OCTOBER, 1993

FINAL

FEASIBILITY STUDY REPORT

GLOVERSVILLE MUNICIPAL LANDFILL
GLOVERSVILLE, NEW YORK

Tighe&Bond
Consulting Engineers
Environmental Specialists

EXECUTIVE SUMMARY

The Gloversville Municipal Landfill was placed on the New York State Register of Inactive Hazardous Waste Disposal Sites in 1981. In 1989, Tighe & Bond Consulting Engineers, P.C. was retained by the City of Gloversville to complete a Remedial Investigation (RI)/ Feasibility Study (FS) of the landfill site. The Phase 1 RI report was submitted to the New York State Department of Environmental Conservation (NYSDEC) in May, 1991. The draft Phase 2 RI report was submitted in October 1992, and this document comprises the Feasibility Study portion of the project.

The Gloversville Municipal Landfill occupies approximately 80 acres of a 175-acre property located in the south-central portion of Fulton County in the Town of Johnstown, New York. Open refuse disposal practices began at the site in the early 1900's and were updated to sanitary landfill practices in 1958. The landfill continued to receive waste until it was closed in mid-1989.

Waste in the northern "old fill" area is comprised mainly of tannery wastes and sludges as well as wood and glass. The more recently used "active area" contains mainly municipal solid waste (MSW) with sewage sludge, and comprises the majority of the landfill area. Waste thickness is up to 70 feet in some sections of the active area.

This Feasibility Study was prepared to present and evaluate landfill remedial alternatives and their respective technologies in order to determine which alternatives provide the best protection of human health and the environment while considering costs. The alternatives are appropriate combinations of technologies that were retained after an extensive screening process. For this Feasibility Study, the following four remedial alternatives are considered:

Alternative No. 1: No Action
- Site Monitoring
- Public Awareness Program

Alternative No. 2: Limited Action
- Site Monitoring
- Public Awareness Program
- Site Access Restrictions
- City Water to Residences

Alternative No. 3: Impermeable Cap/ City Water Line
- Site Monitoring
- Public Awareness Program
- Site Access Restrictions
- City Water to Residences
- Landfill Cap

Alternative No. 4: Impermeable Cap/City Water Line/Groundwater Pump & Treat
- Site Monitoring
- Public Awareness program
- Site Access Restrictions
- City Water to Residences
- Landfill Cap
- Groundwater Pump & Treat System

The above four alternatives were compiled utilizing proven, reliable technologies suitable for remediating a site of the size and with the types of wastes found at the Gloversville Landfill. The alternatives were selected to provide a range of protection of human health and the environment with a corresponding range of costs. They are evaluated and compared with respect to: short-term effectiveness; long-term effectiveness; reduction of toxicity, mobility and volume; implementability; compliance with Applicable or Relevant and Appropriate Requirements (ARARs); and cost.

Alternative No. 1, No Action, is required by the EPA and NYSDEC and provides a baseline level to which other remedial alternatives can be compared. The no-action alternative consists of a public awareness program in order to keep the public apprised of landfill based risks and any new developments. In addition, a program of continued site monitoring will be implemented. This involves sampling and analysis of groundwater monitor wells, private drinking water wells and surface water. In order to fulfill groundwater monitoring requirements, new monitor wells are required.

Alternative No. 2, Limited Action, involves the technologies included in Alternative No.1 with the exception of private well monitoring. In addition, Alternative No. 2 requires installation of site access restrictions and extension of the water system from the City of Gloversville to the area of impacted residents. The water line extension will require installing approximately 6 miles of 12-inch water line, which will replace contaminated and potentially contaminated private drinking water supplies with City water. This will eliminate risks associated with ingestion of, and dermal contact with, contaminated groundwater.

Alternative No. 3, an impermeable cap with a City water line, includes all of the items of Alternative No. 2 with the addition of a landfill cap. The 6NYCRR Part 360 geomembrane cap overlain with a drainage net is the recommended cap for this landfill because it complies with existing regulations, provides good protection against the production of contaminated leachate from the hazardous waste site, and can be constructed at a reasonable cost. The geomembrane version of the Part 360 cap is chosen over the low permeability clay version because, it provides better protection of groundwater and is less expensive. Further, it has been estimated that approximately 10,000 truck loads of clay will be required for construction of the low permeability barrier for a 6NYCRR Part 360 clay cap. By utilizing a geomembrane, the truck traffic associated with cap construction on nearby roads will be greatly reduced. However, delivery of other elements associated with a new cap will require a large number of truck trips.

Installation of a cap will also involve extensive site regrading including refuse excavation, implementation of runoff controls, and a landfill gas management system. These aspects of landfill capping are all proven, reliable technologies.

Alternative No. 4, an impermeable cap with a City water line and a groundwater pump & treat system, includes all of the aspects of Alternative No. 3 with the addition of a network of groundwater recovery wells and a groundwater treatment facility. The recovery wells intercept contaminated groundwater leaving the landfill site in the overburden and pump it to an on-site treatment facility from which it is discharged to a nearby surface water body. This provides an additional level of protection to the surrounding environment. The treatment facility required to treat the large volume of recovered groundwater to surface water discharge standards is extensive, involving many unit processes and the production of large quantities of treatment residuals. The added benefit of constructing the ground water pump and treat system is that any remaining contaminant plume migration off-site in the overburden after capping will be greatly reduced.

The costs of the four alternatives are summarized below:

	ALTERNATIVE NO.			
	1	2	3	4
Capital	$190,000	$3,550,000	$25,950,000	$31,950,000
Annual O&M	$229,000	$134,000	$193,000	$1,012,000
Present Worth	$3,030,000	$5,210,000	$28,340,000	$44,510,000

This Feasibility Study recommends Alternative No. 3 (an impermeable cap with water line) for remediation of the Gloversville Landfill. It is recommended because it eliminates the risks associated human ingestion of contaminated drinking water in private homes by providing a City water line, and greatly reduces the negative impacts of the landfill on the groundwater and nearby surface water bodies through installation of a landfill cap. Alternative No. 4 offers additional protection to the surrounding environment in the form of contaminant plume interception, but this is minimal compared large reduction provided by the landfill cap alone. Adding the pump and treat technology of Alternative No. 4 increases the capital and O&M costs significantly.

Alternative No. 3 provides a large reduction in landfill based impacts to the surrounding environment and eliminates the risks associated with ingestion and contact with contaminated groundwater from private wells. This alternative also greatly reduces the risks associated with waste contact by capping the waste and implementing site access restrictions. The O&M requirements of Alternative No. 3 are limited to drainage and sedimentation basin cleanout, mowing of the vegetative cover, inspections for cap integrity, and site monitoring. This Alternative uses only proven, reliable technologies and can be implemented at a moderate cost per acre.

G191\REPORT\EXSU

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

G191\REPORT\TOC.PGB

LIST OF FIGURES

LIST OF TABLES

G191\REPORT\TOC.PGB

SECTION 1.0
INTRODUCTION

This Feasibility Study (FS) Report has been prepared by the City of Gloversville, New York to screen and identify alternatives appropriate for the remediation of the Gloversville Landfill. The FS is the second step of a two step process known as the Remedial Investigation/Feasibility Study (RI/FS) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (29), the Superfund Amendment and Reauthorization Act (SARA) of 1986 (30), and the Revised National Contingency Plan (NCP) of 1990 (22). Phase 1 of the RI was completed in early 1991 and a Draft RI Report (1) was submitted to the New York State Department of Environmental Conservation (DEC) in May 1991. Phase 2 field activities were completed in early 1992 and a Phase 2 Draft RI Report (2) was submitted to DEC in October 1992. The RI/FS was conducted in accordance with the DEC and U.S. Environmental Protection Agency (EPA) requirements for hazardous waste investigations and clean-up actions under CERCLA, SARA and the NCP.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this FS Report is to examine the results of the Phase 1 RI and Phase 2 RI and to develop and evaluate remedial alternatives that address the areas of contamination identified during the remedial investigation. The feasibility study process is aimed toward determining the remedial alternative which best ensures the protection of human health and the environment in a cost and time efficient manner. The FS discussions and recommendations will be used by DEC to select the remedial alternative to be implemented at the Gloversville Landfill. This decision will be set forth by DEC in a Record of Decision (ROD) document.

The organization of this FS is modelled after the three phases of the feasibility study process identified in EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (23). These phases include development, screening and detailed analysis of remedial action alternatives. The FS is divided into six sections.

Section 1 provides an introduction to the RI/FS process and a description of the Gloversville Landfill site.

Section 2, Development of Alternatives, provides a description of the evaluation process, identifies chemical, location and action-specific Applicable or Relevant and Appropriate Requirements (ARARs), characterizes the wastes and health risks of the Gloversville Landfill and discusses the technology of the various remedial processes. General Response Actions and the contaminated media to which they are applicable are also developed in this Section.

Section 3 provides more detailed descriptions of the process options and technologies identified in the General Response Actions which are developed in Section 2.4. Technologies which technically cannot be implemented are eliminated from further consideration.

Section 4, Screening and Analysis of Alternatives, describes the preliminary and detailed screening and analysis of alternatives. Those alternatives remaining after the preliminary screening are evaluated further for their short and long-term effectiveness, ability to reduce toxicity, mobility and volume of contaminated media, implementability, compliance with ARARs, protection of human health and the environment, and cost.

Section 5 provides a summary and comparison of the alternatives presented in Section 4.

Section 6, Recommendations for Further Action, discusses the proposed remedial action alternative.

1.2 SITE DESCRIPTION

The Gloversville Landfill was placed on the New York State Register of Inactive Hazardous Waste Disposal Sites in 1981. Reportedly, open refuse disposal occurred at the site from near the turn of the century until disposal practices were upgraded to sanitary landfilling procedures in 1958. According to a 1986 report by Wehran Engineering, P.C. (24), the site accepted all wastes generated by the City of Gloversville and part of the Town of Johnstown including domestic, commercial and industrial wastes. Several other Towns in Fulton County disposed of solid waste at the Gloversville Landfill until it closed in July 1989. The Gloversville Landfill occupies approximately 80 acres of a 175-acre property located in the south-central portion of Fulton County in the Town of Johnstown, New York.

For the purposes of discussion in this report, the actual landfill area is divided into the "active" and "inactive" areas. The "active" disposal area is the central portion of the site where disposal activities occurred throughout the late 1980's. Disposal activities in this area were terminated in 1989. The inactive area refers to older sections of the landfill which are currently overgrown with brush and small trees.

The area surrounding the landfill is densely wooded along the west, north and east sides. South of the landfill, private residences on small open lots predominate beyond a wooded buffer area. For reference, a Locus Map and Site Plan are included as Figures 1-1 and 1-2.

The active area is terraced and the waste is up to 70 feet thick. A large open borrow pit exists south of the active area from which sand was excavated for use as cover material. An old scrap metal disposal area surrounds a depression north of the active area which frequently contains standing water.

The extent of the disposal area is fairly well delineated along the northern, western and northwestern sides, while overgrown vegetation obscures the extent of the trash on the

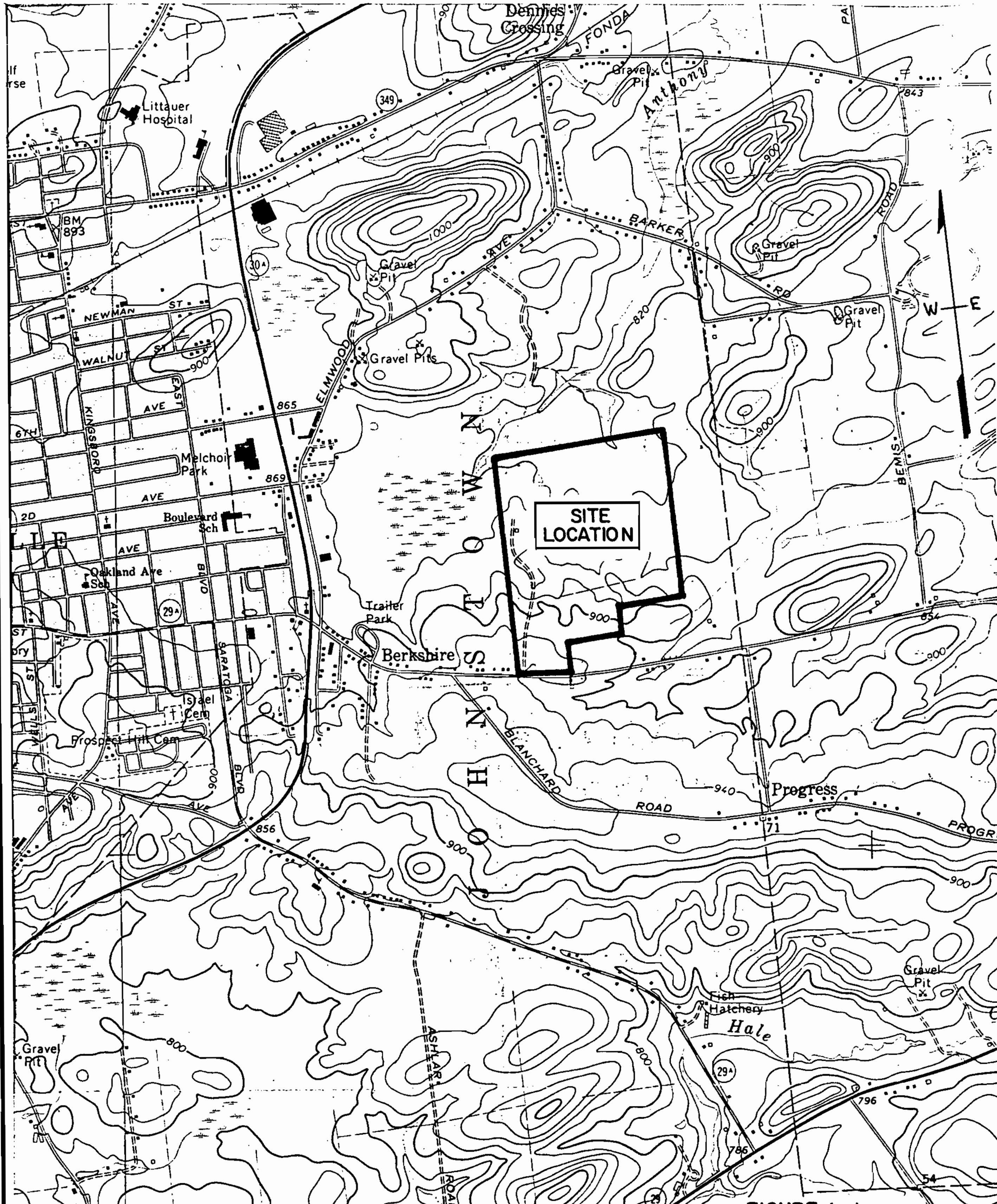


FIGURE 1-1

SOURCE NO. USGS GLOVERSVILLE QUADRANGLE

LOCUS PLAN

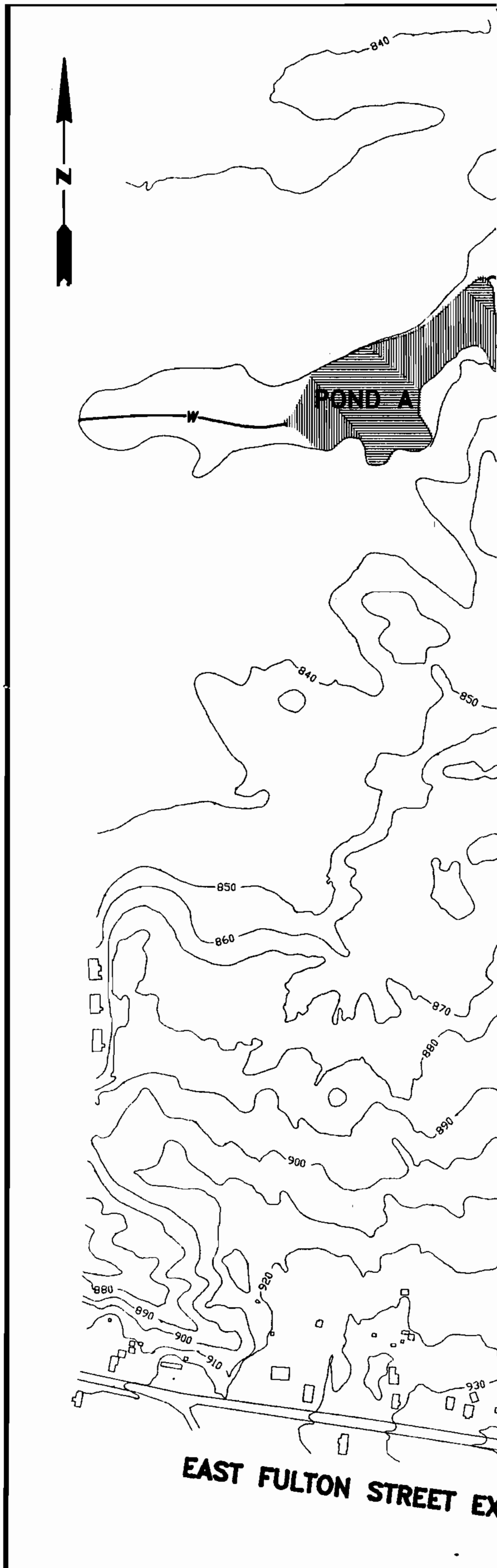
MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

SCALE: 1" = 2000'

DATE: OCT. 1992

NYSDEC SITE NO: 518001



NYSDEC SITE NO:518001

DRAWN BY: KJK		SITE PLAN	DATE: NOV., 1992
NO.	DATE	REMEDIAL INVESTIGATION/FEASIBILITY STUDY GLOVERSVILLE MUNICIPAL LANDFILL GLOVERSVILLE, NEW YORK	SCALE: 1"= 400'
1	4/93		FIGURE: 1-2

eastern and southern sides. The top of the active area of the landfill is relatively flat and covered with a fine sand cover material.

