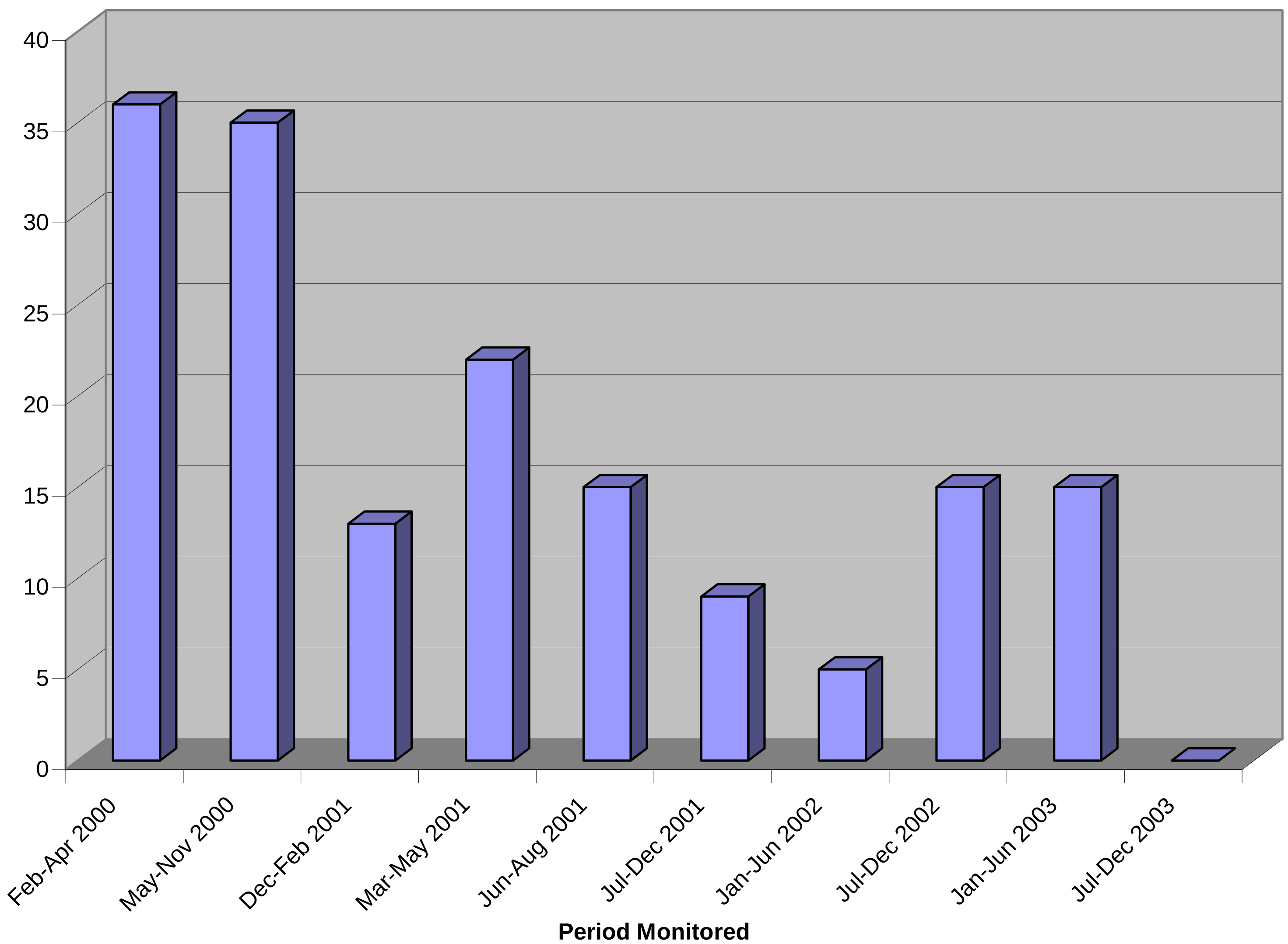


Figure 8
Monthly Effluent Discharge Volume
Charles George Landfill

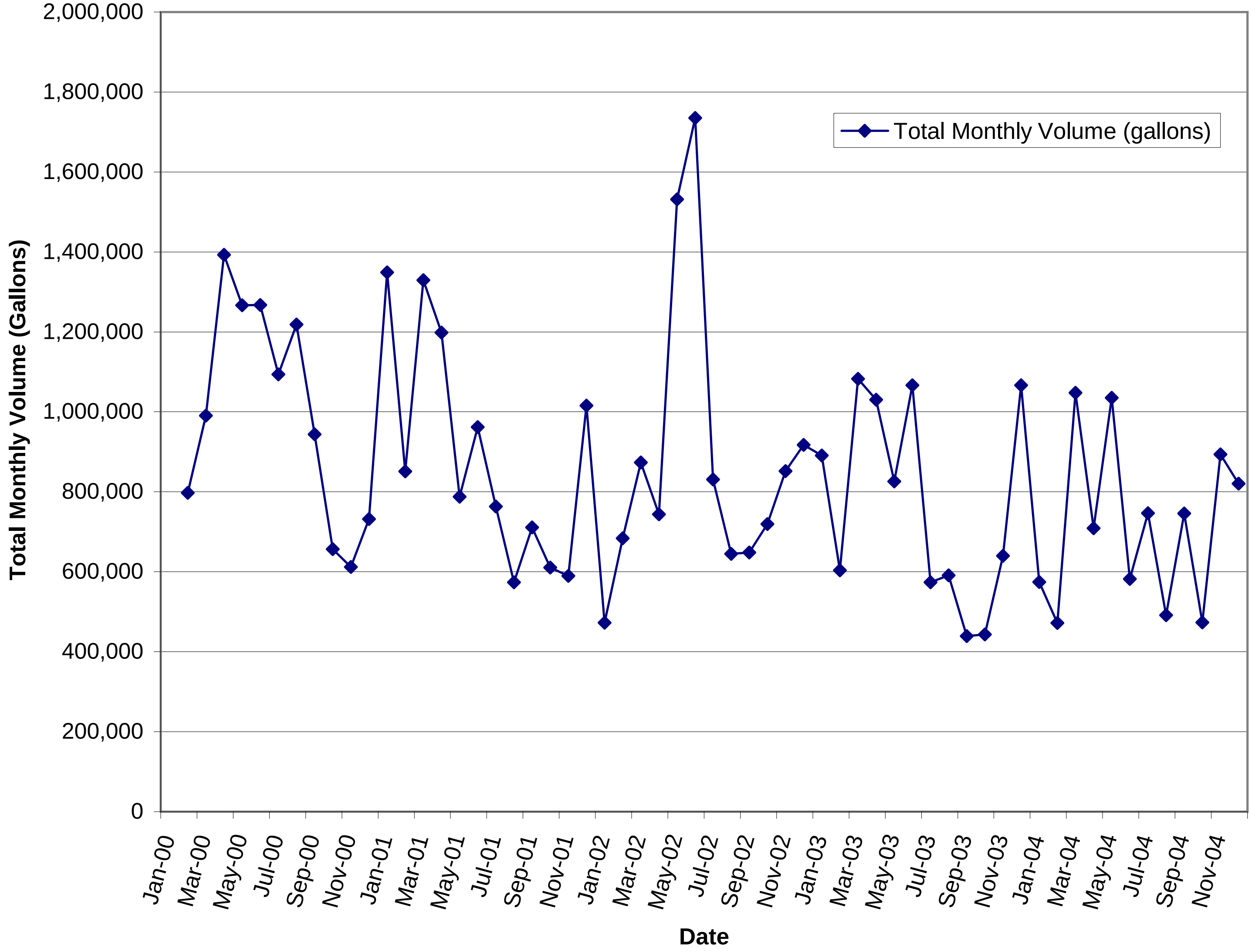
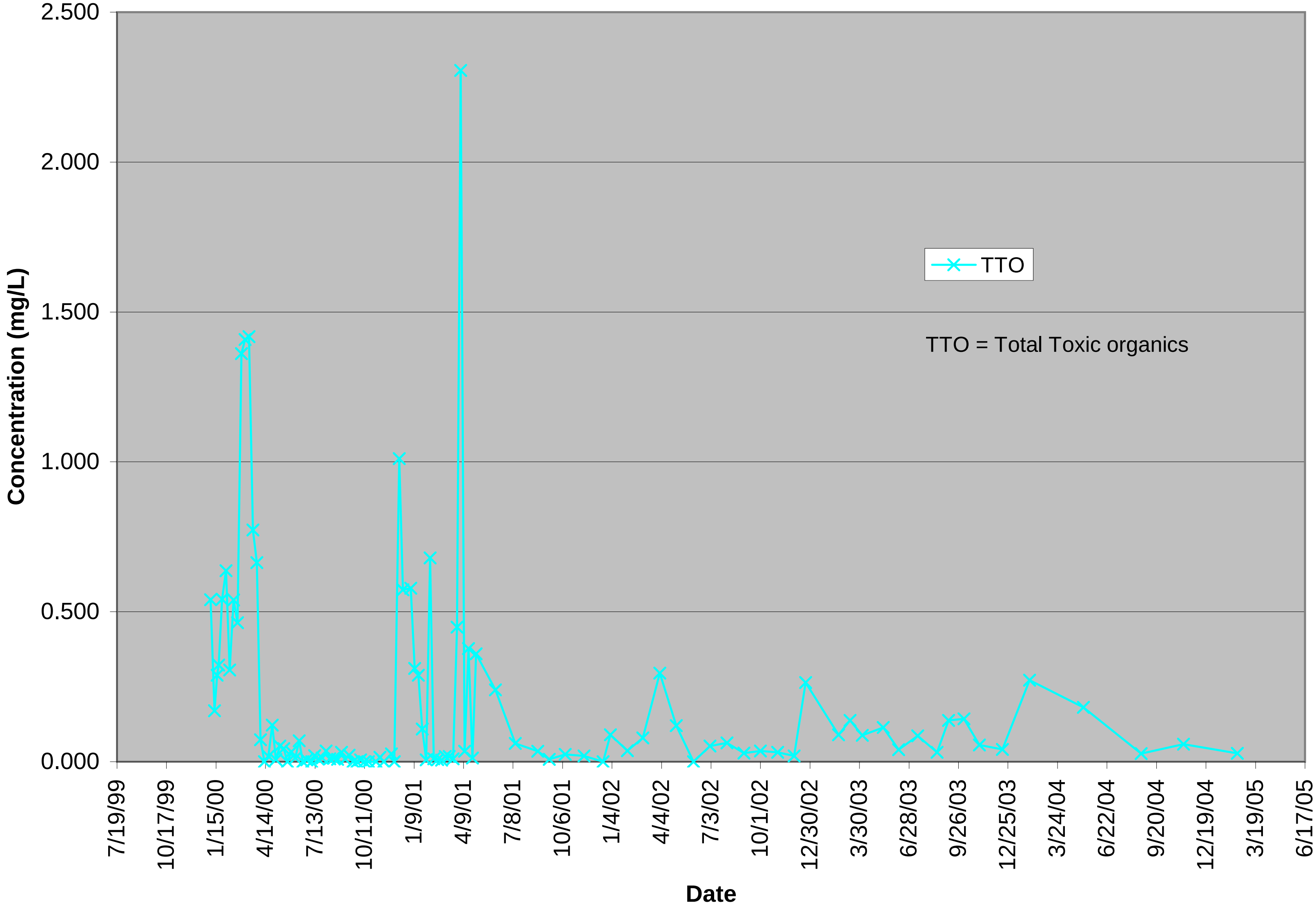


Figure 9
TTO (mg/L) at Effluent Monitoring Station
Charles George Landfill, Tyngsborough, MA



ATTACHMENT 2

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ATTACHMENT 3

GROUNDWATER DATA STATISTICAL EVALUATION

TECHNICAL MEMORANDUM

To: Greg Mischel P.E., Project Manager

From: Jeff Park, Scientist

Subject: Charles George Landfill Five-Year Review
Statistical Analysis of Groundwater Data

Date: March 22, 2005

1.0 METHODS

1.1 Data Reduction and Summary Statistics

The THF, Benzene, and 1,4 Dioxane analytical data included a number of non-detect values (including multiple detection limits) and as such are regarded as censored data sets (Gilbert, 1987; Navy, 1998). Given the small sample size (N = 6-10), only overburden (OB) and bedrock (BR) wells with <50% non-detects were included in the analysis.

All data sets were first tested for normality with a Shapiro-Wilk *W* test. The Shapiro-Wilk *W*-test for normality is appropriate when dealing with sample sizes smaller than 50 (Shapiro & Wilk, 1965; Gilbert, 1987). For the purposes of this analysis, multiple detection limits at a given site were converted to a mean (Navy, 1998). One half of this mean was used as the default value for all non-detects. The converted data sets containing the default non-detect values were then used in the trend analysis.

Descriptive statistics are provided for all data sets, including mean, median, minimum (MIN), maximum (MAX), variance, standard deviation (SD), standard error (SE), skewness, and kurtosis.

1.2 Time-series Analysis

The time series data for all compounds investigated did not exhibit an obvious linear relationship with time, which necessarily precluded analysis with simple linear regression. Furthermore, many of the data sets were not normally distributed. In light of these characteristics, a time series analysis of each compound was assessed with the non-parametric (distribution-free) Mann-Kendall test for trend (Gilbert, 1987). The Mann-Kendall test (S) can be viewed as a non – parametric test for zero slope of the linear regression of time ordered data (Gilbert, 1987) where S is calculated:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sign\left(x_j - x_k \right)$$

The Mann-Kendall statistic (S) was modified to reflect the number of ties in the data where:

$$VAR(S) = 1/18\left[n(n-1)(2n+5) - \sum_{p=1}^{g} t_p\left(t_p - 1\right)\left(2t_p + 5\right)\right]$$

The normal approximation (Z) was used to assign a significance level to the Mann Kendall statistic where:

$Z = S - 1/\left[VAR(S)\right]^{0.5}\ ifS > 0$;
$Z = 0\ ifS = 0$; and
$Z = S + 1/\left[VAR(S)\right]^{0.5}\ ifS < 0$

The critical value for $Z_{0.95}$ (p 0.05), as obtained from a cumulative normal distribution table is 1.60 (-1.60). Positive and negative z values larger than the critical value indicate increasing and decreasing trends respectively. Values smaller than $Z_{0.95}$ indicate no trend. It is important to note that the Mann-Kendall test is a directional test. Specifically, assumptions about the direction of the trend (increasing or decreasing) are being tested. As such, only the one-tailed probability value is reported.

2.0 RESULTS

2.1 Tetrahydrofuran

Tetrahydrofuran (THF) data exhibit extremely large ranges, variance and standard error (Table 2-1). Furthermore, the data sets are highly non-normal (Table 2-2).

Table 2-1. Summary statistics for THF (*u*g/L).

Well ID	Valid N	Mean	Median	MIN	MAX	Variance	SD	SE	Skewness	Kurtosis
GEI-F2 (BR)	10	289.5	25.0	7.0	920.0	168,862.5	410.9	129.9	0.99	-1.21
E&E FIT2 (OB)	10	250.2	46.0	25.0	770.0	99,323.7	315.1	99.6	0.97	-1.04
CDM-5S (OB)	6	110.0	38.0	5.0	460.0	30886.4	175.7	71.7	2.20	4.97

Table 2-2. Summary of Shapiro-Wilk test for normality (THF).

Well ID	N	W	*p*-value
GEI-F2 (BR)	10	0.670	**0.0003**
E&E FIT2 (OB)	10	0.723	**0.0016**
CDM-5S (OB)	6	0.676	**0.0034**

A line plot of the data indicate that there is a pronounced decrease in THF starting in late April 1996 within bedrock well GEI-F2 (BR) and overburden well E&E FIT2 (OB) (Figure 2-1). The decrease in THF does not occur within overburden well CDM-5S (OB) until three years later in late April 1999. THF concentrations have remained low up through April 2001.

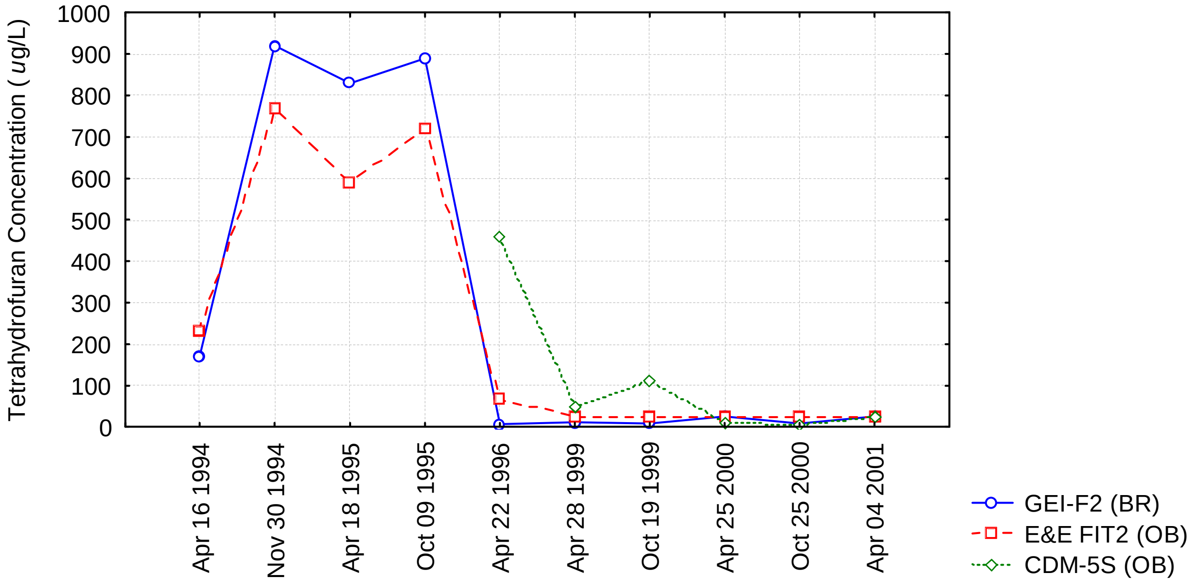

Figure 2-1. Temporal trend in tetrahydrofuran concentrations (*u*g/L).

The Mann-Kendall Test indicates that the decrease in THF concentrations is only significant within overburden well E&E FIT2 (OB).

Table 2-3. Summary of Mann-Kendall analysis of time series tetrahydrofuran data.

Well ID	S	Z crit. 0.95	Z	*p*-value	Trend
GEI-F2 (BR)	-16	1.645	-1.34	0.08	No trend
E&E FIT2 (OB)	-30	1.645	-2.78	**0.002**	Decreasing
CDM-5S (OB)	-9	1.645	-1.50	0.06	No trend

2.2 Benzene

Benzene concentrations exhibit a fairly wide range, in addition to high variance and standard error (Table 2-4). Of the four wells included in the analysis, none are normally distributed (Table 2-5).

Table 2-4. Summary statistics for benzene (*u*g/L).

Well ID	Valid N	Mean	Median	MIN	MAX	VAR.	SD	SE	Skewness	Kurtosis
MW-5 (BR)	10	26.4	11.0	1.0	86.0	1,010.93	31.79	10.05	0.93	-0.58
GEI-F2 (BR)	10	62.7	15.5	2.0	190.0	7,006.01	83.70	26.46	1.00	-1.22
E&E FIT2 (OB)	10	165.4	51.5	0.5	490.0	39,330.68	198.31	62.71	0.66	-1.45
CDM5-S (OB)	6	69.8	29.0	13.0	270.0	9,836.17	99.17	40.48	2.33	5.52

Table 2-5. Summary of Shapiro-Wilk test for normality (benzene).

Well ID	N	W	*p*-value
MW-5 (BR)	10	0.80	**0.018**
GEI-F2 (BR)	10	0.67	**0.0004**
E&E FIT2 (OB)	10	0.79	**0.012**
CDM5-S (OB)	6	0.62	**0.0009**

All overburden and bedrock wells exhibit a decreasing trend in benzene concentrations with time (Figure 2-2) and this is highly significant in all wells examined (Table 2-6). Benzene concentrations have remained low through April 2001.

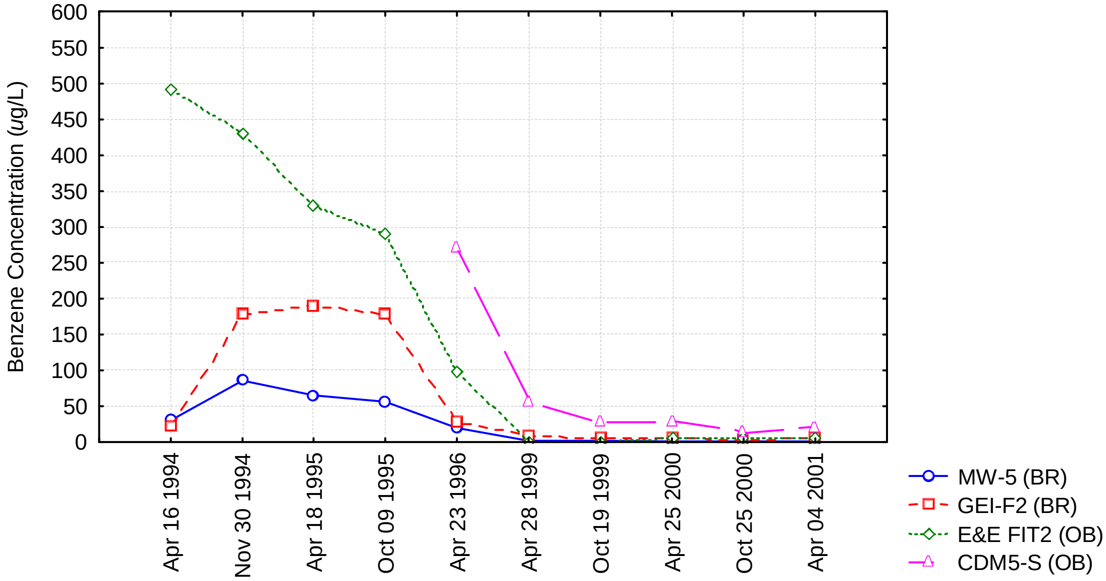

Figure 2-2. Temporal trend in benzene concentrations (*ug*/L).

Table 2-6. Summary of Mann-Kendall analysis of time series benzene data.

Well ID	S	Z crit. 0.95	Z	*p*-value	Trend
MW-5 (BR)	-34	1.645	-2.92	**0.001**	Decreasing
GEI-F2 (BR)	-29	1.645	-2.50	**0.005**	Decreasing
E&E FIT 2 (OB)	-34	1.645	-2.99	**0.001**	Decreasing
CDM5-S (OB)	-12	1.645	-2.10	**0.015**	Decreasing

2.3 1,4 Dioxane

As is characteristic for all compounds analyzed, 1,4 Dioxane concentrations occur over an extremely wide range, in addition to exhibiting elevated variance and standard error (Table 2-7). Furthermore, three of the four data sets were not normally distributed (Table 2-8).