Along the northeast side of the landfill, demolition debris appears to form the shoreline of a large beaver pond (Pond B). On the northwest side of the inactive area, glass and metal debris extend to the south bank of Anthony Creek.

Several other potential sources of environmental contamination exist around the landfill. These include a scrap yard, auto repair shops, a trucking company terminal, a farm, a manufacturer of precast concrete steps and other businesses.

The topography of the area surrounding the Gloversville Landfill is characterized by relatively flat wetland areas and numerous glacially - derived terraces and drumlins. To the north of the site, small rounded hills rise to an elevation of approximately 1000 feet above mean sea level (msl). They have moderate relief of roughly 100 feet. There is a slight northeast-southwest long-axis orientation to these rounded hills. Less than 4 miles to the north of the site, the foothills of the Adirondack Mountains rise steeply to the north.

The active portion of the landfill consists largely of two terraces. The top terrace is relatively flat at an elevation of 891 to 895 feet above msl. The lower terrace is not as uniformly flat with elevations ranging from 868 to 883 feet above msl. The landfill mound rises approximately 50 feet above the adjacent ground surface on the east side, while only approximately 30 feet above the adjacent ground surface on the west and north sides. These features and additional site features are shown on Figure 1-2.

North of the landfill, there are a number of ponds created by beaver activity. A large pond (Pond A) on the northwest side of the site forms the headwaters of Anthony Creek. The landfill property lies completely within the Anthony Creek drainage basin. Anthony Creek discharges to the Great Sacandaga Lake approximately 5 miles north of the landfill.

A small tributary to Anthony Creek traverses the northeast corner of the City's property, flowing northwesterly. The stream flows to a 4-acre pond (Pond C) prior to discharge to Anthony Creek. Another large beaver pond (Pond B) is situated in the northeastern area of the City's property. This 5-acre pond receives a substantial portion of the overland runoff and groundwater underflow from the landfill area. It discharges over and through an approximately 10-foot high beaver dam into the small tributary stream mentioned at the beginning of this paragraph.

In general, the Gloversville Landfill is underlain by stratified drift composed mainly of fine sand and silt with zones of coarser sand and gravel. The thickness of the drift varies across the site from 22 feet in the southeastern corner of the site to as much as 70 feet thick on the western side of the site. The stratified drift deposit contains occasional lenses of clay, which are restricted to the northern and western side of the site. Underlying the stratified drift over most of the site is a very dense glacial till. Bedrock at the site ranges from about 50 to 150 feet below the ground surface.

G191\REPORT\SEC1

SECTION 2.0

DEVELOPMENT OF REMEDIAL ALTERNATIVES

2.1 DESCRIPTION OF EVALUATION PROCESS

As stated previously in Section 1.1, the purpose of the feasibility study process is to identify the most appropriate alternative for remediation of a particular waste site. The development of these remediation alternatives involves evaluating different remediation technologies and applying them to the appropriate contaminated media at the site in question. Emphasis is placed on technologies that reduce the toxicity, mobility and volume of wastes and contaminated materials. Alternatives may contain technologies that affect more than one media and, a given alternative can address contamination on a site wide basis or as a discrete, identifiable unit of contamination.

In accordance with the CERCLA Guidance Document for conducting feasibility studies (23) the alternative development process generally includes the following steps:

- Development of remedial action objectives (long-term, permanent goals to prevent/minimize hazardous chemical releases from the site) that consider the type and level of contamination, the media involved, pathways for exposure, threat to human health and the environment and the Applicable or Relevant and Appropriate Requirements (ARARs). One example of a remedial action objective would be the restoration of surface water to ambient water quality standards.

- Development of general response actions that define the level of remedial activity for each media (soil, surface water, groundwater). General response actions may include containment, excavation, pumping, treatment or a combination of these and other technologies. The goal is to satisfy the remedial action objectives.

- Identification of the volumes of contaminated media involved in each general response action.

- Identification and screening of the various remedial technology types and process options for their appropriateness to a specific general response action. Technology types are general categories of technologies, whereas process options are more specific processes within a technology type. For example, containment technologies can be broken down into more specific process options such as slurry walls or impermeable liners.

- Evaluate and select one process option for each remedial technology type. Effectiveness, implementability and cost are prime considerations in evaluating process options.

- Assemble the alternatives appropriate for the site by combining general response actions and the chosen process options.

The process of developing remedial alternatives should be viewed as a series of analytical steps in which successively more specific definitions of potential remedial alternatives are made. The process results in a list of appropriate potential remedial alternatives for the site which will then be subjected to preliminary and detailed screening. These screening processes are detailed in Sections 3 and 4.

2.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Superfund Amendment and Reauthorization Act (SARA) (30) and the National Contingency Plan (NCP) (22) require a comparison of all alternative site remedies to all Applicable or Relevant and Appropriate Requirements (ARARs) during the selection and evaluation of remedial actions for a waste site. Compliance with both Federal and State ARARs is required. ARARs are defined as follows:

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. (CERCLA is the Comprehensive Environmental Response Compensation and Liability Act which created the "Superfund" program and which was reauthorized by Congress through the enactment of SARA).

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

ARARs are separated into three categories: chemical-specific, location specific and action-specific. Chemical-specific ARARs are health/risk-based standards that set limits for acceptable levels of chemicals in the various environmental media. An example of a chemical-specific ARAR would be the chemical-specific drinking water standards set by the Safe Drinking Water Act (SDWA).

Location-specific ARARs set limitations on the remedial activities based on the proximity of the waste site (and remedial activities) to various natural resource areas such as wetlands and floodplains. An example of a location-specific ARAR would be the restrictions on the discharge of dredged or fill materials into wetlands prescribed by the Federal Clean Water Act.

Action-specific ARARs are technology-based limitations or requirements placed on the actions taken to remediate or cleanup a waste site.. An example of an action-specific requirement would be landfill capping design standards - permeability, thickness, etc. - prescribed by the NYSDEC Part 360 Solid Waste Management regulations (4).

The following subsections discuss the various ARARs which must be considered when evaluating remedial response alternatives for the Gloversville Landfill.

2.2.1 Chemical Specific ARARs

- RCRA Maximum Contaminant Levels (MCLs) (18), have been established for 14 toxic compounds (mainly metals and pesticides) for the purpose of groundwater protection. These standards apply to groundwater at RCRA regulated facilities, such as landfills, that received RCRA hazardous wastes after July 26, 1982, and are considered potentially applicable to the Gloversville Landfill.

- The Federal Safe Drinking Water Act (SDWA) (25) established national interim primary drinking water standards which, as in RCRA, are set as maximum contaminant levels. EPA develops these MCLs based upon maximum contaminant level goals (MCLGs) which are non-enforceable health goals at which there are no known adverse health effects caused form utilizing the water. EPA has also developed secondary MCLs under SDWA which address aesthetic characteristics of drinking water such as odor and turbidity.

  The SDWA MCLs apply to public drinking water supplies and, therefore, are not applicable to the Gloversville Landfill because no public water supplies are affected by the landfill. However, because of the private water supplies in the area, these MCLs are considered appropriate and relevant for evaluating the quality of these supplies.

- National Ambient Air Quality Standards (NAAQS) (15) were established by EPA in 1987 in response to the Clean Air Act (CAA) of 1970 and subsequent amendments. NAAQS are health and welfare-based standards for control of specific air emissions such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter

(TSP), carbon monoxide (CO), ozone and lead. These are known as criteria pollutants. New York State has adopted the federal regulations and administers them through DEC's Division of Air Resources. DEC has also developed ambient guidance concentrations for many additional organic and inorganic compounds (6NYCRR257) (3). These standards are applicable to any remedial activity resulting in airborne discharges of contaminants from the site.

- New York State DEC Surface and Groundwater Quality Standards are codified at 6 NYCRR Part 703 (8). The surface water standards were developed by DEC under the authority granted by the Federal Clean Water Act which established ambient water quality criteria. The standards are subdivided into various water quality classifications based upon various uses (water supply, fisheries, recreation). Anthony Creek, which runs adjacent to the Gloversville Landfill is a Class C water body and has the potential to be affected by remedial activities, therefore, the surface water standards are applicable to this project.

  The groundwater standards are meant for the protection of drinking water supplies and are considered appropriate and relevant to this project.

- New York State Department of Health (DOH) has been granted primacy by the EPA to regulate public water systems under the provisions of the SDWA that is discussed above. DOH drinking water standards were established under the authority of the State Public Health Law, Section 225, and are listed in the State Sanitary Code, Part 5 (9). They are not applicable to this project because no public water supplies are located in the area. However, they are considered appropriate and relevant because of the presence of private water supplies in the area.

- The National Pollutant Discharge Elimination System (NPDES) was established by the Clean Water Act for the purpose of regulating the chemical and physical quality of direct (point source) dischargers to water bodies. The NPDES permit program requires characterization and monitoring of the discharge and sets limitations on the level of contaminants in the discharge. Regulations regarding effluent water quality are codified at 40 CFR 122 and 123 (16). In New York State, EPA has delegated authority for the administration of the NPDES program to the NYSDEC Division of Water. In New York, therefore, a State Pollutant Elimination System - SPDES - permit will be required of any remedial alternative at the Gloversville Landfill which proposes to discharge to the adjacent water bodies. A SPDES stormwater permit will be required for construction activities associated with any remedial alternative involving disturbance of more than 5 acres. Stormwater conveyances at a closed landfill are not subject to SPDES permitting.

2.2.2 Location Specific ARARs

- Section 404 of the Clean Water Act (26) prohibits the discharge of dredged or fill material into "waters of the United States", including wetlands, without first obtaining a permit from the Army Corps of Engineers (COE). The COE dredge and fill permitting regulations are contained in 33 CFR 320-330 (13). Because of the proximity of Anthony Creek to the various beaver ponds and associated wetlands at the Gloversville Landfill, these regulations are potentially applicable to the project.

- New York State Freshwater Wetland Regulations, 6 NYCRR 662-665 (7), require a permit from the State or local governmental authority for activities which will alter wetlands, including activities occurring outside the wetland boundary up to a distance of 100 feet. These regulations are applicable to the Gloversville Landfill project.

- The Fish and Wildlife Coordination Act, 16 USC 1271 (25), requires measures to protect fish and wildlife from activities which modify streams or areas affecting streams, including wetlands. This act is potentially applicable to the Gloversville Landfill project and is also appropriate and relevant.

- 40 CFR Part 6, Appendix A (14) details the requirements of Executive Order 11990 (Wetlands Protection) which require EPA to avoid direct or indirect support of construction activities in wetlands wherever there are practicable alternatives. These regulations are appropriate and relevant to the Gloversville Landfill project.

2.2.3 Action Specific ARARs

- RCRA Subtitle C, Hazardous Waste Management Requirements, and Subtitle D, Solid Waste Management Requirements, detail how closure is of hazardous or solid waste management facilities is to be accomplished. Included are standards for the design of landfill caps and procedures for the excavating, marking and transportation of hazardous wastes as well as requirements for post-closure operation and maintenance of waste facilities. These requirements are applicable to the Gloversville Landfill project. Additionally, regulations for identifying and characterizing hazardous waste under RCRA - 40 CFR 261 (19) - are potentially applicable to the Gloversville Landfill project. RCRA hazardous wastes must comply with the RCRA Land Disposal or "Land Ban" regulations which are codified at 40 CFR 268 (21). These regulations will be applicable to all off-site disposal and treatment options. Excavating, testing and redepositing wastes on site will not trigger the Land Ban regulation.

  The NYSDEC's Division of Hazardous Substance Regulation has been assigned responsibility for administration of RCRA in New York State.

- The Clean Air Act (28) will be applicable to any on-site gas collection systems, if installed.

- New York State Part 360 Solid Waste Management Facility regulations (4) are also applicable to the design, construction, maintenance and monitoring of solid waste facility caps.

- The Occupational Safety and Health Administration (OSHA) has regulations codified at 29 CFR, Parts 1910 (11), 1926 (12) and 1904 (10) which address worker safety during remedial activities at hazardous waste sites.

- 6 NYCRR Part 364 (5) and Part 372 (6) refer, respectively, to Waste Transporter Permits and the hazardous waste manifesting system. These regulations are potentially applicable depending upon the chosen remedial alternative.

2.2.4 Waiver of ARARs

CERCLA Section 300.430 (f)(3) details several conditions under which compliance with all ARARs need not be attained. These conditions are waivers which apply only to meeting the ARARs with respect to the remedial activities occurring on-site. A waiver must be used for each ARAR that will not be attained.

CERCLA Section 121(d)(4) list the five criteria for waivers as follows:

1. The remedial action selected is only part of a total remedial action that will attain an equivalent level or standard of control when completed. This waiver is generally applicable to interim measures which will be followed by complete measures that will attain the ARARs.

2. Compliance with such requirement(s) at the facility will result in a greater risk to human health and the environment than alternative options.

3. Compliance with such requirement(s) is technically impracticable from an engineering perspective.

4. The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation, through use of another method or approach.

5. With respect to a State standard, requirement, criteria, or limitation, the State has not consistently applied (or demonstrated the intention to apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial actions.

Compliance with ARARs for the remedial alternatives for the Gloversville Landfill is discussed in detail in Section 4 of this Feasibility Study.