Table 2-7. Summary statistics for 1,4 Dioxane (*ug*/L).

Well ID	Valid N	Mean	Median	MIN	MAX	VAR	SD	SE	Skewness	Kurtosis
MW-5 (BR)	10	95.1	86.0	10.0	220.0	4,868	69.77	22.06	0.69	-0.50
GEI-F2 (BR)	10	293.5	165.0	16.0	1,100.0	114,746	338.74	107.11	1.75	3.07
E&E FIT2 (OB)	10	760.9	136.8	5.0	3,300.0	1,156,629	1075.46	340.09	1.68	2.77
CDM-5S (OB)	6	471.8	470.0	6.0	1,300.0	226,200	475.60	194.16	1.03	1.42
JSB-1 (BR)	9	405.1	77.0	3.0	3,000.0	950,917	975.15	325.05	2.97	8.89
MW-8 (BR)	10	655.3	445.0	45.0	1,900.0	402,829	634.68	200.70	0.97	-0.14
MW-8A (OB)	10	720.8	565.0	58.0	2,000.0	349,526	591.20	186.95	1.24	1.41

Table 2-8. Summary of Shapiro-Wilk test for normality (1,4 Dioxane).

Well ID	N	W	*p*-value
MW-5 (BR)	10	0.933	0.487
GEI-F2 (BR)	10	0.798	**0.013**
E&E FIT2 (OB)	10	0.751	**0.003**

CDM-5S (OB)	6	0.884	0.290
JSB-1 (BR)	9	0.449	**0.000002**
MW-8 (BR)	10	0.867	0.093
MW-8A (OB)	10	0.892	0.179

The trend in 1,4 Dioxane concentrations in all wells examined is episodic (Gilbert, 1987) (Figures 2-3a and 2-3b) but exhibit a general decrease with time. The decrease with time is however, only statistically significant within bedrock well GEI F2 (BR) (Table 2-9).

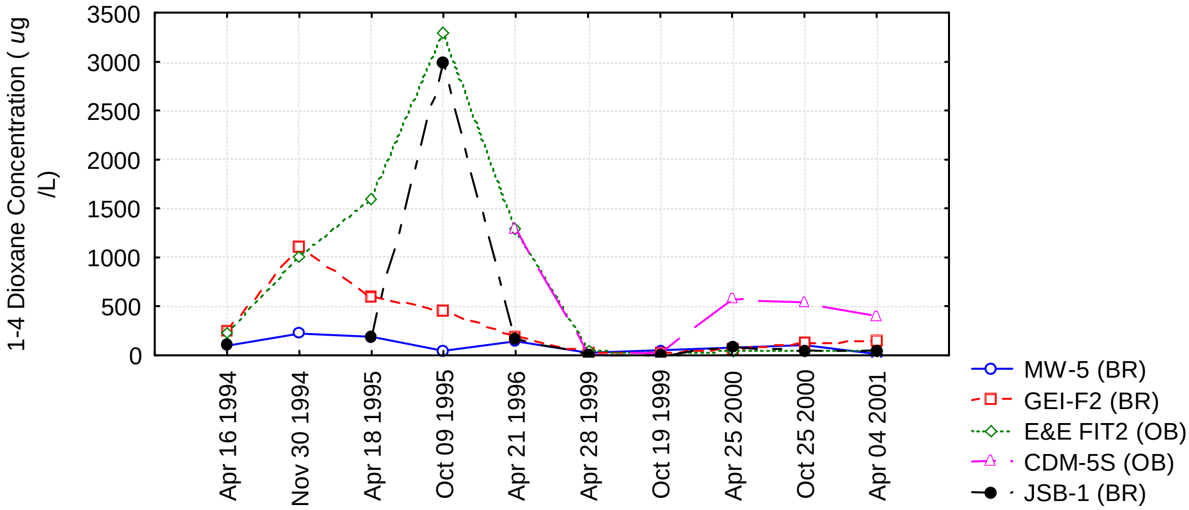

Figure 2-3a. Temporal trend in 1,4 Dioxane concentrations (*u*g/L) (Well Set 1).

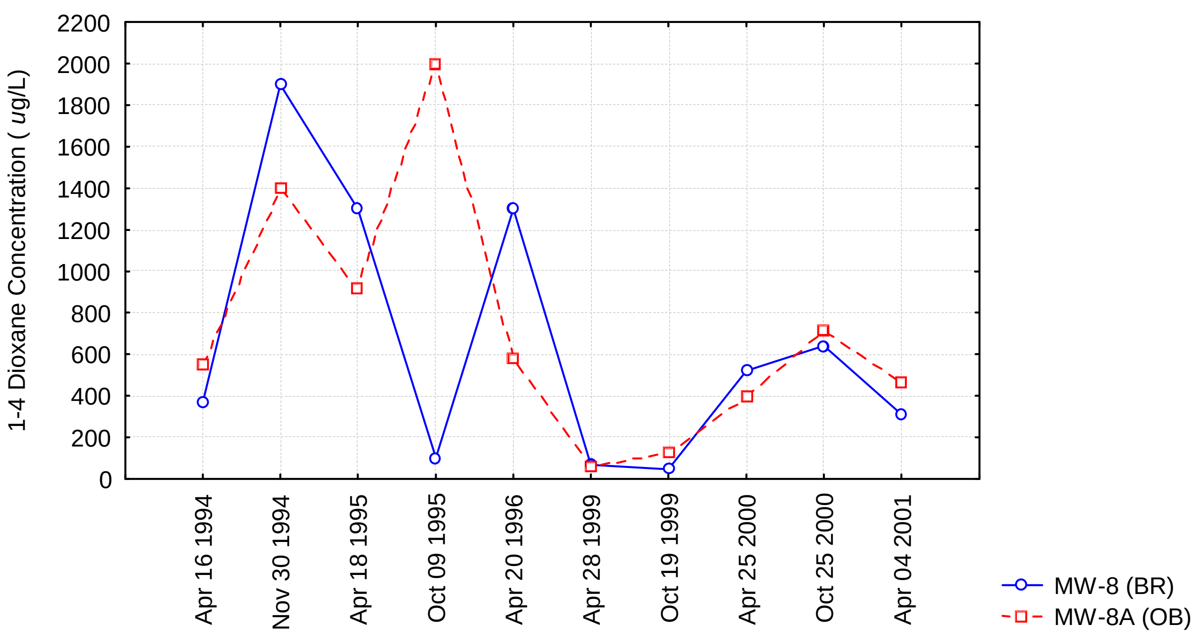

Figure 2-3b. Temporal trend in 1,4 Dioxane concentrations (*u*g/L) (Well Set 2).

Table 2-9. Summary of Mann-Kendall analysis of time series 1,4 Dioxane data.

Well ID	S	Z crit. 0.95	Z	*p*-value	Trend
MW-5 (BR)	-19	1.645	-1.43	0.07	No trend
GEI-F2 (BR)	-18	1.645	-1.61	**0.05**	Decreasing
E&E FIT 2 (OB)	-17	1.645	-1.48	0.06	No trend
CDM5-S (OB)	-1	1.645	0	0.50	No trend
JSB-1 (BR)	-13	1.645	-1.25	0.08	No trend
MW-8 (BR)	-2	1.645	-0.08	0.44	No trend
MW-8A (OB)	-11	1.645	-0.89	0.17	No trend

3.0 LITERATURE CITED

Gilbert, R.O. (1987). Statistical Methods for Environmental Pollution Monitoring. John Wiley and Sons, Inc.

Naval Facilities Engineering Command (1998). Procedural Guidance for Statistically Analyzing Environmental Background Data. SWDIV and EFA West of Naval Facilities Engineering Command.

Shapiro, S.S. & Wilk, M.B. (1965). An analysis of variance test for normality (complete samples). Biometrika, 52, 591-611.

ATTACHMENT 4

SOIL GAS PROBE LOCATIONS (FROM M&E, 1997)

LEGEND

- Town Roadway
- Access Roads
- Community Boundary
- Fence
- Stream
- Limits of HDPE Liner
- Leachate Collection Pond
- 1500 Foot Buffer Outside of HDPE Liner
- Detention and Sedimentation Basin
- Ponds and Water Bodies
- Buildings and Structures
- Wetland
- Cap Probe Location
- Perimeter Probe Location
- Previous Soil Gas Detection > 10% LEL
- F Flow Insufficient For GA-90 and HMX-271
- PF Flow Insufficient For HMX-271
- W Water Encountered
- ND CH_4, H_2S, VOCs Not Detected

SOURCE:

Roads & Hydrology - 1993 MassGIS
Landfill - U.S. Army Corp. of Engineers
Property Boundaries - Town of Tyngsborough Assessors Maps #13 and #14
Buildings - M&E Field Investigation - Jan. 1997
Wetlands - Approximate Locations, M&E
Soil Gas Probes - Approximate Locations, M&E

Metcalf & Eddy

SCALE: 250 0 250 SCALE IN FEET

Figure 1.
SOIL GAS PROBE LOCATIONS
AND DETECTIONS OF CH_4, H_2S, and VOCs :
FIRST QUARTERLY MONITORING ROUND RESULTS
CHARLES GEORGE RECLAMATION LANDFILL
TYNGSBOROUGH, MA.

M&E TASK NO.
004609.0030.017.012

SHEET 1 OF 1

landfill_nd3
6.9.97

ATTACHMENT 5

SITE INSPECTION PHOTOS AND INTERVIEW RECORDS

Photo 1: West side of landfill.

Photo 2: North side of landfill.

Photo 3: East side of landfill.

Photo 4: Former Leachate Lagoon.

Photo 5: Perimeter access road looking east.

Photo 6: Perimeter access road looking west.

Photo 7: East Sedimentation Basin looking north.

Photo 8: Riser pipe of East Sedimentation Basin outlet structure.

Photo 9: East Pumping Station building.

Photo 10: Typical East Extraction System well vault.

Photo 11: Southwest Sedimentation Basin.

Photo 12: Southwest Groundwater Extraction System well vaults.

Photo 13: West Pumping Station.

Photo 14: West Pumping Station control panels.

Photo 15: Storm water culvert under Dunstable Road.

Photo 16: Effluent Monitoring Station.

Photo 17: Landfill gas flare.

Photo 18: New office building to the north of the landfill looking south.

INTERVIEW RECORD

Site Name: Charles George Landfill	**EPA ID No.:**	
Subject: Five Year Review	**Time:** 11:00 am	**Date:** March 10, 2005
Type: **Telephone X** Visit Other **Location of Visit:**	Incoming **Outgoing X**	

Contact Made By:

Name: Greg Mischel	**Title: Project Manager**	**Organization:** TRC Environmental

Individual Contacted:

Name: Joan Ferrari	**Title: Health Administrator**	**Organization: Tyngsborough Board of Health**

Telephone No: 978-649-2300 ext. 118 **Fax No:** **E-Mail Address:**	**Street Address:** Town Offices **City, State, Zip:** Tyngsborough, MA

Summary Of Conversation

Q1 Are you familiar with the site?
A1 Yes.

Q2 Is there a Town bylaw or requirement to connect to the public water supply line, can anyone install a drinking water well near the site?
A2 Residents in the vicinity of the site cannot install a drinking water well without a permit from the Town. The Town is not granting permits if there is access to the public water line, and there is good coverage of the area around the site with the water line for Tyngsborough. The water line does not extend into Dunstable. The Town did permit the installation of a well for irrigation purposes at the industrial park located to the north of the site at 31 Progress Avenue. The irrigation well was installed on August 1, 2002.

Ms. Ferrari noticed orange staining on Dunstable Road in front of the West Pump Station this past winter. The staining appeared to be caused by water from the site.

Ms. Ferrari does not believe that there is any additional evidence of visible contamination (i.e. leachate) on the west side of the site near Route 3.

INTERVIEW RECORD

Site Name: Charles George Landfill	**EPA ID No.:**	
Subject: Five Year Review	**Time:** 1:00 pm	**Date:** March 11, 2005
Type: **Telephone X** Visit Other **Location of Visit:**	Incoming **Outgoing X**	

Contact Made By:

Name: Greg Mischel	**Title:** Project Manager	**Organization:** TRC Environmental

Individual Contacted:

Name: Alan Curseaden	**Title: Superintendent**	**Organization: Tyngsborough Sewer Commission**
Telephone No: 978-649-2300 x134 **Fax No:** **E-Mail Address:**	**Street Address:** 25 Bryants Lane **City, State, Zip:** Tyngsborough, MA 01879	

Summary Of Conversation

Q1 Are you familiar with the site?
A1 Yes, Alan was involved with the construction of the remedy prior to working for the Tyngsborough Sewer Commission.

Q2 Are you aware of any problems with the site in the last five years?
A2 Odors have been noticed coming from the wet well at the Cummings Road pump station. Iron bacteria growth has been observed on the walls of the Cummings Road Pump Station wet well. Mr. Curseaden was concerned that the iron bacteria may also be growing in, and clogging the sewer pipe downstream. Seeps near the West Pump Station on Dunstable Road sometimes flow over the road.

INTERVIEW RECORD

Site Name: Charles George Landfill	**EPA ID No.:**	
Subject: Five Year Review	**Time: 9:00 am**	**Date:** March 17, 2005
Type: Telephone **<u>Visit X</u>** Other **Location of Visit: Project Site**	Incoming Outgoing	

Contact Made By:

Name: Greg Mischel	**Title:** Project Manager	**Organization:** TRC Environmental

Individual Contacted:

Name: Various, see below	**Title:** See Below	**Organization:** See Below
Telephone No: See Below **Fax No:** **E-Mail Address:**	**Street Address:** See Below **City, State, Zip:** See Below	

Summary Of Conversation

Questions and answers are provided on the attached sheets.

Names and contact information for interviewees are provided below:

David Buckley
Massachusetts DEP
One Winter St., Boston, MA
617-556-1184

David O'Connor
Army Corps of Engineers
50 MacArthur Ave.
Ayer, MA
978-318-8129

Jason Bierly
Clean Harbors, Inc.
1501 Washington St.
Braintree, MA
781-849-1800

Names and contact information for interviewees (continued) for March 17, 2005 interview:

Doug Murphy
Clean Harbors, Inc.
1501 Washington St.
Braintree, MA
781-849-1800

Jeff McCullough, P.E.
Nobis Engineering, Inc
18 Chenell Drive
Concord, NH
603-224-4182

Marc Bouvier
Nobis Engineering Inc.
439 South Union St.
Lawrence, MA
978-683-0891

Interview with: David O'Connor, ACOE; Jeff McCullough, Nobis Eng; Marc Bouvier, Nobis Eng.

Interviewer: Greg Mischel, TRC

Questions Regarding the East Extraction System

1. Which extraction wells are currently in use?

WES-1, PW-1A, and CDM-3 are currently in use. Use of CDM-1 has been discontinued due to low contaminant load.

2. Are citric acid and biocide still being added to the effluent at the east and west pump stations?

Yes automatic injection by chemical feed pumps at the pump stations.

3. Is the leachate storage lagoon still in use? If not, when was use discontinued?

No, approval from the POTW to bypass the lagoon was granted May 8, 2001.

4. How are flows measured and where?

Flow is measured at the East Extraction wells, the East and West Pump Stations and the Effluent Monitoring Station.

5. How does the O&M contractor verify that the pumps are operating?

Visual inspection of flow meters and flows are recorded by the control system in the Operation and Maintenance Building.

6. Is the collection system still shut down over weekends?

The collection system was never shut down. Pumping from the Leachate Lagoon and discharge to the sewer system was restricted to business hours at one time. Pumping and discharge is now 24/7 since the Leachate Lagoon was taken off-line in 2001.

7. Has there been any water quality testing of the effluent?

Samples are collected from effluent monitoring station to satisfy the POTW permit. There has been limited sampling of the extraction system wells.

8. Have there been any problems with fouling of lines or pumps?

Minor fouling noted. The fouling is controlled by routine maintenance. The force main line was cleaned out once, no clogging was noted. The line between WES-1 and the East Pump Station has had some fouling in the past, but the line is now cleaned periodically using a water jet.

9. Have there been any problems with the effluent monitoring station?

No problems noted. No problems with pH in the past. The system is set to shut down if the pH drops below 6. No problem with temperature.

Interview with: David Buckley, MADEP; Jason Bierly, Clean Harbors; Doug Murphy, Clean Harbors.

Interviewer: Greg Mischel, TRC

Questions Regarding the Landfill Gas Management System

1. Are the temporary gas monitoring probes still being used? If yes, what is the frequency of monitoring? Has there been any impact to the new buildings mentioned in the last five year report to the north of the landfill?

Probes are monitored quarterly. Some of the probes originally installed have been damaged and may not be suitable for monitoring. Currently 19 or 20 of the original probes are being monitored.

2. Have there been any landfill gas odors noted during inspections or reported by the public?

Minor odors have been noted on the south side of the landfill by the Southwest Trench system.

3. What is the permitted flow rate and flare temperature to ensure contaminant destruction?

The flare blower is running at about 210 to 230 cfm and a temperature of 1600 degrees Fahrenheit

4. Is oxygen intrusion still a problem?

Yes, the flare shuts down at 7% oxygen in the influent gas. No evidence of a leak in the lines was found during pressure testing. There is no auto dialer to notify the O&M contractor of a flare shut down. The flare is restarted manually during weekly site visits.

5. Is the flare self sustaining or is supplemental fuel needed?

No supplemental fuel is needed at this time.

6. Is there any system balancing being performed? Please describe.

No balancing is performed. All wells are ¼ open except the monitoring wells which are open full.

7. How deep are the temporary gas probes installed?

Shallow, <10 feet.

8. Has there been any stack testing of the flare off gas in the last five years?

No. Flare stack testing is overdue and will be performed this year.

9. Has there been any ambient air testing in the last five years?

No. Modeling was done using the last stack test data to evaluate possible off-site impacts.

Questions Regarding the SW Extraction Trench System

1. Which extraction wells are currently in use?

All are in use. Pumps are currently off due to problem with the West Pump Station.

2. Are citric acid and biocide still being added to the effluent at the east and west pump stations?

Yes, this is done by the Army Corps O&M contractor at the East and West Pump Stations.

3. Is the leachate storage lagoon still in use? If not, when was use discontinued?

This was the responsibility of the Army Corps.

4. How are flows measured and where?

Flow meters do not work on the Southwest Extraction wells. The flow meters were inappropriate for the conditions, fouling was a problem. Total flow of SW Extraction system and the leachate collection system is measured at the West Pump Station by the Army Corps.

5. How does the O&M contractor verify that the pumps are operating?

Monitor the running amperage of the pumps, observe drawdown in the well, and check the circuit breakers.

6. Is the collection system still shut down over weekends?

This is an Army Corps issue.

7. Has there been any water quality testing of the effluent?

Water quality testing is not performed by MADEP and Clean Harbors.

Questions Regarding the Landfill Cap

1. Where is the "Depression Area Repair"?

It is shown on the as-built drawing.

2. Have any leachate breakouts been observed in the last five years?

Orange staining ahs been noted on the landfill side of Dunstable Road.

3. Have there been any recurring bare spots or areas of poor cap vegetation growth? If yes, was there any repair?

No problems have been noted.

4. Has there been a problem with animals burrowing into the cap? If yes, was there an effort to eradicate the animals?

Holes have been noted, mostly near the gas pipes. There is currently no animal control program in place.

5. How is the growth of woody vegetation being controlled on the landfill cap?

Crushed gravel areas on the side slopes are sprayed with herbicide once per year. The grass at the top of the landfill is cut twice per year.

6. Have there been any problems with erosion, settlement, or sloughing of cap soils?

No slumps have been observed. No significant differential settlement has been observed.

7. Have the leachate collection and transfer lines been inspected or cleaned in the last five years?

No but visual inspection is performed at cleanouts.

8. Has there been any notable change in flow from the leachate collection system in the last five years?

There is no good way to measure leachate flow since the flow is combined with extracted groundwater before the flow meters.

9. Has there been any problem with site security or vandalism in the last five years?

In one instance the fence was cut by contractors removing trees on an adjacent piece of land. In a second instance, the gate by the East Detention basin was removed from the *hinges and kids on dirt bikes entered the site. The fence has been repaired and the gate has been modified to prevent removal.*

End of Interview.

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: Charles George Landfill	**Date of inspection:** 3/17/05
Location and Region: Tyngsboro, MA	**EPA ID:**
Agency, office, or company leading the five-year review: M&E and TRC	**Weather/temperature:** Clear, 45°F

Remedy Includes: (Check all that apply)

- ✓ Landfill cover/containment
- ✓ Access controls
- ✓ Institutional controls
- ✓ Groundwater pump ~~and treatment~~
- Surface water collection and treatment
- Other Leachate collection system
- 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** Jason Bierly (Name) for MADEP   ~~[illegible]~~ Remediation Engineer (Title)   3/17/05 (Date)
   Interviewed (at site — circled) at office by phone Phone no. ______
   Problems, suggestions; Report attached ______

2. **O&M** ~~**staff**~~ Manager Jeff McCullough (Name) for ACOE   Sr. Project Manager (Title)   3/17/05 (Date)
   Interviewed (at site — circled) at office by phone Phone no. ______
   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 MA DEP
Contact David Buckley ______ 3/17/05 ______
Name Title Date Phone no.
Problems; suggestions; Report attached ______

Agency Army Corps of Eng.
Contact David O'Connor ______ 3/17/05 ______
Name Title Date Phone no.
Problems; suggestions; Report attached ______

Agency Tyngsborough Sewer Dept.
Contact Allen Cuiseaden Superintendent 3/17/05 ______
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			
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 Last monitoring event conducted April 2001			
8. ✓ **Leachate Extraction Records**	Readily available	Up to date	(N/A)
Remarks Leachate flow is not measured directly. Flow is combined with extracted groundwater			
9. ✓ **Discharge Compliance Records**			
Air	(Readily available)	Up to date	N/A
Water (effluent)	Readily available	Up to date	N/A
Remarks Stack testing is over due.			
10. ✓ **Daily Access/Security Logs**	(Readily available)	(Up to date)	N/A
Remarks			

IV. O&M COSTS

1. **O&M Organization**
State in-house — Contractor for State (circled) — SW extraction trench / Landfill Cap / Gas system/flare
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other Army Corps of Engineers and their contractor (Nobis) perform O&M of East Extraction system and Effluent Monitoring Station.

2. **O&M Cost Records**
Readily available — Up to date — Cost Data provided by MADEP & ACOE
Funding mechanism/agreement in place — Yes
Original O&M cost estimate NA — Breakdown attached

Total annual cost by year for review period if available
Cost data from ACOE and MADEP are attached.

From (Date)	To (Date)	Total cost	
			Breakdown attached
			Breakdown attached
			Breakdown attached
			Breakdown attached
			Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: None indicated by MADEP & ACOE

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable (circled) — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured (circled) — N/A
Remarks: Entire length of fence not inspected due to deep snow.

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A
Remarks

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

Institutional controls need review to determine if they are legally enforceable.