2.3 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

This section identifies the remedial action objectives, or goals, for minimizing or eliminating the threat to human health and the environment presented by the Gloversville Landfill. These objectives were reached after careful analysis of data gathered during the RI. Factors considered in developing the remedial action objectives include the types of waste involved, the type(s) of contaminated media involved, the level of contaminants, and the potential exposure pathways and level of risk associated with exposure to the contaminated media. These factors are discussed below. A list of Remedial Action Objectives is presented in Table 2-1 near the end of this section.

2.3.1 Waste Characterization - The Phase 1 RI and Phase 2 RI revealed, through the excavation of test pits and drilling of boreholes, an average waste thickness of 12 feet in the "inactive area" of the landfill. The waste in this area is comprised largely of mixed animal hides, leather scraps, glass and wood fragments.

The waste in the active area of the landfill is a mix of household, tannery, and demolition waste. The depth of the waste in this area ranged from 70 to 80 feet thick. The limits of refuse disposal are depicted on Figure 1-2.

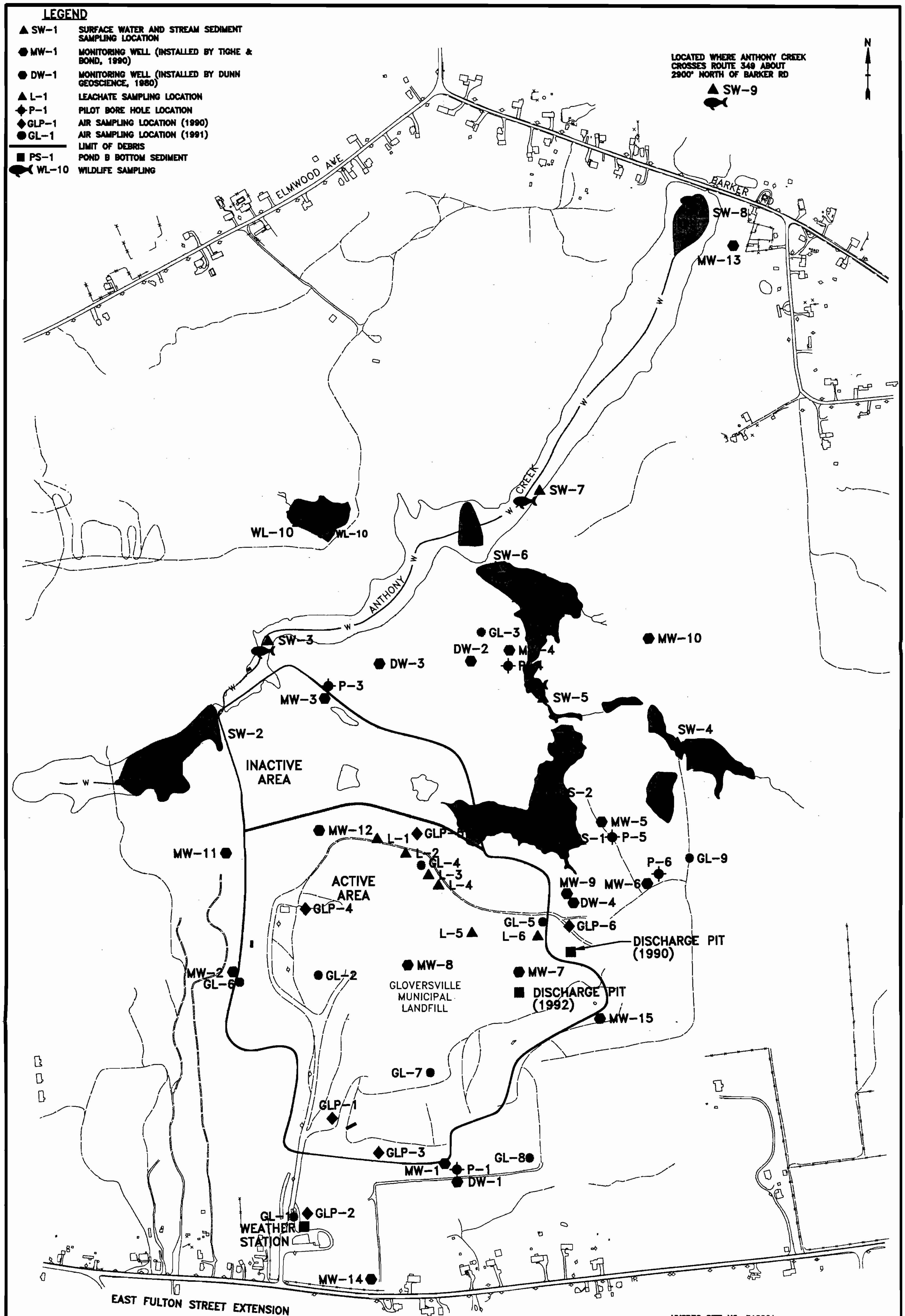
2.3.2 Contaminants and Media of Concern - The Phase 1 and Phase 2 RI identified contaminant levels in the landfill soils (surface and subsurface), leachate, groundwater, private drinking water wells, surface water, stream and pond sediments and ambient air. Additionally, samples of the waste itself were collected and subjected to Toxicity

Characteristic Leaching Potential (TCLP) testing. A detailed description of the nature and extent of contamination found at the Gloversville Landfill site was provided in Section 4.0 of the Phase 2 RI report submitted to DEC in October 1992. A very brief summary is provided below to give the reader a general idea of the types of contaminants and where they were found. Sampling locations for the various media are shown on Figure 2-1. Private well locations sampled during the Phase 1 and Phase 2 RI are shown on Figure 2-2.

At the waste disposal area, numerous volatile organic compounds (VOCs), semi-volatile organic compounds and metals were found in the leachate and landfill soils. Chloride and ammonia nitrogen were commonly detected in the leachate. Additionally, pesticide compounds were found in the leachate, test pit samples and surface soil samples (pesticide contamination has not migrated off-site). The chromium concentration in one of the TCLP samples from the "inactive" area exceeded toxicity characteristic limits established by the EPA, indicating that the refuse sampled is a characteristic hazardous waste. The sample which failed the TCLP test was comprised primarily of materials that appeared to be leather dust, leather scraps and animal hair. If these wastes originated from a tannery or leather finishing industry, they may be exempt from hazardous waste regulation. The source of the wastes that comprised the sample cannot be determined.

Trace levels of VOCs were detected in groundwater from six of the groundwater monitor wells, with benzene exceeding groundwater standards in two of these wells. Samples collected from MW 9i/9s, located in the northeast corner of the waste disposal area, contained several VOCs at concentrations above groundwater standards. Semi-volatile organics contamination of groundwater appears limited to this area as well. Iron, aluminum, chromium, lead and manganese were detected at concentrations above groundwater standards. Barium was found consistently above background levels and sodium concentrations were elevated in many of the deep groundwater monitor wells. Ammonia nitrogen concentrations exceeded groundwater standards in many of the shallow and bedrock monitor wells.

Private well contamination of residences in the vicinity of the landfill is limited to the high sodium levels which were detected in many of these wells. Ammonia nitrogen concentrations exceeded ground water standards in a few of the private wells. Barium



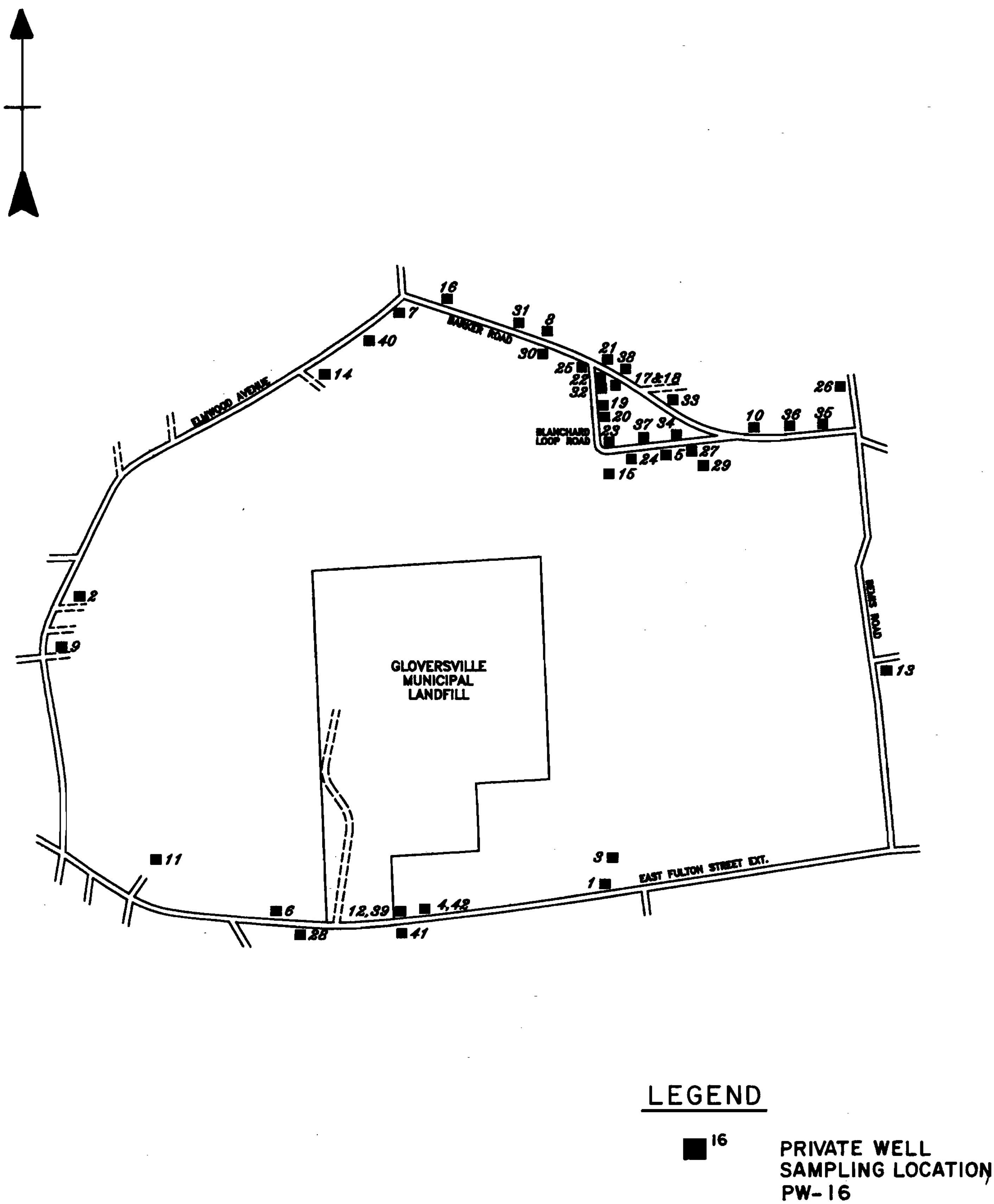
NO.	DATE	REVISIONS	BY
1	6/5/91	CORRECT LIMIT OF DEBRIS LINE	TMB
2	7/9/92	ADD 1992 AIR SAMPLING LOCATIONS	MPL
3	4/93	ADD INACTIVE/ACTIVE DELINEATION	TMB

TIGHE & BOND
CONSULTING ENGINEERS, P.C.
WESTFIELD, MASSACHUSETTS

SAMPLING LOCATIONS

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
GLOVERSVILLE MUNICIPAL LANDFILL
GLOVERSVILLE, NEW YORK

DATE: JULY, 1992
SCALE: 1"=500'
FIGURE: 2-1



NYSDEC SITE NO: 518001

TIGHE & BOND *CONSULTING ENGINEERS, P.C.* *WESTFIELD, MASSACHUSETTS*	PRIVATE WELL SAMPLING LOCATIONS	*TIGHE & BOND, INC.*
		DATE: AUG. 1992
	REMEDIAL INVESTIGATION GLOVERSVILLE MUNICIPAL LANDFILL	SCALE: 1" = 1500'±
		FIGURE:

was detected in several of the private wells at concentrations significantly below drinking water standards, but at levels that may indicate an influence from the landfill.

Analysis of surface waters adjacent to the Gloversville Landfill showed little indication of VOC and semi-volatile organic contamination. Iron exceeded surface water standards at all sampling locations and zinc, aluminum, copper and lead also exceeded standards, but less frequently. Un-ionized ammonia concentrations were frequently detected at concentrations exceeding surface water standards.

Five VOCs were detected in ambient air samples collected at the site, all at concentrations well below Ambient Guideline Concentrations. Ambient particulate and chromium concentrations were also below applicable standards.

2.3.3 Risk Assessment Summary and Conclusions - As part of the Gloversville Landfill Remedial Investigation, a Risk Assessment was conducted, using analytical data collected during all rounds of sampling, to evaluate the potential risks to human health and the environment associated with the site as it currently exists. Additionally, conservative assumptions were made about the possible future uses of the site to generate risk estimates for potential future exposure routes.

The risk assessment process involved the identification of the chemicals of concern for exposure in each of the various media (groundwater, private wells, surface water, sediments, air, leachate and landfill surface and subsurface soils), the identification of exposure pathways (ingestion, inhalation, adsorption, etc.), the identification of potential receptor groups and the calculation of hazard indices.

Six theoretical receptor groups were identified:

1. An Adult Landfill Worker (Off-Site Resident and Non-Resident of the Area): The Off-Site Resident Adult Landfill Worker is an individual who works at the landfill, lives near the landfill, and uses private well groundwater. The Non-

Resident Adult Landfill Worker is an individual who works at the landfill, but does not live within the potentially impacted area. Both of these receptor groups are applicable under the current and future exposure scenarios.

2. An Adult Landfill Area Resident (On-Site and Off-Site):
The On-Site Adult Landfill Area Resident is an individual who uses contaminated groundwater from the site. This receptor group is applicable only under the future exposure scenario. The Off-Site Adult Landfill Area Resident is an individual who lives near the landfill. This receptor group is applicable under both the current and future exposure scenarios. Under the current exposure scenario, the individual uses private well groundwater. Under the future exposure scenario, the individual uses contaminated groundwater that has migrated off the site.

3. An Adult Off-Site Landfill Area Resident and Landfill Trespasser:
The Off-Site Adult Landfill Area Resident and Landfill Trespasser is an individual who lives near the landfill. This receptor group is applicable under both the current and future exposure scenarios. Under the current exposure scenario, the individual uses private well groundwater. Under the future exposure scenario, the individual uses contaminated groundwater that has migrated off the site. Under both scenarios, the receptor group is additionally exposed to landfill contaminants as a result of trespassing.

4. An Adolescent Landfill Area Resident (On-Site and Off-Site):
The On-Site Adolescent Landfill Area Resident is an individual who uses contaminated groundwater from the site. This receptor group is applicable only under the future exposure scenario. The Off-Site Adolescent Landfill Resident is an individual who lives near the landfill. This receptor group is applicable under both the current and future exposure scenarios. Under the current exposure scenario, the individual uses private well groundwater. Under the future exposure

scenario, the individual uses contaminated groundwater that has migrated off the site.

5. An Adolescent Off-Site Landfill Area Resident and Landfill Trespasser:
The Off-Site Adolescent Landfill Area Resident and Landfill Trespasser is an individual who lives near the landfill. This receptor group is applicable under both current and future exposure scenarios. Under the current exposure scenario, the individual uses private well groundwater. Under the future exposure scenario, the individual uses contaminated groundwater that has migrated off the site. Under both scenarios, the receptor group is additionally exposed to landfill contaminants as a result of trespassing.

6. A Child Landfill Area Resident (On-Site and Off-Site):
The On-Site Child Landfill Area Resident is an individual who uses contaminated groundwater from the site. This receptor group is applicable only under the future exposure scenario. The Off-Site Child Landfill Area Resident is an individual who lives near the landfill. This receptor group is applicable under both current and future exposure scenarios. Under the current exposure scenario, the individual uses private well groundwater, and the future exposure scenario, the individual uses contaminated groundwater that has migrated off the site.

Sixteen potential exposure pathways were identified:

- Inhalation of ambient air (site workers, trespassers, and future site residents).

- Incidental ingestion of active surface soil (site workers, trespassers, and future site residents).

- Dermal contact with active surface soil (site workers, trespassers, and future site residents).

- Incidental ingestion of excavated active subsurface soil (future site workers).
- Dermal contact with excavated active subsurface soil (future site workers).
- Incidental ingestion of inactive surface soil (site workers, trespassers, and future site residents).
- Dermal contact with inactive surface soil (site workers, trespassers, and future site residents).
- Incidental ingestion of excavated inactive subsurface soil (future site workers).
- Dermal contact with excavated inactive subsurface soil (future site workers).
- Incidental ingestion of sediment (site workers, trespassers, and future site residents).
- Dermal contact with sediment (site workers, trespassers, and future site residents).
- Current use of private well water (area residents via ingestion, inhalation of volatiles while showering, and dermal contact while bathing or showering).
- Future use of contaminated groundwater (future area residents via ingestion, inhalation of volatiles while showering, and dermal contact while bathing or showering).

- Ingestion of surface water (site workers, trespassers and future site residents).

- Dermal absorption of surface water (site workers, trespassers, and future site residents).

- Dermal absorption of leachate water (site workers, trespassers, and future site residents).

Potential health impacts from exposure to non-carcinogenic chemicals were identified by computing hazard indices (HI) which are determined by comparing estimated intakes of chemicals with verified reference doses. The HI is not a mathematical prediction of the severity of toxic effects, it is simply a numerical indication of the possibility of the occurrence of non-carcinogenic effects. U.S. EPA policy states that if the hazard index is less than one, negative health effects are unlikely to occur.

A conservative total HI (summing the individual HI's of the various exposure routes) was calculated for the present and assumed future conditions. In the present conditions, the total HI for one of the report groups - child off-site resident - exceeded unity. Of the individual HI's calculated for each media, those for private wells were the highest.

In the future scenario - which conservatively assumed that the site is used for residential purposes in the future, off-site groundwater contains the same level of contaminants as on-site groundwater and a short-term subsurface soil excavation project occurs on the site - ingestion of groundwater by adolescent and child residents exceeded one. Additionally, the HI for a potential exposure of an adult on-site worker to active area subsurface soils through ingestion and dermal exposure exceeded unity.

For carcinogens, health risk is estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. An estimated lifetime excess cancer risk (LECR) of 1E-06, for example, indicates that the exposed receptor has a one in one million chance of developing cancer after a lifetime of exposure. The U.S. EPA has established a range of acceptable cancer risk of 1E-04 to 1E-07.

Under the present risk conditions at the site, the LECR for all potential receptors was within the EPA acceptable range. Under the future scenario (described above), the LECR for an off-site worker and an off-site trespasser were 2.5E-04, above the EPA acceptable range. The higher values were associated with exposure to groundwater, and beryllium in particular, in the future scenario.

2.3.4 Remedial Action Alternatives - Given the factors discussed above, the Remedial Action Objectives applicable to the Gloversville Landfill site are indicated on Table 2-1 below.

2.4 GENERAL RESPONSE ACTIONS

General response actions are those types of actions that will satisfy the remediation goals for the site as outlined in the Remedial Action Objectives. General response actions are media-specific. Table 2-2 below lists the general response actions for the Gloversville Landfill site and the technologies/processes appropriate to each media.

G191\REPORT\SEC2

TABLE 2-1

REMEDIAL ACTION OBJECTIVES
GLOVERSVILLE LANDFILL

MEDIA	REMEDIAL ACTION OBJECTIVE
Leachate	• Minimize future leachate generation
	• Prevent exposure to leachate to minimize impact on human health and the environment
Solid Waste and Landfill Soils	• Prevent exposure to solid waste and soils by humans and potential vectors
Groundwater	• Prevent ingestion of groundwater containing contaminants in excess of drinking water standards or at levels that create a significant health impact.
	• Restore groundwater quality to meet ARARs
Surface Water	• Restore surface water quality to NYSDEC Class C standards

G191\REPORT\SEC2

TABLE 2-2

GENERAL RESPONSE ACTIONS

RESPONSE ACTION	MEDIA
• No Action	All
• Limited Action	
- Restrict Access	All
- Site Security	All
- Site Monitoring	All
- Alternative Water Supply	Private Drinking Water
• Containment/Source Control	
- Impermeable Cap	Leachate, Soils & Groundwater, Surface Water, Air
- Run-off Control	Surface Water
- Vertical Barriers	Leachate, Groundwater
- Collect and Treat	Air, Groundwater, Surface Water
• Removal of Source	
- Excavate and Off-site Disposal	Solid Waste and Soils
- Excavate and Treat On-site	Solid Waste and Soils

A more detailed description of the various process options and technologies is provided in Section 3.

G191\REPORT\SEC2

SECTION 3.0

INITIAL SCREENING OF PROCESS OPTIONS AND TECHNOLOGIES

The purpose of this Section is to present, evaluate and screen process options and technologies to determine which options will be most effective at meeting the proposed remedial action objectives summarized in Table 2-1. The initial screening process eliminates from further consideration any processes or technologies that are not technically feasible or that do not aid in meeting the objectives.

Processes for screening are divided into six (6) categories: Groundwater, Soil, Surface Water, Air, and Solid Waste. Each category is then divided into remedial technologies and process options for these technologies. A summary of these process options and technologies is presented in Table 3-1 at the end of this section.

3.1 GROUNDWATER TECHNOLOGIES

3.1.1 No Action - The "no action" alternative is required under the USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (23). This alternative is a baseline from which to evaluate other technologies and process options. No action usually involves continued site monitoring and implementation of a public awareness program. Because this technology is a requirement, it is retained for further evaluation.

3.1.2 Limited Action - The limited action alternative involves implementation of institutional actions such as the installation of perimeter fencing, the posting of signs, and providing site security. Restrictions can also be imposed to limit the future use of, and access to, the property. In addition, a program of continued site monitoring and a public awareness policy is usually implemented. Because this option offers risk reduction at a very limited expense, it is retained for further evaluation.

3.1.3 Groundwater Collection

3.1.3.1 Groundwater Recovery Wells - Groundwater recovery wells involve the installation of groundwater extraction wells either in the standard vertical orientation or possibly horizontally oriented in order to pump groundwater to the surface. Whether this technology can be implemented or not depends on soil characteristics, site access, and the desired area of influence of each well. In addition to bringing the contaminated groundwater to the surface for subsequent treatment or reinjection, groundwater pumping can also be designed to intercept a migrating plume and inhibit its migration off the landfill site. Treated groundwater can be reinjected into the subsurface through surface infiltration, infiltration galleries, or injection wells, in order to increase the hydraulic gradient and enhance collection of contaminated groundwater. This technology is retained for further evaluation due to its effectiveness and relative ease of implementation.

3.1.3.2 Interceptor Trenches and Drains - Interceptor trenches, like recovery wells, allow groundwater to be collected and brought to the surface for treatment and also inhibit contaminated plume migration from the landfill area. Unlike groundwater pumping systems which utilize individual wells, interceptor trenches involve the excavation of a linear trench to a depth below the water table which is usually filled with stone and perforated collection pipes. Water flows passively under hydraulic gradient into the trench, where it is collected via sumps and pumped to the surface. Impermeable barriers may be installed on the downgradient wall of the trench to prevent excessive infiltration of uncontaminated groundwater. Due to the continuous, linear nature of these trenches, they are very effective at stopping plume migration. They are most practical in shallow aquifers and where contaminants are present in the upper portion of the aquifer (eg. petroleum product plumes). Their primary disadvantage is the fact that large quantities of potentially contaminated soils and refuse must be excavated during construction, especially where the overburden aquifer is very thick. A similar system may be constructed upgradient of the landfill to capture and divert uncontaminated groundwater prior to contact with which a biofilm is developed. Trickling filters have limited capabilities as single stage treatment systems and are usually better suited as roughing filters to even out organic loads. Rotating biological contactors (RBCs) involve a rotating disc media which host a biofilm. These discs rotate in and out of the wastewater stream alternately receiving nutrients from the wastewater and oxygen from the atmosphere. RBCs offer more flexibility in terms of load variations than trickling filters, but are still only applicable to low strength wastes. Biotowers are enclosed, typically cylindrical vessels filled with packing media on which a biofilm is developed. Wastewater is pumped to the top of the tower and trickles down over the media. To enhance the degradation process, the influent may be heated, or a bio-inoculum added. Attached culture systems can be slow to recover if the biomass is disrupted.

Treatment Ponds and Lagoons - Treatment ponds and lagoons, also called stabilization ponds or oxidation ponds, may be broken down into several different categories. Shallow aerobic ponds are typically used as polishing or tertiary processes and provide minimal treatment. Deeper anaerobic ponds are used for partial treatment of strong organic wastes and are usually followed by shallow aerobic ponds to achieve the appropriate end products. Facultative ponds employ both aerobic and anaerobic treatment zones and thus offer total treatment for some wastewaters. Lagoons are classified by the degree of mixing that is provided. Aerobic lagoons involve the total mixing of liquid and settled solids. When only the liquid is mixed and solids are left on the bottom, the lagoon is called facultative due to the aerobic nature of the liquids and the anaerobic nature of the settled solids.

All of the above biological treatment processes are effective, proven technologies for the degradation and removal of biodegradable organics and some inorganics and all are retained for further consideration.

3.1.4.2 Physical/Chemical Treatment - Physical treatment processes involve the concentration, phase change and/or collection of undesirable substances in wastewater to enhance their removal. Chemical treatment processes utilize chemical reactions to alter the nature of, or enhance collection of, undesirable substances in the wastewater stream for subsequent treatment or removal. The following is a list of typically used Physical/Chemical treatment processes:

- Chemical Oxidation/Reduction
- Precipitation
- Neutralization
- Coagulation/Flocculation
- Sedimentation
- Activated Carbon
- Air Stripping
- Ion Exchange
- Reverse Osmosis
- Filtration
- Dissolved Air Flotation

Chemical oxidation/reduction involves changing the oxidation state of certain contaminants to break them down into carbon dioxide, water, and oxides of nitrogen. The goal of the oxidation/reduction process is to produce compounds which are either less toxic than the original compounds or easier to remove from the wastewater stream. Typical oxidation processes include chlorination, exposure to ultraviolet light and ozonation.

Precipitation involves manipulating the balance of existing chemical equilibria to reduce the solubility of the contaminants of interest which then precipitate out of solution. Because solubility is usually a function of pH, pH adjustment is a commonly used method of precipitation, especially for metals removal. After chemical alteration, the contaminants form an insoluble precipitate which then settles out of solution or is removed by filtration.

Neutralization is the process of adjusting the pH of the wastewater through the addition of an acid or base to enhance the performance of other treatment processes or to modify effluent pH for discharge.

Coagulation/Flocculation is the process by which the addition of chemical flocculants promotes the grouping of smaller particles into larger particles which readily settle out of solution and take other suspended particulates out with them. The grouping of the smaller particles is usually aided by a gentle mixing process. Coagulation/Flocculation is a common method used to remove suspended particulates from wastewater streams.

Sedimentation is a physical process wherein particles suspended in a liquid are settled in a tank by means of gravity and inertial forces acting on both the particles suspended in the liquid and the liquid itself. Settling occurs when gravity and inertial forces acting on the particles in the downward direction are greater in magnitude than the various forces acting in the opposite direction. Settling is typically used in conjunction with other biological or chemical treatment processes.

Activated Carbon is commonly used for removal of dilute concentrations of organic compounds. Removal is accomplished by adsorption of these compounds onto the surface of the carbon. Wastewater passes through the fixed beds of carbon allowing contact between the water and the carbon. Eventually, when organic contaminants occupy all the sorption sites available in the carbon bed, replacement or reactivation of the carbon is necessary. Extensive filtering of groundwater is required prior to carbon adsorption to prevent plugging of the carbon bed by suspended and dissolved solids.

Air Stripping is accomplished by passing air or steam through contaminated liquid to remove volatile organic and inorganic compounds. Typically, a wastewater stream flows countercurrent to a forced air or steam in a packed tower. Packing media in the tower is designed to maximize the transfer of volatile materials in the liquid to the gaseous phase. In both the air and steam stripping processes, pollutants are transferred from the wastewater to a gaseous stream which then often requires further treatment before discharge.

Ion Exchange involves the exchange of harmless ions attached to a resin for contaminants in solution. The ion exchange resin is periodically regenerated to remove the contaminant ions. Suspended solids and soluble organics may foul the resin material and therefore must be removed prior to the ion exchange column.

Reverse Osmosis (RO) is a process by which high pressure is used to force water through a membrane while leaving impurities behind. In reverse osmosis, water flows from a more concentrated solution across a semi-permeable membrane to a less concentrated solution. Due to the nature of the membranes used, a high quality influent is required for RO systems. Pretreatment by filtration and carbon adsorption is usually necessary. Salt and organics, depending on the size are effectively removed by reverse osmosis.

Filtration is the process of removing suspended solids by passing liquid through a matrix of filter media allowing liquids to pass through while trapping particulates. A wide variety of filter media are available including cloth, membrane, diatomaceous earth and sand. These media require periodic backwashing and/or replacement to prevent clogging and increased headloss due to particulate buildup.

Dissolved Air Flotation involves the generation of fine air bubbles at the base of a flotation tank which then attach themselves to particulates within the wastewater stream. Particulates are carried to the water surface with the air bubbles and are then removed by a skimming device. It is an effective method for the removal of suspended solids, oils and grease.

All physical/chemical treatment processes are potentially applicable and are retained for further evaluation in this Feasibility Study.

3.1.4.3 In-Situ Treatment - In-situ treatment of groundwater involves treating the groundwater while it remains in the ground without pumping or collection. Current in-situ treatment technologies include:

Air sparging is a process in which air is injected below the water table to strip volatiles out of the groundwater which are then collected by pneumatic collection systems in the soil or at the surface.

Soil flushing involves chemicals which are pumped into the subsurface to alter the characteristics of groundwater contaminants to less hazardous or more treatable forms.

Biological treatment involves micro-organisms and nutrients which are pumped into the groundwater where biodegradation of contaminants can occur in the subsurface.

In-Situ treatment technologies for groundwater are generally still not proven technologies and are usually better suited for smaller areas with a narrow range of contaminants. Due to the large area and wide range of contaminants within the leachate impacted groundwater at the Gloversville Landfill, in-situ treatment technologies for groundwater at the site will not be retained for further evaluation.

3.1.4.4 Effluent Discharge - Once groundwater from the site has been collected and treated, it must be discharged either back into the ground, to a surface water body such as a nearby stream or pond, or to an existing wastewater treatment plant (WWTP).

Subsurface Discharge - Discharge into the subsurface (recharging) is an effective method for disposing of treated water. Water can be recharged by a variety of methods including recharge wells, infiltration trenches, and infiltration basins. A benefit of this method is that the groundwater can be recharged in such a way as to redirect the contaminated groundwater for more efficient collection. A disadvantage of this technology is the extensive treatment required to meet groundwater standards for recharge. In addition, extensive construction is required to implement recharge wells and/or trenches.