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 Based on limited inspection ~~and~~ interviews

2. **Land use changes on site** N/A
Remarks None

3. **Land use changes off site** N/A
Remarks Yes recent construction of commercial buildings to north of site

VI. GENERAL SITE CONDITIONS

A. Roads (Applicable) N/A

1. **Roads damaged** Location shown on site map ~~Roads adequate~~ N/A
Remarks Not all roads visible due to snow cover

B. Other Site Conditions

Remarks____

VII. LANDFILL COVERS (Applicable) N/A

A. Landfill Surface Landfill surface not visible due to snow

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
Areal extent________ Depth________ (NA)
Remarks________________________

2. **Cracks** Location shown on site map Cracking not evident
Lengths________ Widths________ Depths________ (NA)
Remarks________________________

3. **Erosion** Location shown on site map Erosion not evident
Areal extent________ Depth________ (NA)
Remarks________________________

4. **Holes** Location shown on site map Holes not evident
Areal extent________ Depth________ (NA)
Remarks________________________

5. **Vegetative Cover** Grass Cover properly established No signs of stress
Trees/Shrubs (indicate size and locations on a diagram) (NA)
Remarks________________________

6. **Alternative Cover (armored rock, concrete, etc.)** (N/A)
Remarks present on side slopes, not visible

7. **Bulges** Location shown on site map Bulges not evident
Areal extent________ Height________ (NA)
Remarks________________________

NA = Not applicable; could not inspect due to snow

8. **Wet Areas/Water Damage**		Wet areas/water damage not evident	
Wet areas	NA	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______		NA	
Remarks______			

B. Benches Applicable N/A NA

(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 Did not directly inspect
Properly secured/locked (Functioning) (Routinely sampled) Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks Monitoring records indicate the vents are routinely sampled and functioning.

2. **Gas Monitoring Probes** Could not locate
Properly secured/locked Functioning (Routinely sampled) Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks 20 probes are routinely sampled; some have been damaged.

3. **Monitoring Wells** (within surface area of landfill) Did not inspect
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks________

4. Groundwater ~~**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** Piping in flare building was inspected
   (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______

1400°F
set point.
220-230 cfm
VFD

F. Cover Drainage Layer (Applicable) N/A

1. **Outlet Pipes Inspected** (NO) Functioning N/A snow covered
   Remarks______

2. **Outlet Rock Inspected** (NA) Functioning N/A snow covered
   Remarks______

G. Detention/Sedimentation Ponds (Applicable) N/A

1. **Siltation** Areal extent______ Depth______ (N/A)
   Siltation not evident
   Remarks______

2. **Erosion** Areal extent______ Depth______ (NA) snow covered
   Erosion not evident
   Remarks______

3. **Outlet Works** Functioning N/A
   Remarks Undermining / by pass of outlet works for East Basins (stand pipe and culvert)

4. **Dam** Functioning (N/A)
   Remarks______

OK → Southwest Basin — outlet undermined by erosion.
East Basin ↗
West Basin — OK
Leachate Collection Pond — OK, not in use
Woody vegetation should be removed from basins

H. Retaining Walls	Applicable	N/A (circled)	
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 (circled)	N/A	Covered with snow
1. **Siltation**	Location shown on site map	Siltation not evident	
Areal extent______________	Depth______________	NA (circled)	
Remarks____			
2. **Vegetative Growth**	Location shown on site map	N/A	
Vegetation does not impede flow		Snow (circled)	
Areal extent______________	Type____________		
Remarks____			
3. **Erosion**	Location shown on site map	~~Erosion not~~ evident	
Areal extent______________	Depth____________	Snow (circled)	
Remarks____			
4. **Discharge Structure**	Functioning	N/A	(see Detention Ponds)
Remarks____			
VIII. VERTICAL BARRIER WALLS	Applicable	N/A (circled)	
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~~ GAM	
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~~ GAM Remarks Monitoring and O&M records indicate pumps are well maintained. Electrical controls etc. in buildings appeared to be in good condition
2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** Not inspected 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

West Pump Station
East Pump Station
Operations and Maintenance Blg.
Effluent Monitoring Station

West Pumping System
CDM1 No flow CDM3 0.89 gpm
WES1 3.5 gpm PW1/A 4.58 gpm
FM 15.5 gpm

C. Treatment System Applicable N/A (circled)

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____________________

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 (NA)

I. **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.).

The remedy is effective and functioning as intended to prevent direct exposure to solid waste/leachate, abate impact to surface waters & wetlands, minimize continued release to groundwater, control gas, reduce risks from ingesting groundwater, remediate shallow eastern groundwater, reduce risks due to gas.

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.

Overall O&M appears to be adequate except that burrowing animals should be controlled on the landfill cap and woody vegetation should be removed from the sedimentation basins.

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.
	None identified except animal control and removal of woody vegetation.

D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.
	The landfill gas management system should be evaluated to determine if a smaller blower or other modifications could reduce flare down time and maintain a steady, sustainable flow rate.

Mischel, Greg

From: Buckley, David (DEP) [David.Buckley@state.ma.us]
Sent: Monday, March 14, 2005 1:53 PM
To: Mischel, Greg
Subject: RE: Charles George questions

Here is a quick estimate for Charles George O&M costs for the period of 1/2000 through 12/2004: $308,604

Please note, of the above stated amount, $72,930 was funded by EPA for operation of the southwest trench. EPA may provide you trench operation costs also so you may want to be aware of a possible double counting.

-----Original Message-----
From: Mischel, Greg [mailto:GMischel@TRCSOLUTIONS.com]
Sent: Wednesday, March 09, 2005 4:51 PM
To: Buckley, David (DEP)
Subject: Charles George questions

Dave,

Attached is a list of questions I may ask during the Charles George site inspection and interview. I may think of a few more between now and then.

<<DEP_questions.doc>>

Gregory A. Mischel, P.E.

TRC Environmental Corporation
Foot of John Street
Lowell, Massachusetts 01852

Office: (978) 656-3569
Fax: (978) 453-1995
Cell: (978) 852-3424

Construction/Operations Division
North Central Resident Office

CHARLES GEORGE LANDFILL SUPERFUND SITE

Operation and Maintenance of Operable Unit IV — **1996 to DEC 11, 2000**
DACW33-95-D-0002 — **Contractor:** Weston Solutions

Contract Amount	Estimated Placement	Completed to Date

O&M work included in the Task Orders under a RAC contract.

Operation and Maintenance of Operable Unit IV — **DEC 12, 2000 to DEC 31, 2002**
DACW33-01-C-0004 — **Contractor:** Coastal Environmental

Contract Amount	Estimated Placement	Completed to Date
$379,951		$379,951

Operation and Maintenance of Operable Unit IV — **JAN 1, 2003 to FEB 24, 2003**
Purchase Orders — **Contractor:** Tim Jones & Nobis Eng

Contract Amount	Estimated Placement	Completed to Date
$20,00		$20,000

Operation and Maintenance of Operable Unit IV — **FEB 25, 2003 to Present**
DACW33-03-C-0004 — **Contractor:** Nobis Engineering

Contract Amount	Estimated Placement in February 05	Completed to Date
$517,116	13,000 +/-	$419,219

ATTACHMENT 6

ARARS REVIEW

ATTACHMENT 6, TABLE 1
POTENTIAL CHEMICAL-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

MEDIA and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
<u>Groundwater</u>				
Federal Regulatory Requirements	SDWA - Maximum Contaminant Levels (MCLs) (40 CFR 141.11 - 141.16)	Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water. When risks to public health due to consumption of groundwater were assessed, concentrations of contaminants of concern, including benzene and TCE, were compared to their MCLs. Projected concentrations of benzene exceeded the MCL in several locations. SDWA MCLs also were used in setting discharge requirements.	MCLs and non-zero MCLGs have the status of ARARs for areas not directly overlain by waste. Some MCLs and MCLGs have changed since ROD completion. An update of the MCLs/MCLGs is provided in Table 2. Residential well monitoring did not indicate any exceedences of groundwater COCs. This ARAR is being attained. The MCL for arsenic is changed from 50 ppb to 10 ppb, effective 1/23/06. This change will need to be considered during evaluation of when the groundwater extraction system can be shut down.
	RCRA - Subpart F, Groundwater Protection Standards, Concentration Limits (40 CFR 264.94(a))	Relevant and Appropriate	The onsite landfill contains material sufficiently similar to RCRA Subtitle C wastes; therefore RCRA landfill rules are relevant and appropriate. The groundwater protection regulations require the setting of groundwater protection standards which must be protective of the public health and the environment. RCRA standards for 14 toxic compounds have been adopted as part of RCRA groundwater protection standards. These limits were originally set at MCLs. RCRA sets the limit for organic constituents at background levels. Groundwater contaminant levels were compared to these limits. Although eastern shallow groundwater is not a potential drinking water source, it does exceed these limits. Therefore it requires remediation.	Site COCs arsenic, chromium, mercury and cadmium are included in the 14 toxic compounds for which standards have been adopted. Currently, only COC cadmium has a RCRA MCL (0.01 mg/L) that differs from the SDWA MCL (0.005 mg/L). RCRA sets the limit for organic constituents at background levels. Constituents in site groundwater exceed RCRA MCLs for background concentrations for a few, scattered organic constituents, at very low levels. Groundwater requires continued remediation under this rule.

MEDIA and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
	RCRA - Subpart F Groundwater Protection Standards, Alternate Concentration Levels (ACLs) (40 CFR 264.94(b))	Relevant and Appropriate	ACLs are one of three possible standards (aside from MCLs and background concentrations) available under Subpart F for setting a clean-up level for remediation of groundwater contamination from a RCRA facility. ACLs may be relevant and appropriate if certain conditions relating to transport and exposure are met. ACLs may need to be determined by EPA. Procedures for developing ACLs are outlined in RCRA Subpart F, Section 264.94(b).	There is no change from the ROD presentation for this ARAR. At this time, ACLs are not being sought.
Massachusetts Regulatory Requirements	Massachusetts Groundwater Quality Standards (314 CMR 6.00)	Applicable	Massachusetts Groundwater Quality Standards have been promulgated for a number of contaminants. When state levels are more stringent than federal levels, the state levels will be used. DEP Groundwater Standards were considered when determining discharge levels.	Massachusetts groundwater standards are updated and presented in Table 2. Groundwater underlying the site is designated Class I.
	Massachusetts Drinking Water Requirements (310 CMR 22.05 to 22.09)	Relevant and Appropriate	Requirements were considered; however, standards do not apply to contaminants found in site groundwater.	Because the site is within 500 feet of a private water supply well that was in use at the time of site discovery, drinking water requirements are relevant and appropriate. Many of the Massachusetts MCLs have changed since ROD completion; an updated list is provided in Table 2. Residential well monitoring did not indicate any exceedences of groundwater COCs. This ARAR is being attained.
Federal Criteria, Advisories, and Guidance	SDWA - Maximum Contaminant Level Goals (MCLGs)	Relevant and Appropriate /To Be	MCLGs are health-based criteria that are to be considered for drinking water sources as a result of SARA. These goals are available for a number of organic and inorganic contaminants.	Non-zero MCLGs have the status of ARAR for areas not directly overlain by waste. Zero MCLGs cannot have the status of ARARs but are,

MEDIA and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
		Considered	Projected groundwater concentrations of copper, trans-1,2-dichloroethene, toluene, benzene, and TCE were compared to their MCLGs. For benzene and TCE, MCLGs are set at zero.	however, to be considered in developing site remedies. Many of the MCLGs have changed since ROD completion. An update of MCLGs is provided in Table 2. There are scattered organic constituent hits which are low but do exceed zero MCLGs. These compounds, however, were not listed as groundwater COCs in the ROD. They include: chloroform, bromoform, 1,4-dioxane, 1,2-dichlorobenzene, methylene chloride, 1,1,2,2-trichloroethane, and others. Groundwater requires continued remediation under this rule.
	Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. Health Advisories were considered for contaminants in groundwater that may be used for drinking water.	These criteria are no longer maintained by EPA. These health advisories are not updated on the accompanying tables.
	EPA Risk Reference Doses (RfDs)	To Be Considered	RfDs are dose levels developed by EPA for non-carcinogenic effects. EPA RfDs were used to characterize risk due to exposure to contaminants in groundwater, as well as other media. They were considered for non-carcinogens including toluene, 2-butanone, n-dibutylphthalate, acetone, mercury, and thallium.	This factor is one of several factors used to calculate risk at a site. Reference doses and slope factors have changed from 1988. See Section 7 for discussion.
	EPA Carcinogen Assessment Group	To Be Considered	Potency factors are developed by EPA from Health Effects Assessments of evaluation by the	This factor is one of several factors used to calculate risk at a site.