In an effort to protect aquifer resources, the permits required for groundwater recharge are more stringent and difficult to acquire than surface water discharge permits. More extensive treatment is required to meet effluent discharge standards for subsurface discharge. In addition, recharge options are limited. An upgradient recharge area would be counter productive when all other efforts are being made to dewater the waste mass. A downgradient location could impact the collection wells, causing the uptake of clean water unnecessarily. It would also tend to reduce the groundwater gradient through the landfill and reduce the natural flushing action of the groundwater flowing beneath it. For these reasons, the option to recharge treated groundwater into the subsurface will not be considered further.

Surface Water Discharge - Discharge to a surface water body also involves extensive pretreatment of leachate impacted groundwater, in this case, particularly for the removal of ammonia. The treatment required for other parameters, however, is less stringent than that for groundwater recharge. Because the site is in close proximity to Anthony Creek and technologies for proper treatment are available, this option will be retained for further evaluation.

WWTP Discharge - Discharge to the WWTP requires pretreatment of leachate impacted groundwater. However, the level of treatment required is far less than that of the other two discharge options because additional treatment occurs at the WWTP. The pretreatment required would be for metals, ammonia, and solids removal. Benefits of this option are that with only limited pretreatment, the site treatment facility would be more reliable and less expensive to construct and operate. The disadvantages of this method are the need to convey pretreated groundwater to an existing sewer with sufficient capacity to accept the additional hydraulic load and also the fees associated with WWTP usage. In addition, the Gloversville/Johnston WWTP discharges to the Mohawk River while groundwater flowing beneath the landfill would naturally flow north to Lake Sacandaga and on to the upper Hudson River. Because the Mohawk and Hudson Rivers serve two different drainage basins, this would be considered an inter-basin diversion and possible permitting issues could arise. These issues are minor in nature.

Both the surface water and WWTP discharge options are retained for further analysis.

3.1.5 Groundwater Protection by Containment - Containment technologies (capping, vertical barriers, and horizontal barriers) are used to minimize leachate generation and/or to limit migration of contaminants.

3.1.5.1 Capping - Landfill caps are designed to minimize infiltration of surface water caused by runoff or precipitation events, thereby substantially reducing the potential for leachate generation. They also eliminate the potential for human physical contact with the waste. Capping involves placement of an impermeable barrier and related soil systems over the landfill along with a suitable cover soil to protect the barrier and support vegetative growth. Capping materials include clay, synthetic membranes, asphalt, and concrete or soil mixtures. An impermeable cap is necessary to prevent or minimize generation of leachate at the Gloversville Landfill site unless the detailed analysis of alternatives shows that excavation of the waste material and subsequent reburial in a lined facility is more feasible.

<u>3.1.5.2 Vertical Barriers</u> - Vertical barriers are installed to divert groundwater away from waste materials, thereby preventing contact with the waste and associated contaminants. Technologies currently employed include slurry walls, sheet piling, and grout curtains. Slurry walls are constructed by digging a trench around areas of contamination and filling it with soil/bentonite or cement/bentonite mixtures. Sheet pilings are typically interlocking wood, concrete, or steel sections driven into the ground around the areas of contamination to form a sheet barrier that eliminates or minimizes groundwater flow. A grout curtain involves the pressure injection of grout in a regular pattern of drilled holes to fill voids in fractured rock or to consolidate rocky soil.

Because the Phase 1 and 2 RI reports indicate that contaminants are leaving the site through the underlying bedrock, vertical barriers would not be sufficient to intercept the entire leachate plume. For this reason, vertical barriers will not be considered further in this Feasibility Study.

<u>3.1.5.3 Horizontal Barriers</u> - Horizontal barriers are installed by jet grouting to prevent vertical movement of contaminants. Jet grouting involves the drilling a series of holes through the waste material. Grout is injected at the base of the holes to form a horizontal barrier beneath the waste. Soil typically is excavated underground by high pressure injection of water shielded in a cone of air to cut and lift the soil to the surface, while simultaneously filling the void with a grout of cement/bentonite. The installation of a horizontal barrier at the Gloversville Landfill is not being considered because the varying elevation of the bottom of the waste mass would make installation of a horizontal impermeable barrier extremely impractical.

<u>3.1.6 Alternate Water Supply</u> - As an alternative or complement to groundwater treatment, an alternate water supply could be provided to the area residents whose drinking water supplies (private wells) have been or could potentially be impacted by groundwater contaminated as a result of the landfill. Several options are available for providing an alternate water supply.

<u>3.1.6.1 Bottled Water</u> - The supply of bottled water is probably the least expensive technology that limits the ingestion of contaminated well water. However, it does not reduce the risk associated with dermal absorption, inhalation (from showering), or incidental ingestion (child drinking bath water). Since the risk assessment identified children as the most likely affected group, bottled water is not considered a reliable means of reducing the risks associated with contaminated private well water. This technology is eliminated from further consideration.

<u>3.1.6.2 In-home Treatment</u> - Another potential solution to the public health risk is to install water supply treatment systems in potentially impacted homes. These systems would need to be designed for metals removal to effectively reduce the health risk identified in the Phase 2 RI Report. These systems are relatively inexpensive ($1,000 - $5,000/home), but require frequent preventive maintenance and monitoring to ensure their proper operation. This dependence on homeowner maintenance makes them unreliable in terms of consistently and continuously reducing health risks.

Also, in-home treatment only addresses the current contaminants. If future migration of the contaminant plume from the landfill carries other contaminants such as organics to the impacted wells, then other treatment system components will need to be added to each in-home treatment system.

Ammonia is not easily removed in an in-home treatment system. However, because it does not pose a human health threat, it is not necessary to remove ammonia to reduce the health risk.

In-home treatment systems are eliminated from further consideration due to the dependence on the homeowner and the need for continued monitoring.

3.1.6.3 Replacement Groundwater Supply - Another means of reducing the public health risk is to replace the potentially impacted wells with either new private wells completed in the non-contaminated overburden aquifer or install a community groundwater supply system that serves the affected area from a high production well field. Potential problems with this approach include the time involved with siting the new wells and ensuring that they are completed in non-contaminated portions of the aquifer and that these portions remain uncontaminated. They would also require continued monitoring to ensure that future plume migration does not affect the new water supply. For these reasons, community groundwater supplies and private well replacement are not retained for further consideration.

3.1.6.4 Extension of the City Water Supply - The City of Gloversville water supply currently extends only slightly beyond City limits in the vicinity to Elmwood Avenue and Route 30. These water mains can be extended out Elmwood Avenue and Barker Road to the Blanchard Loop area to supply City water to the potentially impacted homes. Similarly, the water supply on the south side of the landfill can be extended from existing lines on East Fulton Street across Route 30 and out East Fulton Street Extension to serve the potentially impacted homes in that area. This alternative is attractive in that it is a reliable means of supplying uncontaminated water to potentially impacted residents, thereby reducing the health risks that have been identified. It is not dependent on other studies and therefore, can be readily implemented in a timely manner.

This technology is retained as the remedial alternative that most effectively reduces public health risks resulting from contaminant migration from the landfill.

3.2 SOIL TECHNOLOGIES

3.2.1 No Action - The "no action" alternative for soils treatment is required under the US EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (23). This alternative usually involves continued site monitoring and a program of public awareness.

3.2.2 Limited Action - The limited action plan to be instituted for soils is the same as that described previously in the Groundwater Technologies Section under subsection 3.1.2.

3.2.3 Containment - Containment technologies for soils involve capping which was described previously in the Groundwater Technologies Section under subsection 3.1.5.1.

3.2.4 Excavation - Excavation is a common technology used to remove contaminated soils for treatment and/or disposal. After excavation, the soils can be treated by a variety of physical/chemical and biological processes. Treatment or disposal may occur on-site or off-site depending on economic feasibility and human health and environmental considerations. Because most of the contaminated soils are located under the large volume of waste at this site, and the potential health hazards associated with exposing the waste materials, excavation for purposes other than site regrading will not be considered further.

3.2.5 Physical/Chemical Treatment - Because the technology of excavation was previously eliminated, only in-situ physical/chemical processes are considered applicable to contaminated soils at this site. These processes include soil washing, solidification, stabilization, vitrification, and thermal destruction.

<u>3.2.5.1 Soil Washing</u> is a process by which surfactants or solvents are mixed with and/or flushed through soils to remove contaminants bound in the soils. It is applicable to uniform or homogeneous soils that can be thoroughly exposed to the solution either by excavation and mixing or by an extensive injection network. This technology is not applicable to this site because the soils are heterogeneous and inaccessibly located under large amounts of waste materials. For this reason, soil washing will not be considered further.

<u>3.2.5.2 Soil Solidification</u> is a process by which soil and contaminants are mechanically held within a solidified matrix. The chemistry of the contaminants remains unchanged for the most part and, although the problem of leaching is greatly reduced, it can still be a concern. Solidifying agents include cements, thermoplastics and organic polymers. The technology of soil solidification is most practically applied to sites with small volumes of homogeneous, contaminated soils. Due to the large volume of potentially contaminated heterogeneous soils at this site and the fact that the soils are located under large amounts of waste materials, this technology will not be considered for further evaluation.

<u>3.2.5.3 Soil Stabilization</u> involves a chemical fixation process which decreases the toxicity and/or solubility of contaminants in the soil matrix. It is similar to soil solidification in that it locks contaminants within the soil matrix but it does not physically alter the structure of the soil. As with solidification, this process is applicable to areas with small quantities of homogeneous soil that are easily accessible for treatment. Therefore, it is removed from further consideration.

<u>3.2.5.4 Vitrification</u> In-situ vitrification involves the solidification of contaminated soils. This high temperature thermal process volatilizes many contaminants and produces an inert crystalline substance that prevents any non-volatilized contaminants from further migration. Due to the large volume of potentially contaminated heterogeneous soils at this site and the fact that the soils are located under large amounts of waste materials, this technology will not be considered for further evaluation.

3.2.5.5 Thermal Destruction usually involves the combustion or wet oxidation of organically contaminated soils. Thermal destruction is not an in-situ technology, but is included for completeness. Combustion is the most common technology and is usually accomplished through use of a rotary kiln. Within the kiln, soils are subjected to extremely high temperatures and organic contaminants are permanently destroyed. Wet oxidation involves the oxidation of organic wastes in the presence of water and absence of air. The process utilizes high temperature water at high pressures to oxidize organics without vaporization of the water. It is practical when dewatering of soils is difficult.

This technology requires excavation of contaminated soils; it is not an in-situ treatment process. Generally, this technology destroys organic compounds, but no inorganics, such as metals. Since excavation has been eliminated from further consideration and since thermal destruction technologies do not treat inorganics, it is removed from further consideration.

3.2.6 Biological Treatment - In-situ biological treatment involves the injection of microorganisms and nutrients into the soil to enhance the biodegradation process. Injection typically takes place through a series of wells.

As with in-situ groundwater treatment processes, in-situ biological soil treatment processes are usually applicable to small areas with a narrow range of contaminants. Therefore, in-situ biological soils technologies will not be considered further.

3.3 SURFACE WATER TECHNOLOGIES

3.3.1 No Action - As with groundwater and soil technologies, the no action alternative for surface water treatment is required under the USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (23). This alternative usually involves continued site monitoring and a program of public awareness.

3.3.2 Limited Action - The limited action alternative involves the implementation of institutional actions such as access restrictions at the site along with continuous site monitoring. Details of these are described in the Groundwater Technologies Section under subsection 3.1.2.

3.3.3 Surface Water Collection & Treatment - Surface water collection for subsequent treatment is usually accomplished through the installation of a pump station near the waterbody to be treated. The technology alternatives available for surface water treatment are the same as those used for groundwater. In general, because contamination is less severe, the processes required to treat surface waters are less involved than those required to treat leachate impacted groundwater.

3.3.3.1 In-Situ Treatment of Surface Water - In-situ treatment of surface water can be divided into three categories: physical, chemical, and biological treatment. A typical in-situ physical treatment process involves aeration of surface water to strip out contaminants and add oxygen to enhance aerobic biodegradation. Biological treatment processes involve the addition of micro organisms and nutrients to a surface water body to enhance biodegradation. In-situ chemical processes would involve the addition of chemicals in an effort to remove or alter the nature of contaminants in the water body.

3.3.3.2 Surface Water Discharge - The discharge options available for treated surface water are the same as those listed for treated groundwater. They include discharge to a surface water body; reintroduction into the subsurface via injection wells, recharge trenches, or an infiltration basin; or discharge to a WWTP.

3.3.4 Protection Through Diversion/Containment - This option does not treat contaminated surface water but instead prevents further degradation of surface water quality. For the most part, the options involve diversion and collection of runoff from the landfill site. Grading and revegetation of the site prevents surface erosion and enhances sealing of the surface area. The construction of berms provides protection from floods and other heavy flow events that would negatively impact surface water bodies.

3.3.5 Applicability of Surface Water Technologies - With the exception of ammonia, analytical results from the Phase 1 and 2 RI reports indicate that very low levels of contaminants are present in the surface water bodies downgradient of the landfill site. Groundwater modelling results and piezometric well data indicate that Anthony Creek and Pond B are discharge locations for a large portion of the groundwater within the overburden which is being impacted by landfill wastes. This indicates that the majority of contaminants present in the surface water bodies are caused by the discharge of contaminated groundwater.

Treatment of surface water bodies without stopping the inflow of contaminated groundwater will not be practical because the landfill will continue to be a high strength source of these contaminants for years to come. With a capping or capping with groundwater pump and treat alternative in place, the generation of contaminated groundwater will be greatly reduced and contaminant loadings on the surface waters will diminish rapidly. Thus, surface water ARARs likely will be met also. Therefore, surface water treatment technologies other than the previously discussed diversion/containment option for surface runoff, will not be considered further in this Feasibility Study.

3.4 AIR TECHNOLOGIES

3.4.1 No Action - The no action alternative for air is required under the USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (23). This alternative involves continued site monitoring and implementation of a public awareness program.

3.4.2 Limited Action - The limited action alternative involves the implementation of access restrictions to the site along with continued site monitoring. Details of this are described in the Groundwater Technologies Section under subsection 3.1.2.

<u>3.4.3 Containment</u> - In addition to limiting water infiltration, the various capping options outlined in the Groundwater Technologies section also limit the migration of landfill gases and airborne particulates through the top and sides of the landfill. Therefore, capping containment systems, in addition to minimizing groundwater contamination, also minimize the impacts of landfill generated gasses on the surrounding atmosphere and virtually eliminate the potential for migration of wind-entrained contaminated soil particles. This technology is retained for further evaluation.

<u>3.4.4 Gas Collection</u> - Because an impermeable cap traps landfill gases beneath it, a landfill gas collection system is required with capping in order to prevent gas buildup. Gas collection systems involve a permeable soil layer through which the gas can travel until it is intercepted by a collection and removal system. Collection systems are classified as either active or passive.

<u>3.4.4.1 Passive Gas Collection</u> systems usually involve a permeable gas conveyance layer constructed beneath an impermeable landfill cap, and the installation of gravel packed venting wells at approximately 1 acre intervals. Elevated pressures generated within the landfill cause the gases to travel through the permeable layer and to exit through the venting wells to the atmosphere. A trench type collection system may also be installed to prevent lateral gas migration off-site. Collection trenches involve excavation of a narrow trench which is filled with gravel, capped, and vented at various points to the atmosphere.

<u>3.4.4.2 Active Gas Collection</u> systems are comprised of the same permeable gas transmission layer as passive systems with the difference being that negative pressure gradients are induced by a blower, or other means, on the internal landfill cavity, causing gasses to flow out of the landfill to atmospheric vents or a gas collection and treatment system.

Due to the large gas quantities associated with the size of the Gloversville Landfill, a gas collection system of some type will be required. For this reason, all gas collection technologies are retained for further consideration.