ATTACHMENT 6, TABLE 1 (continued)
POTENTIAL CHEMICAL-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE
CHARLES GEORGE LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

MEDIA and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
	Potency Factors (CAGs)		Carcinogenic Assessment Group. EPA Carcinogenic Potency Factors were used to compute the individual incremental cancer risk resulting from exposure to benzene, arsenic, PAHs, trichloroethene, and 1,1-dichloroethene.	Reference doses and slope factors have changed from 1988. See Section 7 for discussion.
	Acceptable Intake - Chronic (AIC) and Subchronic (AIS) - EPA Health Effects Assessment (HEA) Documents	To Be Considered	AIC and AIS values are developed from RfDs and HEAs for noncarcinogenic compounds. AIC and AIS values were used to characterize the risks due to several noncarcinogens in various media. These noncarcinogens include cadmium, chromium, copper, and lead.	AICs and AISs have essentially been replaced by RfDs, and are not used in the 1999 updates.
	EPA Office of Water Guidance - Water-related Fate of 129 Priority Pollutants (1979)	To Be Considered	This guidance manual gives transport and fate information for 129 priority pollutants. The manual was used to assess the transport and fate of a variety of contaminants.	There is no change from the ROD presentation for this ARAR.
Massachusetts Criteria, Advisories, and Guidance	Massachusetts Office of Research and Standards Guidelines (ORSGs)	To Be Considered	DEP Health Advisories are guidance criteria for drinking water. DEP Health Advisories were used to develop discharge levels for surface water and groundwater.	The MADEP Office of Research and Standards issues guidelines for chemicals for which state MCLs have not yet been promulgated. These guidelines apply to non-chlorinated water supplies and represent a level at or below which adverse, non-cancer health effects are not expected to occur, and which generally has associated with it an excess lifetime cancer risk of less than or equal to one in one million. These criteria are included in Table 2.

MEDIA and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
				There is now an ORSG established for 1,4-dioxane of 3 ppb. This value will need to be considered during evaluation of when the groundwater extraction system can be shut down.
Discharge to Publicly Owned Treatment Works				
Federal Regulatory Requirements	RCRA - Pretreatment Standards (40 CFR 403) - Local POTW Approved Pretreatment Program Requirements	Applicable	Discharges to a POTW must comply with the POTW's EPA-approved pretreatment requirements. POTWs in the area with approved pretreatment programs are being identified and the discharge must be treated to those levels required by the program.	Collected leachate and groundwater are treated and discharged to the Lowell Regional Wastewater Utility (LRWU). This discharge is permitted and is in compliance with permit limits.
Discharge to Surface Water				
Massachusetts Regulatory Requirements	Massachusetts Surface Water Quality Standards (314 CMR 4.05)	Formerly Applicable - now not ARAR	DEP Surface Water Quality Standards are given for dissolved oxygen, temperature increase, pH, and total coliform and there is a narrative requirement for toxicants in toxic amounts. In the absence of a state standard for a compound, federal AWQC would be appropriate. Requirements were considered; however, no numerical standards exist for contaminants found in site groundwater which would be discharged to surface water. Federal AWQC will be used in the absence of narrative standards.	These regulations classify the surface waters of the Commonwealth according to the uses of those waters. The Merrimack River has a Class B waterway classification. Class B waters are designated as habitat for fish, other aquatic and wildlife, and for primary and secondary contact recreation. The state surface water minimum criteria for Class B waters are consistent with federal AWQC. These rules are applicable to the Merrimack River, Bridge Meadow Brook, Dunstable Brook, Flint Marsh, and Flint Pond. No discharges to these surface water bodies are occurring. Hence

MEDIA and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
				SWQC are no longer ARAR.
Surface Water				
Federal Criteria, Advisories, and Guidance	Federal Ambient Water Quality Criteria (AWQC)	Formerly Relevant and Appropriate - now Not ARAR	Federal AWQC are health-based and ecologically based criteria which have been developed for 95 carcinogenic and non-carcinogenic compounds. AWQC were considered in characterizing public health risks to aquatic organisms due to contaminant concentrations in surface water at Flint Pond. Because this water is not used as a drinking water source, the criteria developed for aquatic organism protection and ingestion of contaminant aquatic organisms were considered. AWQC were also used as limits for discharge to the Merrimack River.	CERCLA Sec. 121 (d)(2)(A) specifically states that remedial actions shall at least attain federal AWQC established under the Clean Water Act if they are relevant and appropriate. Many of the AWQC have changed since ROD completion. These criteria are ARAR for establishing discharge limits to the Merrimack River, Bridge Meadow Brook, Flint Marsh, and Flint Pond. No discharges to these water bodies are occurring. Hence AWQC are no longer ARAR.
Air				
Federal Regulatory Requirements	CAA - National Ambient Air Quality Standards (NAAQS) - 40 CFR 50	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions. Standards for sulfur dioxide, carbon monoxide and nitrogen dioxide apply.	NAAQS need to be taken into account when establishing discharges to the atmosphere. This includes the landfill gas treatment system.
Massachusetts Regulatory Requirements	Massachusetts - Air Quality, Air Pollution (310 CMR 6.00 - 8.00)	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	310 CMR 6.00 provide ambient air quality standards for the Commonwealth, standards for dust are contained in 310 CMR 7.09, and 310 CMR 7.08 provides incinerator standards. No further land-disturbing activities are planned. In the event of further excavation, dust control standards would become

MEDIA and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
				applicable.
Federal Criteria, Advisories, and Guidance	Threshold Limit Values (TLVs)	To Be Considered	These standards were issued as consensus standards for controlling air quality in workplace environments. TLVs could be used to assess site inhalation risks for soil removal operations.	There is no change from the ROD presentation for this criteria.
Massachusetts Criteria, Advisories, and Guidance	Massachusetts Threshold Effects Exposure Limits (TELs) and Allowable Ambient Levels (AALs), DEP Revised, December 1995.	To Be Considered	These are guidelines in emission permit writing. This guidance evaluates acute and chronic toxicity and sets TELs/ AALs for 115 chemicals. These criteria are used when evaluating human health risks from ambient air. AALs were considered when assessing the significance of monitored and modeled residential contamination from air emissions.	There is no change from the ROD presentation for this guidance.
<u>Soil and Sediment</u>				
Federal Regulatory Criteria, Advisories, and Guidance Federal Criteria, Advisories and Guidance	Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: EPA 1997 Revision	To Be Considered	None.	Guidelines have been developed by EPA for organic and inorganic compounds. These criteria represent levels protective of aquatic life. These benchmark criteria are summarized from three reports (Jones et. al. 1997; Jones et. al., 1996; and Hull and Suter 1994.)

ATTACHMENT 6, TABLE 2. CURRENT NUMERICAL STANDARDS FOR CONTAMINANTS OF CONCERN FOR GROUNDWATER AND LEACHATE, CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

Contaminants Of Concern (COC) [1]	SDWA [2] MCL (mg/L)	SDWA [2] MCLG (mg/L)	RCRA MCL [3] (mg/L)	Massachusetts Drinking Water Stds [4] (mg/L)	Massachusetts Groundwater Quality Stds. Class I[5] (mg/L)	Massachusetts ORSGs [9] (mg/L)
Organic Compounds						
Acetone	--	--	--	--	[10]	6.3
Benzene	0.005	0	--	0.005	[10]	--
Benzo(a)anthracene	--	--	--	--	[10]	--
Benzo(a)pyrene	0.0002	0	--	0.0002	[10]	--
Benzo(k)fluoranthene	--	--	--	--	[10]	--
Benzo(o)fluoranthene	--	--	--	--	[10]	--
Benzoic acid	--	--	--	--	[10]	--
Bromoform	0.08 [12]	0	--	0.08 [12]	[10]	--
Bromomethane	--	--	--	--	[10]	0.01
2-Butanone (MEK)	--	--	--	--	[10]	4.0
Carbon disulfide	--	--	--	--	[10]	--
Carbon tetrachloride	0.005	0	--	0.005	[10]	--
Chlorobenzene	0.1	0.1	--	0.1	[10]	--
Chloroform	0.08 [12]	--	--	0.08 [12]	[10]	0.07 [13]
Chrysene	--	--	--	--	[10]	--
Dibenzo(ah)anthracene [11]	--	--	--	--	[10]	--
1,2-Dichloroethane	0.005	0	--	0.005	[10]	0.07
1,1-Dichloroethene	0.007	0.007	--	0.007	[10]	--
Ethylbenzene	0.7	0.7	--	0.7	[10]	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	[10]	--
4-Methyl,2-pentanone	--	--	--	--	[10]	0.35
4-Methylphenol	--	--	--	--	[10]	--
2-Methylphenol	--	--	--	--	[10]	--
Methylene chloride	0.005	0	--	0.005	[10]	--
PAHs [1]	See indiv. compound		--	--	[10]	--
Phenol	--	--	--	--	[10]	--
1,1,2,2-Tetrachloroethane	--	--	--	--	[10]	--
Tetrachloroethene	0.005	0	--	0.005	[10]	--
Toluene	1	1	--	1	[10]	--
1,1,2-Trichloroethane	0.005	0.003	--	0.005	[10]	--
Trichloroethene	0.005	0	--	0.005	[10]	--
Vinyl chloride	0.002	0	--	0.002	[10]	--
Xylenes (total)	10	10	--	10	[10]	--
Inorganic Compounds						
Arsenic	0.010 as of 1/23/06	0	0.05	0.05*	0.05	--
Cadmium	0.005	0.005	0.01	0.005	0.01	--
Chromium (total)	0.1	0.1	0.05	0.1	0.05	--
Copper	TT [8]	1.3	--	TT [8]	1.0	--
Mercury (inorganic)	0.002	0.002	0.002	0.002	0.002	--

ATTACHMENT 6, TABLE 2. CURRENT NUMERICAL STANDARDS FOR CONTAMINANTS OF CONCERN FOR GROUNDWATER AND LEACHATE, CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

Contaminants Of Concern (COC) [1]	SDWA [2] MCL (mg/L)	MCLG (mg/L)	RCRA MCL [3] (mg/L)	Massachusetts Drinking Water Stds [4] (mg/L)	Massachusetts Groundwater Quality Stds. Class I[5] (mg/L)	Massachusetts ORSGs [6] (mg/L)
Other Chemicals [7]						
Tetrahydrofuran	--	--	--	--	[10]	1.3
1,4-Dioxane	--	--	--	--	[10]	0.003
Antimony	0.006	0.006	--	0.006	--	--
Lead	TT [9]	0	0.05	TT [9]	0.05	--
Nickel	--	--	--	--	[10]	0.1
Thallium	0.002	0.0005	--	0.002	[10]	--

FOOTNOTES

1 Contaminants of concern (COCs) are those listed in Table 6 of ROD III. PAHs include: benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene.