3.4.5 Gas Treatment - Flaring is a cost effective, reliable means of treating landfill gases. Flares are usually of two basic types, the conventional or candlestick flare and the enclosed flare. Conventional flares have the benefit of being economical and simple to operate. Enclosed flares offer more control of and more complete combustion along with the ability to monitor emissions from the stack. This technology is potentially applicable at the Gloversville Landfill and is retained for further analysis.

3.5 SOLID WASTE TECHNOLOGIES

3.5.1 No Action - The "no action" alternative for solid waste treatment is required under the US EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (23). As with the previous technology groups, this alternative involves continued site monitoring and a program of public awareness.

3.5.2 Limited Action - The "limited action" alternative for solid waste is the same as that described for the previous technology groups involving site access and land use restrictions, site monitoring and a program of public awareness, all as described in subsection 3.1.2.

3.5.3 Containment - Containment technologies for solid waste are the same as those for soils and involve capping and vertical and horizontal barriers. For reasons discussed in the groundwater technologies containment section (3.1.5), the only containment technology retained will be capping of the solid waste.

3.5.4 Excavation - Excavation of solid waste involves removal of the waste from the landfill cavity by mechanical means. Typical removal equipment includes draglines or backhoes. This technology is usually combined with an on or off-site treatment technology such as incineration or direct reburial in a facility better designed to contain the waste. While excavation of solid waste provides permanent elimination of waste at the site, the treatment or reburial technologies that follow leave toxic residuals and shift the contamination elsewhere. In addition, this technology, coupled with the required technologies that follow it, are cost intensive. Human health risks to workers are also greatly increased due to exposure to open refuse, treatment processes, and the treatment residuals. Due to the large quantity of waste at the site, relatively low contaminant levels, and the health risks associated with unearthing buried wastes, this technology will not be retained as an option for the entire waste mass. Excavation of wastes from some portions of the site may be feasible to consolidate the wastes and to shape the landfill for proper closure.

3.5.5 Treatment Processes - The first two technologies listed below, post-excavation treatment and waste relocation, are not retained in this screening process because they require waste excavation, which has been eliminated from further consideration. They are presented in this report for completeness.

3.5.5.1 Post-Excavation Treatment - Aside from incineration, there are few practical methods for treatment of large quantities of Municipal Solid Waste (MSW). Solidification, encapsulation and stabilization processes are not practical for use with the heterogeneous wastes present. Screening and composting is not considered applicable to treatment of filled materials at an inactive hazardous waste site because of the wide variety of materials and contaminants present.

On-site incineration provides a great reduction in waste volume but produces treatment residuals in the form of incinerator ash which can be hazardous and also need to be landfilled. The large quantities of industrial and wastewater treatment sludges are not well suited to incineration. Therefore, incineration is not retained.

3.5.5.2 Waste Relocation - Another option is to relocate the waste to a more secure, properly designated landfill site. Again the costs involved with this option are prohibitively high. In addition to constructing another landfill, the wastes must be excavated and transported to the new site thus increasing the potential for endangerment of public health. This technology is not retained.

__3.5.5.3 In-situ Treatment__ - In-situ treatment of municipal solid waste usually involves the addition and collection of a solution which leaches contaminants from the waste. A solution may also be added to neutralize or detoxify contaminants in the waste. Since there are no provisions for the collection of the leachate, in-situ treatment technologies for solid waste at the Gloversville Landfill site will not be considered further in this Feasibility Study.

G191\REPORT\SEC3.ESH

TABLE 3–1
INITIAL SCREENING OF TECHNOLOGIES & PROCESS OPTIONS

GENERAL RESPONSE ACTION/MEDIA	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS	SCREENING COMMENTS	EFFECTIVENESS	IMPLEMENTABILITY	RETAIN
1. NO ACTION	None		Required by NCP. Leachate production continues	Does not meet RAOs	Easily Implemented	Yes
2. INSTITUTIONAL ACTIONS	A. Access / Use Restriction	A1 Deed Restrictions	Leachate production continues. May be applicable in conjunction with other technologies.	Does not meet RAOs when applied alone.	Easily Implemented	Yes
	B. Site Security	B1 Fencing / Guards				
	C. Site Monitoring	C1 Environmental Sampling & Analysis				
3. GROUNDWATER	A. Collection	A1. Recovery Wells	Both technologies extensively used	Both are effective collection methods	A1. Easily Implemented	Yes
		A2. Trenches or Drains			A2. Difficult to implement due to excavation of contaminated material and the deep contaminant plume.	No
	B. Biological Treatment	B1. Suspended Culture	Widely used proven technologies	All are effective at removing a wide variety of organic wastes	B1, B2 & B3 readily implemented, extensive treatment plants are required.	Yes
		B2. Attached Culture				
		B3. Treatment Ponds & Lagoons		B1, B2 offer added process control.		
	C. Physical / Chemical Treatment	C1. Oxidation / Reduction	Change of valence to reduce toxicity or improve treatability.	Effective at changing valence of contaminants.	All readily implemented as part of a wastewater treatment facility.	Yes
		C2. Precipitation	Pretreatment process for metals	Effective metals removal.		
		C3. Neutralization	pH adjustment.	Effective		
		C4. Coagulation / Flocculation	Grouping of particles to improve settleability.	Effective at preparing solids for removal.		
		C5. Sedimentation	Gravity settling.	Effective solids removal.		
		C6. Activated Carbon	Adsorption of organics.	Effective removal of many organic substances.		
		C7. Air Stripping	Transfer of volatiles to air stream.	Effective removal of volatile organics and ammonia.		
		C8. Ion Exchange	Adsorption of ionic inorganics	Effecitve removal of some ionic substances.		
		C9. Reverse Osmosis	Pressure filtration through micro-porous membranes.	Effective removal of salts and some inorganics, dissolved solids.		
		C10. Filtration	Removal of particulates	Effective removal of suspended solids.		
		C11. Dissolved Air Flotation	Flotation and removal of solids and light liquids.	Effective removal of oils and solids.		

TABLE 3–1
INITIAL SCREENING OF TECHNOLOGIES & PROCESS OPTIONS

GENERAL RESPONSE ACTION/MEDIA	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS	SCREENING COMMENTS	EFFECTIVENESS	IMPLEMENTABILITY	RETAIN
3. GROUNDWATER (Cont.)	D. In–Situ Treatment	D1. Sparging	Air introduced below groundwater table.	Effective removal of volatiles.	All are difficult to implement on a large scale with heterogeneous wastes.	No
		D2. Flushing	Alters contaminant characteristics.	Can be effective in some cases. Not effective with heterogeneous wastes.		No
		D3. Biological	Introduction of microorganisms & nutrients.	Difficult to distribute evenly.		No
						No
	E. Discharge	E1. Subsurface	Must meet GW discharge standards, interferes with dewatering of waste mass.	All are effective methods of discharging treated GW.	E1. Requires installation of injection wells/trenches.	No
		E2. Surface Water	Must meet surface water discharge standards.		E2. Easily implemented.	Yes
		E3. WWTP	Must pay user fees.		E3. Requires installation of sewer line.	Yes
	F. Protection thru Containment	F1. Capping	Several capping options.	Very effective, proven containment technology.	F1. Easily implemented technically.	Yes
		F2. Vertical Barriers	Limit plume migration.	Not effective with bedrock contamination.	F2. Readily implemented.	No
		F3. Horizontal Barriers	Limit leachate percolation through bottom of landfill mass.	Not practical on large scale.	F3. Extensive boring required.	No
	G. Alternate Water Supply	G1. Bottled water	Does not eliminate dermal contact, accidental ingestion.	Not effective at eliminating contact based risks.	Easily implemented.	No
		G2. City Water	Permanent solution.	Totally eliminates contact with contaminated well water.	Requires extension of City water line.	Yes
		G3. Municipal Well	Need to site well and install water line.	Effective if well remains uncontaminated.	Need to locate water supply source.	No
4. SOILS	A. Containment	A1. Capping	Occurs in conjunction with waste containment.	All are effective methods of reducing contaminant leaching from soils.	Would be implemented as part of entire waste capping scenario.	Yes
		A2. Vertical Barriers	Discussed in Sections F2, F3.			No
		A3. Horizontal Barriers				No
	B. Excavation	B1. On–site treatment.	Large quality of soil overlain by waste mass.	Removes contaminant source.	Both are extremely difficult and expensive to implement.	No
		B2. Off–site treatment.				
	C. Physical / Chemical Treatment	C1. Soil Washing	Flush contaminants from soil.	All are effective when used in small areas with homogeneous contaminants, requires excavation of soil.	All are not suitable for large areas of soil mixed with heterogenous waste.	No
		C2. Soil Solidation	Changes soil structure.			No
		C3. Soil Stabilization	Locks contaminants in soil.			No
		C4. Vitrification	Solidifies soil.			No

TABLE 3-1
INITIAL SCREENING OF TECHNOLOGIES & PROCESS OPTIONS

GENERAL RESPONSE ACTION/MEDIA	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS	SCREENING COMMENTS	EFFECTIVENESS	IMPLEMENTABILITY	RETAIN
4. SOILS (Cont.)		C4. Thermal Destruction	Energy intensive, applicable to small areas.			No
	D. Biological Treatment	D1. Biological	Introduce microorganisms and nutrients.	Not effective with heterogeneous wastes.	Extremely difficult to implement.	No
5. SURFACE WATER	A. Collection	A1. Pump Station	Installed near water body.	Effective collection.	A1, B1-2, C1-3 are all readily implemented but are not retained. Contamination is groundwater based.	No
	B. Treatment	B1. Physical / Chemical	Collect and treat.	Effective proven methods.		No
		B2. In-situ	Aeration, chemical addition.	Effective, widely used.		
	C. Discharge	C1. Subsurface	Options discussed in Section 3E.	All are effective discharge technologies.	C1-C3 are not retained because collection and treatment have been eliminated.	No
		C2. Surface Water				No
		C3. POTW				No
	D. Protection through Diversion / Containment		Construction of runoff control structures.	Many effective, proven options.	Readily implemented, cost effective.	Yes
6. AIR TECHNOLOGIES	A. Containment	A1. Landfill Cap	In addition to limiting water infiltration, contains landfill gas for collection.	Very effective in conjunction with collection wells.	Readily implemented as part of waste capping scheme.	Yes
	B. Gas Collection	B1. Passive	Gas exits under own pressure.	Effectively vents gas to atmosphere.	Both are easily implemented along with capping.	Yes
		B2. Active	Gas drawn out of waste with blower.	Effectively routes gas to combustion unit.		Yes
	C. Gas Treatment		Combustion of collected gas.	Effective removal of hydrocarbons.	Easily implemented.	Yes
7. SOLID WASTE	A. Containment	A1. Capping	Install barrier layer above waste.	Effectively reduces groundwater contaminant loading.	Readily implemented, large quantity of soil materials required.	Yes
		A2. Vertical Barriers	Impermeable wall to prevent plume migration.	Not effective with bedrock contamination.	Readily implemented.	No
		A3. Horizontal Barriers	Impermeable layer under landfill.	Not applicable in this situation.	Extensive boring required.	No
	B. Excavation	B1. Rebury On Site	Excavate waste and build new landfill.	Effectively eliminates source.	Requires construction of new landfill on site. Health risks.	No
		B2. Burial Off-Site.	Not applicable with large quantity of waste.	Effectively removes source.	Extremely difficult to implement. Health risks.	No
	C. Treatment	C1. Post Excavation Treatment	Requires extensive excavation.	Effective removal of source.	Extremely difficult to implement due to large volume of heterogeneous waste. Health risks.	No
		C2. In-Situ Treatment	Large volume of waste.	Effective for a limited number and small quantity of contaminants.	Very difficult to implement.	No

SECTION 4.0

DEVELOPMENT AND ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

This Section discusses the combination of potentially applicable remedial technologies from Section 3 into remedial alternatives that can reasonably be expected to meet the remedial action objectives outlined in Section 2.3. As required by EPA guidance, other remedial alternatives are developed that do not meet all of the remedial action objectives.

The National Contingency Plan (NCP) classifies remedial alternatives as either source control or migration management. The former category applies to alternatives which either eliminate the source or minimize the migration of contaminants from it. These include several source treatment technologies that were screened out in the preliminary screening of technologies (Section 3). Also included in source control alternatives are the containment type technologies which control the generation of contaminated leachate by minimizing percolation through the waste mass.

Migration minimization alternatives include those designed to address contaminants that have migrated from the source. In the case of the Gloversville Landfill, these apply to the contaminant plume that appears to impact private wells and to degrade the surface water and groundwater quality. These alternatives include technologies such as groundwater collection and treatment systems.

The remedial action objectives outlined in Section 2.3 can be divided into

- Protection of public health
- Protection of the environment
- Compliance with other ARARs

Protection of public health is considered the highest priority. Therefore, remedial actions which most reliably achieve these objectives are considered first. Potentially applicable remediation technologies that minimize the migration of contaminants include groundwater collection and treatment technologies. Other technologies that do not address the migration of contaminants, but do protect health are the alternate water supply technologies including:

- Installation of alternate water supply wells
- Extension of the City water supply to effected homes
- Supply of bottled water to effected homes
- Installation of whole house water treatment systems in affected homes

Extension of the City water supply to effected homes is the only alternate water supply technology which was retained in Section 3.

Protection of the environment and compliance with other ARARs is secondary in importance, and is achievable in degrees. For example, some remedial alternatives may result in a lowering of contaminant levels in the groundwater and surface water but fail to achieve the ARARs. Other technologies, which may be significantly more expensive, may result in complete compliance with the ARARs.

At the Gloversville Landfill, source control (containment) technologies are expected to significantly reduce the production of contaminated leachate by minimizing percolation through the waste mass and by lowering the groundwater table beneath the landfill. The reduced elevation of the groundwater table results in desaturation of the refuse in the landfill and in a reduction in the hydraulic gradient under the landfill. The reduced gradient results in a slower groundwater flow velocity. In the following sections, these effects are considered quantitatively to calculate the effect on groundwater and surface water quality to determine if chemical specific ARARs will be achieved solely by source control. Different types of caps are considered in Section 4.5.1.

A greater level of control can be achieved by combining the source control technologies with migration management technologies. Any contaminant plume remaining after implementation of the source controls previously discussed can be reduced by collecting and treating groundwater immediately downgradient of the landfill. The specific treatment alternatives are discussed in Section 4.7.1.

4.2 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

For the purposes of this Feasibility Study, four alternatives will be presented for detailed analysis. These alternatives were assembled from the technologies screened in Section 3 to provide a range of options with respect to cost and their effectiveness at reducing risk to human health and the environment.

- **Alternative No. 1: <u>No Action</u>**
  - Site Monitoring
  - Public Awareness Program

Analysis of this alternative is required by CERCLA. It provides a baseline from which to judge other alternatives.

- **Alternative No. 2: <u>Limited Action</u>**
  - Site Monitoring
  - Public Awareness Program
  - Site Access Restrictions
  - City Water to Residences

This alternative provides a reduction in current landfill based risks associated with private water wells at a relatively low cost with few impacts to the surrounding area.

- **Alternative No. 3: <u>Impermeable Cap/City Water Line</u>**
  - Site Monitoring
  - Public Awareness Program
  - Site Access Restrictions
  - Landfill Cap
  - City Water to Residences

This alternative provides the same human health based risk reductions as Alternative No. 2 with an added reduction in contaminant loading to the groundwater and surface water through a reduction in leachate production by capping the landfill.