2 National Primary Drinking Water Standards, June 2003. Office of Water (4606M), EPA 816-F-03-016. www.epa.gov/safewater.

3 264.94, Table 1.
RCRA sets the limits for organic contaminants at background levels.

4 Massachusetts Drinking Water Regulations, 310 CMR 22.00, MA Maximum Contaminant Level (MMCL), last promulgated April 2004.

5 Massachusetts Groundwater Quality Standards, 314 CMR 6.06.

6 Massachusetts Department of Environmental Protection, Office of Research and Standards, Drinking Water Standards and Guidelines, April 2004.

7 Analytes detected in groundwater

8 TT: Treatment technique. NOTE: 90% of tap samples must meet a "no action" level of 1.3 mg/L copper.

9 TT: Treatment technique. NOTE: 90% of tap samples must meet a "no action" level of 0.015 mg/l lead at the tap.
Public water systems exceeding the action level must for further treatment; b) undertake a public education program to inform consumers about how to reduce exposure to lead in drinking level continues, replace all lead service pipes.

10 None in such concentrations which in the opinion of the department would impair the waters for use as a source of potable water or to cause or contribute to a condition in contravention of standards for other classified waters of the Commonwealth.

11 Even though dibenzo(ah)anthracene was not included in the ROD, it was included in the list of carcinogenic PAHs for which human health risk was calculated and is, thus, included here.

12 Criteria is for total trihalomethanes. TTHM equal the sum of bromodichloromethane, dibromochloromethane, bromoform, and chloroform.

13 This drinking water guideline is for non-chlorinated supplies only.

* The MCL for arsenic was changed in 2001 and will become effective at 0.01 mg/L as of 1/23/06 following implementation Guidance issued in August 2002.

ATTACHMENT 6, TABLE 3
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
Federal Regulatory Requirements			
RCRA - Standards for Owners and Operators of Permitted Hazardous Waste Facilities (40 CFR 264.10 - 264.18)	General facility requirements outline general waste analysis, security measures, inspections, and training requirements - **Relevant and Appropriate**	All facilities on-site will be constructed, fenced, posted, and operated in accordance with this requirement. All workers will be properly trained. Process wastes will be evaluated for the characteristics of hazardous wastes to assess further requirements. Treatment residuals from wastewater treatment will be disposed of according to RCRA Subtitle C.	These requirements remain relevant and appropriate, and are being complied with.
RCRA - Preparedness and Prevention (40 CFR 264.30-264.37)	This regulation outlines safety equipment and spill control requirements for hazardous waste facilities. Part of the regulation includes a requirement that facilities be designed, maintained, constructed, and operated so that the possibility of an unplanned release which could threaten public health or the environment is minimized - **Relevant and Appropriate**.	Safety and communication equipment will be installed at the site; local authorities will be familiarized with site operations. RCRA requirements must be considered when evaluating extensions to the present landfill.	These requirements remain relevant and appropriate, and are being complied with.
RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50-264.56)	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc. This regulation also requires that threats to public health and the environment be minimized - **Relevant and Appropriate**.	Plans will be developed and implemented during site work including installation of monitoring wells, and implementation of site remedies. Copies of the plans will be kept on-site. RCRA requirements must be considered when evaluating extensions to the present landfill.	These requirements remain relevant and appropriate, and are being complied with.
RCRA - Manifesting, Recordkeeping, and Reporting (40 CFR 264.70-264.77)	This regulation specifies the recordkeeping and reporting requirements for RCRA facilities - **Relevant and Appropriate**.	Records of facility activities will be developed and maintained during remedial actions.	These requirements remain relevant and appropriate, and are being complied with.

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
RCRA - Groundwater Protection (40 CFR 264.90-264.109)	This regulation details requirements for a groundwater monitoring program to be installed at the site - **Relevant and Appropriate**.	A groundwater monitoring system must be installed as part of any alternative. During site characterization, the location and depth of monitoring wells will be evaluated for use in this monitoring program.	These requirements remain relevant & appropriate. A groundwater monitoring program has been implemented at the site.
RCRA - Closure and Post-Closure (40 CFR 264.110-264.120)	This regulation details specific requirements for closure and post-closure of hazardous waste facilities - **Relevant and Appropriate**.	Those parts of the regulations concerned with long-term monitoring and maintenance of the site will be considered during remedial design. A post-closure plan will be developed.	These requirements remain relevant & appropriate. A post closure plan has been developed by the EPA and USACE.
OSHA - General Industry Standards (29 CFR Part 1910)	This regulation specifies the 8-hour time-weighted average concentration for various organic compounds **- Not ARAR.**	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentrations.	OSHA has promulgated standards for protection of workers at hazardous waste operations at RCRA or CERCLA sites. These regulations are designed to protect workers who would not be exposed to hazardous waste. OSHA requirements are no longer considered ARAR by the EPA as OSHA is viewed as an employee protection law rather than an "environmental" law, and as OSHA standards apply directly to all CERCLA response actions. (see Federal Register volume 55, page 8679, March 8, 1990). EPA requires compliance with the OSHA standards in the NCP (40 CFR 300.150), not through the ARAR process. OSHA standards are discussed in the Site Health and Safety Plan.
OSHA - Safety and Health Standards (29 CFR Part 1926)	This regulation specifies the type of safety equipment and procedures to be followed during site remediation **- Not ARAR.**	All appropriate safety equipment will be on-site. In addition, safety procedures will be followed during on-site activities.	
OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA - **Not ARAR.**	These requirements apply to all site contractors and subcontractors and must be followed during all site work.	

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
RCRA - EPA Regulations on Land Disposal Restrictions (40 CFR 268)	This regulation outlines land disposal requirements and restrictions for hazardous wastes - **Relevant and Appropriate**.	Regulations to be phased in over the next few years require contaminated soils to be treated to the Best Demonstrated Available Technology levels before being placed or replaced on the land. Hazardous waste cannot be stored except when accumulated for recovery, treatment, or disposal. Land disposal restrictions for PAHs have not yet been developed.	Land disposal restrictions (LDR) apply (or are relevant and appropriate) only to wastes being placed on the land and not to wastes already in place. These rules may be applied only to new wastes generated on-site as a result of treatment or to wastes excavated or dredged that meet RCRA characteristics for hazardous wastes. LDR criteria have been developed for most site contaminants.
Clean Water Act - 40 CFR Parts 122, 125	Any point source discharges must meet NPDES permitting requirements, which include compliance with applicable water quality standards; establishment of a discharge monitoring system; and routine completion of discharge monitoring records. **Not ARAR.**	If groundwater that has been treated by on-site treatment processes is discharged to surface waters on-site, treated groundwater must be in compliance with applicable water quality standards. In addition, a discharge monitoring program must be implemented. Routine discharge monitoring records must be completed.	Identified as applicable in the ROD, these requirements are no longer ARAR. Collected leachate is treated and discharged to the LRWU, a local POTW. Currently, these NPDES requirements do not apply and are not relevant or appropriate. No direct, point-source surface water discharge is occurring. If discharge to a surface water body were to occur in the future, these requirements would need to be reconsidered.
CWA - 40 CFR Part 403	This regulation specifies pretreatment standards for discharges to a POTW - **Applicable.**	If a leachate collection system is installed and the discharge is sent to a POTW, the POTW must have an approved pretreatment program. The collected leachate runoff must be in compliance with the approved program. Prior to discharging, a report must be submitted containing identifying information, list of approved permits, description of operations, flow measurements, measurement of pollutants, certification by a qualified professional, and a compliance schedule.	Identified as not ARAR in the ROD, these requirements are now applicable, and are being complied with. Collected leachate is treated and discharged to the LRWU, a local POTW, under permit.

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
CWA - 40 CFR Part 230	This regulation outlines requirements for discharges of dredged or fill material. Under this requirement, no activity that impacts a wetland will be permitted if a practicable alternative that has less impact on the wetland is available. If there is no other practicable alternative, impacts must be mitigated - **Applicable**	During the identification, screening, and evaluation of alternatives, the effects on wetlands must be evaluated.	There were no practicable alternatives that would have prevented impacts to adverse impacts to wetlands. This requirement is no longer an ARAR as there are no longer any wetlands on-site.
CAA - NAAQS for Total Suspended Particulates (40 CFR 129.105,750)	This regulation specifies maximum primary and secondary 24-hour concentrations for particulate matter - **Not ARAR**	Fugitive dust emissions from site excavation activities will be maintained below 260 Wg/m^3 (primary standard) by dust suppressants, if necessary.	These requirements were applicable to excavation and landfilling activities. Landfill construction is now completed. These requirements are only applicable if further land disturbing activities are conducted. None are currently planned.
Protection of Archeological Resources (32 CFR Part 229, 229.4; 43 CFR Parts 107, 171.1-171.5)	This regulation develops procedures for the protection of archeological resources - **Not ARAR**	If archeological resources are encountered during soil excavation, work will stop until the area has been reviewed by federal and state archaeologists.	No archeological resources have been, or are expected to be encountered at the site.
DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-171.5)	This regulation outlines procedures for the packaging, labeling, manifesting, and transportation of hazardous materials - **Not ARAR**	Contaminated materials shipped off-site will be packaged, manifested, and transported to a licensed off-site disposal facility in compliance with these regulations.	Shipping of hazardous materials has been in compliance. EPA no longer considers DOT rules an ARAR as they are not environmental rules and must always be complied with for all off-site shipments.

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
State Regulatory Requirements			
Massachusetts Hazardous Waste Regulations, Phase I and II (310 CMR 30.000, MGL Ch. 21C)	These regulations provide a comprehensive program for the handling, storage, and recordkeeping at hazardous waste facilities. They supplement RCRA regulations - **Relevant and Appropriate**	Because these requirements supplement RCRA hazardous waste regulations, they must also be considered at the site.	These requirements remain relevant and appropriate, and are being complied with.
Massachusetts General Laws, Ch. III, Sec. 150B	Under this regulation, the local board of health may require a local site assignment for hazardous waste treatment, storage, and/or disposal facilities **- Relevant and Appropriate**	The local board of health should be made aware of any hazardous waste activities.	The local board of health is aware of all site activities and has been a participant in remediation efforts.
Acts of 1982, Ch. 232, Sec. 150A and 150B. (Now Codified in Massachusetts Solid Waste Management regulations at 310 CMR 19.141)	This regulation requires that notice be recorded in the Registry of Deeds whenever certain types of solid or hazardous waste activity occur on property **- Applicable.**	Notification of remedial actions will be given to the County Registry of Deeds.	This requirement remains to be fulfilled.

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
Massachusetts - Air Quality, Air Pollution (310 CMR 6.00 - 8.00)	This regulation outlines the standards and requirements for air pollution control in Massachusetts; all provisions, procedures, and definitions are described - **Applicable.**	Particulate matter emissions from site excavation activities must be maintained at an annual geometric mean of 75 Wg/m$_3$, and a maximum 24-hour concentration of 40 mg/m^3 (primary standards).	Engineering controls are specified to prevent excessive emissions of particulate matter (310 CMR 7.09). These requirements were applicable to excavation and landfilling activities. Landfill construction is now completed. These requirements are only applicable if further land disturbing activities are conducted. None are currently planned. All air emissions facilities as defined in 310 CMR 7.02 must meet Best Available Control Technology (BACT) requirements (310 CMR 7.02(2)(a)(2)(g) and (b)(2)(g)). The Charles George site remediation does not include any facilities that meet the definition of 310 CMR 7.02.
Massachusetts Wetlands Protection (310 CMR 10.00)	This regulation outlines the requirements necessary to work within 100 feet of a coastal or inland wetland. The act sets forth a public review and decision-making process by which activities affecting waters of the state are to be regulated to contribute to their protection - **Applicable.**	Wetland remediation will comply with the substantive but not the administrative requirements for wetland protection.	There were no practicable alternatives that would have prevented impacts to adverse impacts to wetlands. This requirement is no longer an ARAR as there are no longer any wetlands on-site.