- **Alternative No. 4: <u>Impermeable Cap/City Water Line/Groundwater Pump and Treat</u>**
  - Site Monitoring
  - Public Awareness Program
  - Site Access Restrictions
  - Landfill Cap
  - Supply City Water to Residences
  - Groundwater Pump and Treat System to Intercept the Migrating Plume

This alternative provides all the risk reductions associated with Alternative No. 3 and in addition, actively treats contaminated groundwater migrating off-site in the vicinity of the landfill through groundwater pumping with treatment of the pumped water. This system, in effect, stops any additional contaminant plume migration off-site in the overburden.

4.3 PROCEDURE FOR DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives involves the evaluation of each retained alternative based on the following criteria:

- Short-term effectiveness
- Long-term effectiveness
- Reduction of toxicity, mobility, and volume of contaminants
- Implementability
- Compliance with ARARs
- Protection of human health and the environment
- Cost

4.3.1 Short-Term Effectiveness - This criterion examines the effectiveness of alternatives during the construction and implementation phase of a remedial action until the response objectives have been met. The factors to be evaluated include:

- Protection of the surrounding community while the remedial action is implemented, including any potential risks such as fugitive dust emissions during construction or impacts on air quality from, for example, an air stripping tower associated with a groundwater remediation system.

- Protection of site workers during implementation of a remedial action. This aspect addresses potential risks imposed on construction workers and other on-site personnel. Also considered are the effectiveness and reliability of any protection measures that might be utilized.

- Any environmental impacts that may result from the implementation of a chosen alternative along with any control or mitigation measures to minimize these impacts.

- Time from record of decision (ROD) until remedial response objectives are met.

4.3.2 Long-Term Effectiveness and Permanence - This criterion evaluates the risk remaining at the site after the remedial response objectives have been met. Specifically, this criterion evaluates the effectiveness of the implemented controls to manage the risks associated with residuals from the treatment process and/or untreated waste. Specific factors to be evaluated are:

- The magnitude of remaining risk(s)imposed by treatment residuals or untreated waste. These residuals may be evaluated either numerically (i.e. cancer risk) or as a measurement of the volumes or concentrations of contaminants remaining at the site after remedial activities have been completed.

- The adequacy of the controls to provide the degree of protection needed to prevent exposure to untreated contaminants left on-site and treatment residuals to be left on-site after remedial action objectives have been met. Specifically, containment of waste and site access restrictions to be imposed after the remedial action are addressed here.

4.3.3 Reduction of Toxicity, Mobility and Volume: This criterion addresses how well an alternative permanently and significantly reduces the toxicity, mobility or volume of a hazardous substance. Factors considered in the evaluation include:

- The treatment processes implemented and the media they will treat.

- The amount of material that will be treated and how this addresses principal threats.

- The expected degree of reduction in toxicity, mobility or volume.

- The degree of permanence associated with the treatment.

- The type and quantity of treatment residuals that will remain.

4.3.4 Implementability - This criterion addresses the technical and administrative feasibility associated with the implementation of a given alternative as well as the availability of various required services and materials. The specific items are:

- Technical Feasibility - This category can be broken into several sections: Construction, operation, reliability, ease of undertaking additional actions, and monitoring considerations. Construction and operation involve the technical difficulties associated with designing, building and operating a particular technology process. Reliability of technology evaluates the effectiveness of the technology at meeting performance goals and also the inherent operating reliability associated with the particular process. The ease with which additional remedial actions can be undertaken evaluates what future remedial actions may be necessary and how difficult the implementation could be. This is generally more applicable to interim measure situations. Monitoring considerations evaluate the ability to monitor and evaluate the effectiveness of the given remedial action.

- Administrative Feasibility - This criterion evaluates the implications involved in coordinating remedial efforts with the State, Federal and Local agencies.

- Availability of Services and Materials - This criterion assesses the availability and capacity of off-site treatment, storage or disposal facilities, the availability of treatment materials and specialists, and the ability to obtain competitive bids.

4.3.5 Compliance with ARARs - This criterion evaluates the ability of the remedial action to comply with chemical specific, action specific and location specific ARARs. ARARs applicable to the Gloversville Landfill site are described on Section 2.2 of this Feasibility Study.

4.3.6 Protection of Human Health and the Environment - Each alternative is evaluated for its ability to protect human health and the environment. Reductions in health based risk and negative environmental impacts associated with the remedial action are considered.

4.3.7 Cost - The costs associated with remedial alternatives can be broken down into two categories: Capital costs and Operations & Maintenance (O&M) costs. Capital costs can be broken down further into direct and indirect costs. Direct capital costs include outlays for equipment, labor and materials associated with construction of remedial alternatives. Indirect costs include expenditures such as legal fees, permit costs, start-up, contingency allowances and other services that may not be part of construction. O&M costs are post-construction costs necessary for continued operation of the remedial action. These costs include expenditures for materials, chemicals, labor, equipment, maintenance, residuals disposal and administrative costs.

Both capital and O&M costs for given alternatives are prepared on the basis of present worth. The present worth of each alternative is calculated by adding the capital cost to the product of the yearly O&M cost and a multiplier. The multiplier, 12.4090, converts an annual cost to an equivalent present worth cost assuming a constant interest rate of 7% over an operating period of 30 years. In this manner, the costs represent the actual dollar amount that, if invested at the start of the project, would provide funding for the expected duration of the remedial alternative.

4.4 EVALUATION OF ALTERNATIVE NO. 1 - NO ACTION

4.4.1 Description - The no-action alternative does not attempt to reduce, contain, or remediate any contamination on or off the landfill site. The no-action alternative consists of a program of continued site monitoring and implementation of a public awareness program. This alternative provides a baseline by which other remedial alternatives can be judged. It is a requirement of the EPA and NYSDEC that this alternative be evaluated in the detailed screening and analysis section.

Continued site monitoring involves sampling of groundwater, private wells, surface water, soils, sediments and air in order to assess any changes in landfill impacts that may occur over time. In addition, NYCRR Part 360 regulations require that additional monitoring wells be installed at this site. Approximately 20 new wells (10 clusters of shallow and intermediate wells) will need to be installed as part of the site monitoring program.

A program involving public educational meetings and the printing of informational documents must also be implemented. The purpose of this action is to increase public knowledge of potential impacts to area residents from the landfill and also to keep the public apprised of new information that could result from site monitoring or new risk standards.

__4.4.2 Short-Term Effectiveness__ - The no-action alternative offers no reduction in current risks to the surrounding community. On the other hand, no new additional negative risks, such as fugitive dust emission or impacts on air and water quality related to remediation are created. The installation of the new groundwater monitoring wells will require site workers to follow the proper health and safety guidelines. Additional site work is limited to sampling, the impacts of which on site workers is minimal.

There are no negative environmental impacts associated with implementation of this alternative. However, the no-action alternative, by definition, does nothing to correct existing negative environmental impacts created by the landfill. Implementation of this plan can begin immediately.

__4.4.3 Long-Term Effectiveness__ - Site risks will not be reduced by the no-action alternative except by natural processes (biodegradation, chemical transformation, and dilution). Because treatment does not take place, there will be no treatment residuals. Therefore, they are not a factor.

__4.4.4 Reduction of Toxicity, Mobility, Volume__ - Because this alternative does not remove, treat or alter contaminants, there will not be any accelerated reduction of contaminant levels in groundwater, soils, solid waste, surface water, or sediments at the landfill site. Any reduction in toxicity, mobility or volume will occur by natural processes, (i.e. chemical, biological, or dilution). Because nothing will be done to contain or eliminate the source, leachate generation will continue to contaminate the groundwater and surface water downgradient of the site.

4.4.5 Implementability - The no-action alternative is technically the easiest of all the alternatives to implement. The installation of new monitoring wells will be required to meet 6NYCRR Part 360 guidelines for site monitoring. All other sample points can be accessed without additional construction. There will be few operational problems associated with this alternative other than the logistics of well installation and sampling. Because this alternative does little to alter site characteristics, additional remedial activities can be implemented at any time without interference. Implementation of a public awareness program including meetings and literature distribution can also be readily implemented.

Administratively, this alternative will be easy to implement, requiring preparation of a site sampling/monitoring plan and distribution of materials to the public. All services and materials required to implement this alternative are readily available.

4.4.6 Compliance With ARARs - The no-action alternative does not eliminate the source of contaminants or remediate the soils or groundwater at the site. It also does not follow the minimal criteria for remediation of a solid or hazardous waste facility as outlined in the action specific ARARs. Therefore, this alternative does not meet any of the ARARs set for the site.

4.4.7 Protection of Human Health and the Environment

Implementation of the no-action alternative does not reduce the risk associated with the ingestion of contaminated groundwater by off-site residents, ingestion of area soils by site workers or trespassers, or inhalation of gaseous emissions from the site. Because no contaminant or source elimination is involved, production of leachate will continue to contaminate the groundwater that flows beneath the landfill discharging, in part, to nearby surface water bodies and partially to the bedrock aquifer which is used for several private water supplies. This alternative does not meet any of the remedial action objectives, but is retained for baseline assessment purposes.

4.4.8 Costs

There are few capital costs associated with the no-action alternative. Most costs are O&M and are based on the site sampling and analysis program, the public awareness program and periodic site reviews. The estimated costs associated with these items are highlighted below and are detailed in Tables 4-1 and 4-2, at the end of this section.

• Capital Costs	$190,000
• Annual O&M Costs	$229,000
• Present Worth Cost	$3,030,000

4.5 EVALUATION OF ALTERNATIVE NO. 2 - LIMITED ACTION

4.5.1 Description - The limited action alternative involves the implementation of site access restrictions, the installation of a water supply line to provide water to private residences, continued site monitoring, and a program of public awareness. This alternative does not attempt to remediate or reduce the contaminant levels at the site. Instead, it focuses on reducing exposure to landfill based contaminants through site restrictions and water supply replacement.

Site access restrictions include the installation of a perimeter chain link fence and security gate, and the posting of appropriate warning signs along the fence and surrounding area. In addition, deed restrictions are required to ensure that any future development of the site will not present an increased risk to human health and the environment.

Impacted residences have been identified in the areas shown on Figure 4-1. To adequately serve these homes without the need for frequent flushing, a looped water line system is proposed. The looped system also allows continued service to most customers in the event of a water line break. The entire water supply system involves constructing an extension of the existing municipal drinking water line beginning in the City of

Gloversville on East Fulton Street, west of Route 30 and forming a loop comprised of the East Fulton Street Extension, Bemis Road, Barker Road, Blanchard Loop, and Elmwood Avenue as shown on Figure 4-1. Approximately 6 miles of 12-inch water main are required to complete the loop. Connections to individual residences are required as part of the remedial action within the impacted areas depicted on Figure 4-1. Connections to homes outside the impacted areas are strongly recommended to preclude the need for long-term monitoring of private well supplies.

Continued site monitoring and the public awareness program are the same as those described under the no-action alternative (No. 1) in Section 4.4.1, except that quarterly monitoring of private wells is not necessary.

4.5.2 Short-Term Effectiveness

The limited action alternative will not pose any additional risk to the surrounding community during its implementation. The installation of the water main and chain link fence do not require workers to be exposed to hazards associated with the landfill. Several new groundwater monitor wells for the sampling program will require installation and proper health and safety guidelines will need to be followed. Continued site monitoring includes sampling, the impacts of which on site workers is minimal. Site workers will be subjected to minimal exposure during perimeter fence installation. Water main installation will be at such a distance from the landfill as to not pose any landfill-based threats to workers' health.

Because this action is limited in scope, as with the no-action alternative, no adverse impacts to the environment result from the limited action alternative. Installation of the water main will require at least 2 stream crossings. Erosion and sedimentation controls will be required during construction to prevent adverse impacts to the stream.

The schedule of this alternative to meet remedial response objectives is governed by the time required to install the water main. The estimated time to completion of this remedial response action is 18-24 months.

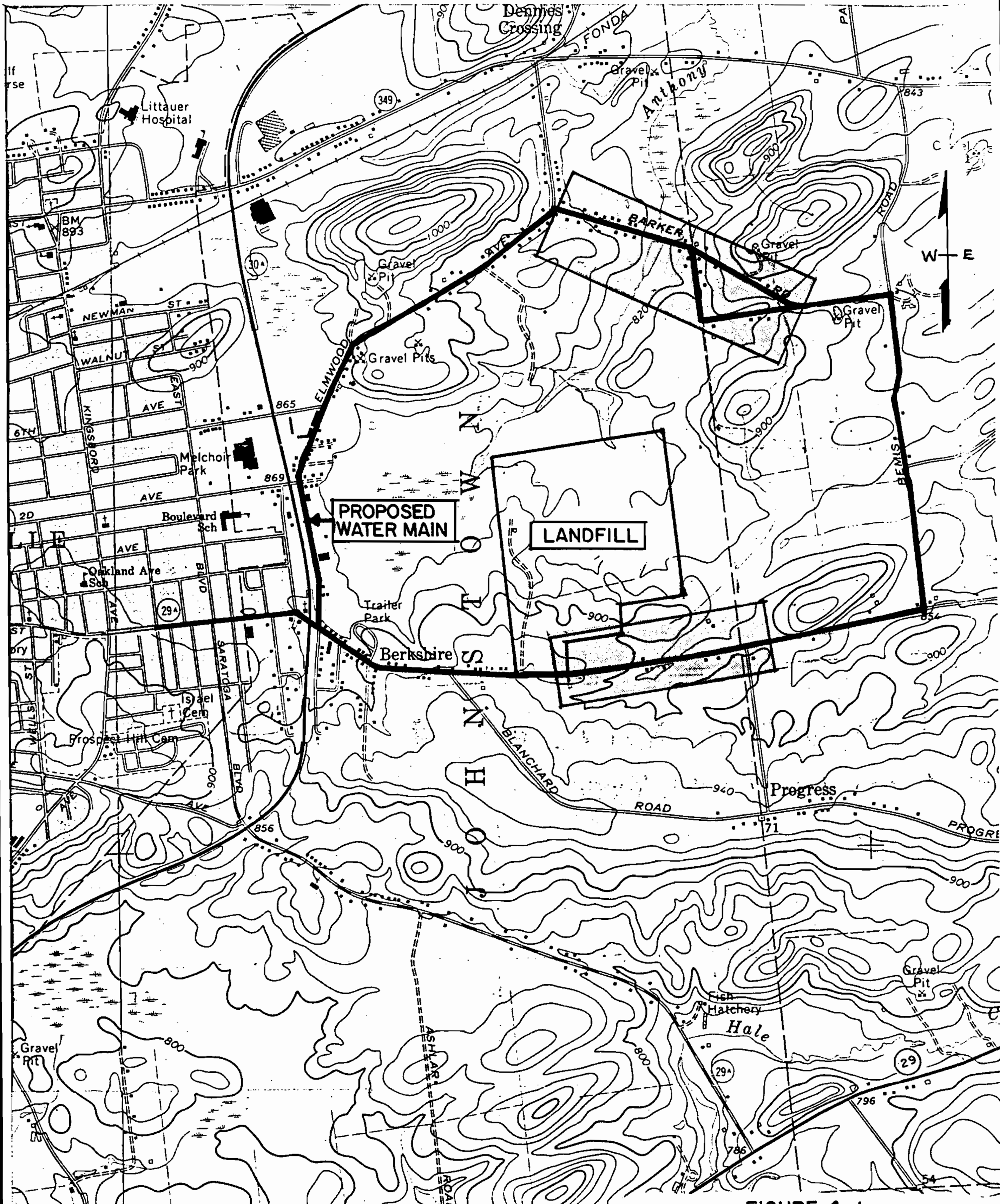


FIGURE 4-1

SOURCE: USGS GLOVERSVILLE QUADRANGLE

WATER MAIN ROUTE

AREA OF IMPACTED PRIVATE WELLS

NYSDEC SITE NO: 518001

PROPOSED
WATER MAIN ROUTING

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

SCALE: 1" = 2000'   DATE: OCT. 1992

4.5.3 Long-Term Effectiveness - This alternative does not actively reduce the quantity or toxicity of contaminants at the Gloversville Landfill site. It reduces human health based risks associated with the waste by limiting site access and thus the risks associated with dermal contract and ingestion of contaminated materials at the site. Landfill-based human health risks are further reduced by eliminating ingestion of contaminated drinking water through the replacement of homeowner wells with a City water supply. Other than site access restrictions, no controls are to be implemented under this alternative to contain or remediate the contaminant source, and significant risk of further groundwater contamination will be present after implementation. Because no active treatment is involved, no treatment residuals are produced by this alternative.