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
Massachusetts Surface Water Discharge Permit Program (314 CMR 2.00 - 4.00)	This section outlines the requirements for obtaining an NPDES permit in Massachusetts - **Not ARAR**	Pollutant discharges to surface water must comply with NPDES permit requirements. Permit conditions and standards for different classes of water are specified.	314 CMR 3.00 establishes the program whereby discharges of pollutants to surface waters are regulated. Outlets for such discharges and any associated treatment works are also regulated. Surface water at the site is classified "B - warm water, treated water supply" under 314 CMR 4.06. The wastewater treatment facility addresses toxic pollutants listed under 314 CMR 3.16. Treated leachate is discharged to LRWU. Currently, these requirements do not apply and are not relevant or appropriate. No direct, point-source surface water discharge is occurring. If discharge to a surface water body were to occur in the future, these requirements would need to be reconsidered.
Massachusetts Groundwater Permit Program and Groundwater Quality Standards (314 CMR 2.00, 5.00, 6.00)	These rules specify the requirements for obtaining a groundwater discharge permit in Massachusetts - **Not ARAR**	Pollutant discharges to groundwater must comply with permit requirements. Permit conditions and standards for different classes of water are specified.	314 CMR 5.00 establishes the program whereby discharges of pollutants to groundwater are regulated, as are outlets for such discharges and any associated treatment works. 314 CMR 6.00 establishes groundwater quality standards and the designation and assignment of groundwater classifications. Groundwater underlying the site is designated Class I. Reinjection of treated groundwater is not planned at this time, so discharge permit-equivalent documentation is not required.

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00)	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulations. These regulations apply to a water treatment unit; a surface impoundment that treats influent wastewater; and a POTW that generates, accumulates, and treats hazardous waste - **Not ARAR**.	All owners and operators of RCRA facilities shall comply with the management standard of 310 CMR 30.500, the technical standards of 310 CMR 30.600, the location standards of 310 CMR 30.700, the financial responsibility requirements of 310 CMR 30.900 and, in the case of POTWs, the standards for generators in 310 CMR 30.300.	314 CMR 8.00 establishes the program whereby wastewater treatment works exempted from RCRA rules would be regulated here. Since the wastewater treatment facility is being managed as a RCRA/MGL 21C facility, these rules are redundant. In the event that the facility is reclassified, these rules may become applicable.
Certification for Dredging, Dredged Material Disposal, and Filling in Waters (314 CMR 9.00, MGL Ch. 21, ss. 26-53)	This regulation is promulgated to establish procedures, criteria, and standards for the water quality certification of dredging and dredged material disposal - **Not ARAR**.	Applications for proposed dredging/fill work need to be submitted and approved before work commences. Three categories have been established for dredge or fill material based on the chemical constituents. Approved methods for dredging, handling, and disposal options for the three categories must be met.	No dredging, discharge of dredge material, or filling in of navigable waters is occurring or planned to occur. However, during remedial actions the discharge of pollutants into surface water bodies will occur; this situation triggers Wetlands Protection Act (MGL Ch. 131) and waterways (MGL ch. 91) requirements.
Operation and Maintenance and Pretreatment Standards for Wastewater Treatment Works, and Indirect Discharges (314 CMR 12.00)	The regulations establish requirements that ensure the proper operation and maintenance of wastewater facilities within the Commonwealth - **Applicable**.	A wastewater treatment facility would be operated and maintained in compliance with this regulation.	These rules are applicable and being complied with.
Implementation of M.G.L. C.111F, Employee and Community "Right to Know" (310 CMR 33.00)	The regulations establish rules and requirements for the dissemination of information related to toxic and hazardous substances to the public - **Applicable**	Information applicable to site activities and characteristics will be made available to the public.	The EPA has implemented an active community relations program to disseminate information about the site to the local community.
Worker "Right to Know" (441 CMR 21.00)	These regulations establish requirements for worker "Right to Know."	These requirements apply to all site workers and must be followed during all site work.	Each contractor performing site work is responsible for compliance with this requirement.

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
Massachusetts Solid Waste Management Regulations under MGL Ch. 21D (310 CMR 19.000)	Not identified in ROD, but identified in O&M Plan and Post-Closure Plan - **Applicable**.	None.	These rules are applicable and are generally being complied with. Maintenance requirements of a solid waste landfill identified here include: prevention of unauthorized access by fences and other barriers; locked gates at all points of entry; and posting of warning signs. Maintenance requirements are being met. Groundwater protection systems are specified to control migration of leachate out of the landfill and into the groundwater. A leachate collection system has been installed at the site. All solid waste landfills must include groundwater, surface water and gas monitoring systems designed, operated, and maintained in accordance with applicable rules. Explosive gases must be controlled to no greater than 25% LEL within on-site structures or at the property boundary. Long-term groundwater and surface water monitoring requirements are being met. Gas monitoring is conducted at the property boundary. Limitations on post-closure construction and use are outlined in the regulations. Alternative end uses need to be proposed. Use restrictions, such as deed restrictions, must be provided for after completion of remedial activities.

ATTACHMENT 6, TABLE 3 (CONTINUED)
POTENTIAL ACTION-SPECIFIC ARARS
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

ARAR	ROD REQUIREMENT SYNOPSIS AND REQUIREMENT STATUS	ROD-SPECIFIED ACTION TO BE TAKEN TO ATTAIN ARARS	FIVE-YEAR REVIEW
Massachusetts Solid Waste Management Regulations under MGL Ch. 21D (310 CMR 19.000) (continued)			Final cover system standards and landfill closure/post-closure care requirements are applicable to the site. Applicable post-closure care requirements include: monitor the site during the post-closure period in order to ensure the integrity of the closure measures and to detect and prevent any adverse impacts of the site on public health, safety or the environment; take corrective actions in response to any conditions which would compromise the integrity and purpose of the final cover; maintain the integrity of the liner system and final cover system; collect leachate from and monitor and maintain leachate collection systems; monitor and maintain the surface water, groundwater, and air quality monitoring systems; maintain landfill gas control systems; maintain access roads; protect and maintain surveyed benchmarks. The site cap is designed to meet the more stringent requirements for a hazardous waste landfill and, thus, achieves compliance with solid waste rules.

ATTACHMENT 6, TABLE 4
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE
CHARLES GEORGE RECLAMATION LANDFILL, TYNGSBOROUGH, MASSACHUSETTS

SITE FEATURE and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
Wetlands				
Federal Regulatory Requirements	Clean Water Act (CWA) - (40 CFR Part 230)	Applicable	Under this requirements, no activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available. During identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated.	There were no practicable alternatives that would have prevented impacts to adverse impacts to wetlands. This requirement is no longer an ARAR as there are no longer any wetlands on-site.
	Fish and Wildlife Coordination Act (16 U.S.C. 661)	Applicable	This regulation requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service. This requirement is addressed under CWA Section 404 requirements.	This ARAR was met; consultation occurred as part of the RI/FS process.
State Regulatory Requirements	Massachusetts - Wetlands Protection (310 CMR 10.00)	Applicable	These requirements are promulgated under Wetlands Protection Laws, which regulate dredging, filling, altering, or polluting inland wetlands. Work within 100 feet of a wetland is regulated under this requirement. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. If alternatives require that work be completed within 100 feet of a defined wetland, these regulations will be considered. Mitigation of impacts on wetlands will be addressed under CWA 404.	There were no practicable alternatives that would have prevented impacts to adverse impacts to wetlands. This requirement is no longer an ARAR as there are no longer any wetlands on-site.
	Hazardous Waste Facility Siting Regulations (990 CMR 1.00)	Relevant and Appropriate	These regulations outline the criteria for the construction, operation, and maintenance of a new facility or increase in an existing facility for the storage, treatment, or disposal of hazardous	A permanent groundwater treatment facility was not constructed because groundwater and leachate are instead being discharged to the

SITE FEATURE and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
			waste. Specifically, no portion of the site may be located within a wetland or bordering a vegetated wetland. These regulations will be addressed during the design phase of the treatment facility construction.	Lowell POTW. Also, there are no longer any wetlands on-site. This requirement is no longer an ARAR.
Federal Requirements to be Considered	Wetlands Executive Order (EO 11990)	To Be Considered	Under this regulation, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. Many of the requirements of this EO will be addressed under CWA Section 404. Any remaining requirements will also be considered during the identification, screening, and evaluation of alternatives.	There were no practicable alternatives that would have prevented impacts to adverse impacts to wetlands. This requirement is no longer an ARAR as there are no longer any wetlands on-site.
<u>Landfill and Leachate Ponds</u>				
Federal Regulatory Requirements	RCRA - Standards for Owners and Operators of Permitted Hazardous Waste Facilities (40 CFR 264.10-264.18)	Relevant and Appropriate	General facility requirements outline waste analysis, security measures, and training requirements. Treatment residuals from the wastewater treatment facility will be disposed according to RCRA Subtitle C.	This action-specific ARAR is discussed in Table 3.
	RCRA -	Relevant	This regulation outlines safety equipment and	This action-specific ARAR is

SITE FEATURE and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
	Preparedness and Prevention (40 CFR 264.30-264.37)	and Appropriate	spill control requirements for hazardous waste facilities. Part of the regulation includes a requirement that facilities be designed, maintained, constructed, and operated so that the possibility of an unplanned release which could threaten public health or the environment is minimized. RCRA requirements must be considered when evaluating extensions to the present landfill.	discussed in Table 3.
Landfill and Leachate Ponds (contd.)	RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50-264.56)	Relevant and Appropriate	This regulation outlines requirements for emergency procedures to be used following explosions and fires. This regulation also requires that threats to public health and the environment be minimized. RCRA requirements must be considered when evaluating extensions to the present landfill.	This action-specific ARAR is discussed in Table 3.
	RCRA - Groundwater Protection (40 CFR 264.90-264.109)	Relevant and Appropriate	Under this regulation, groundwater monitoring program requirements are outlined. A groundwater monitoring system must be installed as part of any alternative. During site characterization, the location and depth of monitoring wells will be evaluated for use in this monitoring program.	This action-specific ARAR is discussed in Table 3.
	RCRA - Closure and Post-Closure	Relevant and	This requirement details the specific requirements for closure and post-closure of	This action-specific ARAR is discussed in Table 3.

SITE FEATURE and AUTHORITY	REQUIREMENT	ROD STATUS	ROD REQUIREMENT SYNOPSIS and CONSIDERATION IN RI/FS	FIVE-YEAR REVIEW
	(40 CFR 264.110-264.120)	Appropriate	hazardous waste facilities. A post-closure plan is currently being developed for the site by EPA.	
State Regulatory Requirements	Massachusetts Hazardous Waste Regulations, Phase I and II (310 CMR 30.000)	Relevant and Appropriate	These regulations provide a comprehensive program for the handling, storage, and recordkeeping at hazardous waste facilities. They supplement RCRA regulations. Because these requirements supplement RCRA hazardous waste regulations, they must also be considered at the site.	This action-specific ARAR is discussed in Table 3.