4.5.4 Reduction of Toxicity, Mobility and Volume - As with Alternative No. 1, the limited action alternative does not actively remove, treat, or alter the contaminant source. Any reductions in these areas will be the result of natural processes (biodegradation, dilution, chemical transformation).

4.5.5 Implementability - Technically, the limited action alternative can be readily implemented with the most difficult portion being the installation of the City water supply to impacted residences. Some previous survey work has been completed relating to the installation of a new water main along East Fulton Street from the existing network to the Landfill access road. The installation involves proven, straight forward construction practices. The operation and maintenance aspect of this alternative is limited to landfill site monitoring and the normal maintenance associated with water distribution systems. This alternative does not alter site characteristics and additional remedial activities can easily be implemented as deemed necessary.

Administratively, the supply of municipal water to residences outside City limits is somewhat complicated. The Gloversville Water Board, which is independent of City government, has adopted resolutions that require annexation of any lands to which water service is extended. All the services and materials required to implement this alternative are readily available from several sources in the area and competitive bids can be obtained.

4.5.6 Compliance with ARARs - This alternative, by providing a new, uncontaminated source of drinking water to the effected residences, will comply with the chemical specific Maximum Contaminant Levels (MCLs) of the Federal Safe Drinking Water Act and the New York State Department of Health drinking water standards as well. The alternative, however, does not address the contamination of the groundwater and surface water in the area; therefore, the RCRA groundwater MCLs and the NYSDEC groundwater and surface water standards will not be met. Additionally, this alternative does not address the NYSDEC Part 360 landfill closure requirements.

The installation of the water main and the fence will not permanently impact wetlands, therefore, this alternative will comply with all applicable location specific ARARs.

4.5.7 Protection of Human Health and the Environment - Implementation of the limited action alternative does not eliminate any of the contaminant sources at the site, but instead focusses on eliminating contaminant exposure pathways. By installing a City water line to replace private wells, a major risk exposure pathway for the ingestion of barium and other landfill derived contaminants that may migrate in the future is eliminated. The Risk Assessment presented in the Phase 2 Remedial Investigation Report reveals that barium ingestion is the major contributor to the elevated health risks associated with consuming water from potentially impacted private wells.

4.5.8 Cost - The costs of the Limited Action alternative are divided between O&M costs for site sampling, public awareness and reports and capital costs associated with installation of the City water main and site access restrictions. The costs of these items are highlighted below and are presented in detail in Tables 4-1 and 4-2, at the end of this section.

- Capital Costs $3,550,000
- Annual O&M Costs $134,000
- Present Worth Cost $5,210,000

4.6 ALTERNATIVE NO. 3 - IMPERMEABLE CAP WITH WATER LINE

4.6.1 Description - This alternative involves extensive site regrading, installation of an impermeable cap, construction of a runoff sedimentation basin, excavation of landfill refuse to reduce the total acreage to be capped, and installation of a City water main to provide water service to potentially impacted residences.

Prior to capping, extensive site regrading will be required at the landfill due to the large (approximately 40 acre) plateau that was created during operation. Appropriate regulations require the landfill to be capped with slopes such that precipitation runs off of the landfill and does not collect and infiltrate, thus producing additional leachate. Due to the relatively recent age of waste in the large plateau area, a 4% slope is recommended to maintain a minimum slope after settling to provide proper runoff characteristics. To construct this slope, a large quantity of existing fill material must be excavated and relocated to achieve the final shape; or, a large quantity of outside fill material must be imported to the site. In reality, a compromise must be reached between the amount of excavation of existing fill material required and the amount of outside fill imported. Estimates of the amount of fill material to be imported and existing refuse excavation and placement are about 350,000 cubic yards and about 100,000 cubic yards, respectively.

As a capping modification and a deviation from 6NYCRR Part 360 guidelines, it is proposed that a section of the landfill cap in the stabilized, old fill area located at the northern end of the site can be constructed with a 2% slope. It is anticipated that this area has settled substantially since it was last operated in the 1950's, and a 2% slope should be adequate for proper drainage. Since little additional settling is expected in these areas of glass and metal fill, a steeper slope should not be necessary. The lesser slope will result in a reduced requirement for borrow material. Preliminary estimates indicate that the borrow material requirements indicated in the proceeding paragraph for a 4% slope may be reduced by approximately 75,000 cubic yards if the slope is reduced to 2% in this area. The estimated reduction in capital cost will be about $750,000, based on a $10 per cubic yard borrow material cost.

Relocating existing refuse material for the purpose of regrading the refuse mound has potential economic advantages as described below. Since the material is already on-site, the amount of vehicle traffic on area roads can be significantly reduced. The disadvantages of waste relocation are mostly health related. Cutting into landfill waste has the potential of being hazardous for both equipment and site personnel. In addition, the nuisance odors associated with refuse excavation can impact area residences.

For this study, waste relocation as opposed to cap installation was considered as a cost saving measure in certain portions of the site. Waste relocation requires that the waste be excavated along with any contaminated underlying soils, that the waste be placed elsewhere on site, and that the removal area be loamed and seeded. In order to evaluate waste relocation, both health risk and economic issues should be considered.

Based on the bid construction costs at the New Windsor, NY landfill, waste material can be excavated, placed and compacted for about $17 per cubic yard, including dewatering and health and safety protection for the equipment operators. At the Gloversville landfill, the excavated waste material can be used as fill material to achieve the 4% slopes that are required prior to installing an impermeable barrier. Waste materials that are used for shaping offset the need to import clean fill which is estimated at $10 per cubic yard. Therefore, the net cost of excavating and relocating trash is $7 per cubic yard. Assuming that the areas where trash has been excavated need to be loamed and seeded, it is economically feasible to relocate trash that is up to 10 feet thick. Where trash is thicker, it is more economical to cap the wastes in place.

Much of the "inactive" area is less than 10 feet deep and therefore, can be economically relocated. Based on the boring and test pit information, it is estimated that approximately 10 acres of wastes can be moved, generating about 175,000 cubic yards of material to be used for regrading. The remaining landfill area requiring an impermeable barrier is about 70 acres.

The waste relocation will necessitate significant construction activity in and adjacent to wetlands areas. The Consent Order under which this project is being undertaken obviates the need to go through formal wetlands permitting for this activity. However, the intent of the wetlands regulations must be followed. Therefore, the construction documents will require the Contractor to adequately protect the wetlands and surface waters from runoff from the site and will require the restoration of any wetlands damaged during the project.

After the site has been properly graded, the disposal area must be covered with an impermeable cap. A typical landfill cap consists of a gas venting layer placed over the graded landfill site, overlain by a geotextile and an impermeable barrier consisting of low permeability clay, a geomembrane, or both. The purpose of the impermeable layer is to minimize the production of landfill leachate by eliminating percolation of precipitation through the fill material. A lateral drainage/protective barrier layer is placed on top of this which allows water to flow laterally off the landfill when it reaches the low permeability layer. It also provides a protective layer to prevent frost and equipment damage to the low permeability layer. Above the protective barrier layer is placed a layer of topsoil on which vegetation, usually grass, is propagated. The vegetation layer adds structural integrity to the cap, prevents erosion, and reduces some of the water content in the cap through evapotranspiration.

Groundwater modelling results presented in the Phase 1 and Phase 2 Remedial Investigations indicate that installation of a landfill cap over the refuse area will reduce the groundwater level approximately 5 feet at the center of the landfill. This would most likely eliminate waste contact with groundwater in all sections of the landfill except, perhaps, the southwest corner. This is probably due to the open borrow pit located adjacent to this area. To address this, the groundwater model has been run with the cap placed over the borrow pit as well. This scenario lowers the groundwater table approximately 7 feet at the center of the landfill and 9 feet in the southwest corner next to this cap and borrow pit area. Because a great benefit is derived from capping the borrow pit area, it is recommended that the pit floor be covered with a low permeability material such as asphalt. The pit floor will be sloped to allow water to flow to the northeast corner of the pit where it will be tied to landfill cap drainage swales for eventual surface water discharge.

During the conceptual design of different capping scenarios, it has been assumed that the "Pond B" surface impoundment will be drained to accommodate proper capping of the waste material. Beaver activity has raised the water level in this impoundment to a point above the level of the waste. Removal of the beaver dam will lower the level of water so that the waste can be properly capped. Lowering the water level will also aid in dropping the water table below the bottom of the waste, thus reducing leachate generation. Consistent monitoring will be required to ensure that beaver do not re-establish a dam at the outlet of Pond B. The cost estimates in Table 4-2 include $25,000 per year for inspections of the cover system and the beaver activity.

In Section 4.6.4, the present and future water quality of Pond B is discussed for different capping scenarios. This discussion and results are provided assuming that the water in Pond B is an indicator of other surface water bodies downgradient of the landfill and these results are indicative of the concentrations that would be present in these other downgradient surface water bodies after capping regardless of whether Pond B is drained or not.

The groundwater underflow to Pond B is comprised almost exclusively of the flow quantified in Segments 3 and 4 of the groundwater flow net presented in the Phase 2 RI report. As shown in the flow net analysis, the majority of the flow passing beneath the landfill flows through these two segments. Segments 1 and 2 of the flow net carry less water and have lower measured impacts in the receiving surface waters (Anthony Creek). Therefore, Segments 1 and 2 are not considered in the evaluation presented in Section 4.6.4.

A variety of different capping schemes can be implemented. Three different capping options are presented and discussed here. They are the 6NYCRR Part 360 cap; a RCRA Subtitle C multi-media cap; and a RCRA Subtitle D (or soil) cap. Diagrams of the various capping alternatives are presented as Figures 4-2 through 4-4.

- The NYCRR Part 360 cap consists of a geotextile over the regraded landfill on top of which is constructed a 12-inch thick, high permeability gas venting layer ($>1 \times 10^{-3}$ cm/s), followed by a 40-mil geomembrane liner, a 24-inch barrier protection lateral drainage layer consisting of high permeability material, and a 6-inch layer of top soil to support vegetation on top of the cap. This cap is shown in Figure 4-2. Part 360 also allows the use of an impermeable soil cap, but this alternative has not been evaluated because the geomembrane alternative is equivalent and avoids the truck traffic related to importing impermeable soil.

- The study also evaluates a modified Part 360 cap which is not shown on the Figures. The modifications involve installing a filter fabric and synthetic drainage net above the 40 mil geomembrane to promote lateral drainage and to minimize hydraulic head on the membrane. The remainder of the cap system is identical to the Part 360 cap diagramed in Figure 4-2.

- The RCRA Subtitle C multi-media cap consists of a 12-inch gas venting layer covered on the top and the bottom with a geotextile; a 24-inch, very low permeability ($<1 \times 10^{-7}$ cm/s) layer on top of which is placed a 40-mil geomembrane; a 12-in vertical and lateral drainage layer consisting of high permeability material, a top layer consisting of 18 inches of cover/protective soil and 6 inches of topsoil for vegetative propagation. This cap is shown in Figure 4-3.

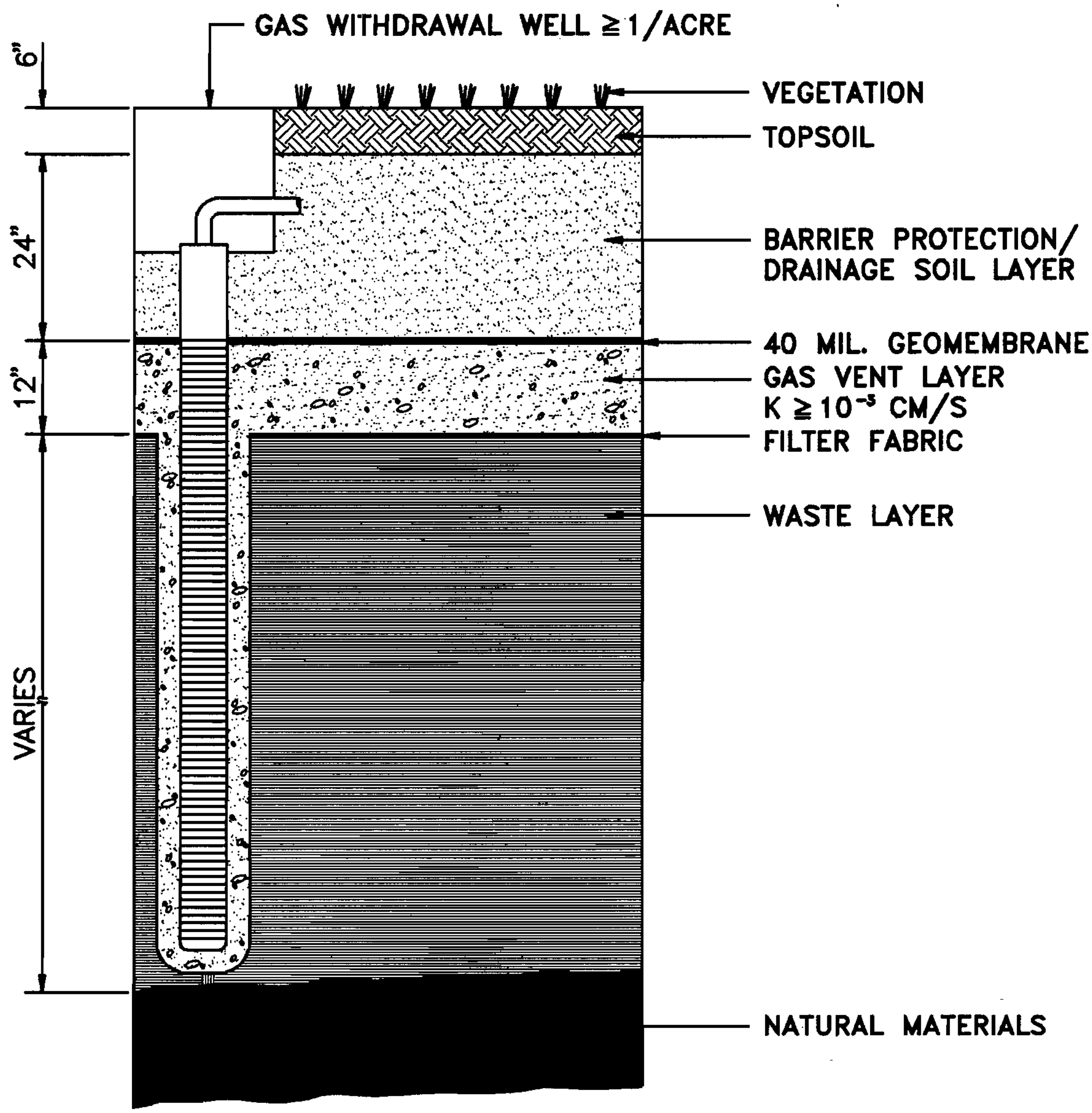


FIGURE 4-2

6NYCRR PART 360 GEOMEMBRANE CAP

CITY OF GLOVERSVILLE
MUNICIPAL LANDFILL
GLOVERSVILLE, NEW YORK

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

SCALE: NONE DATE: OCT. 1992

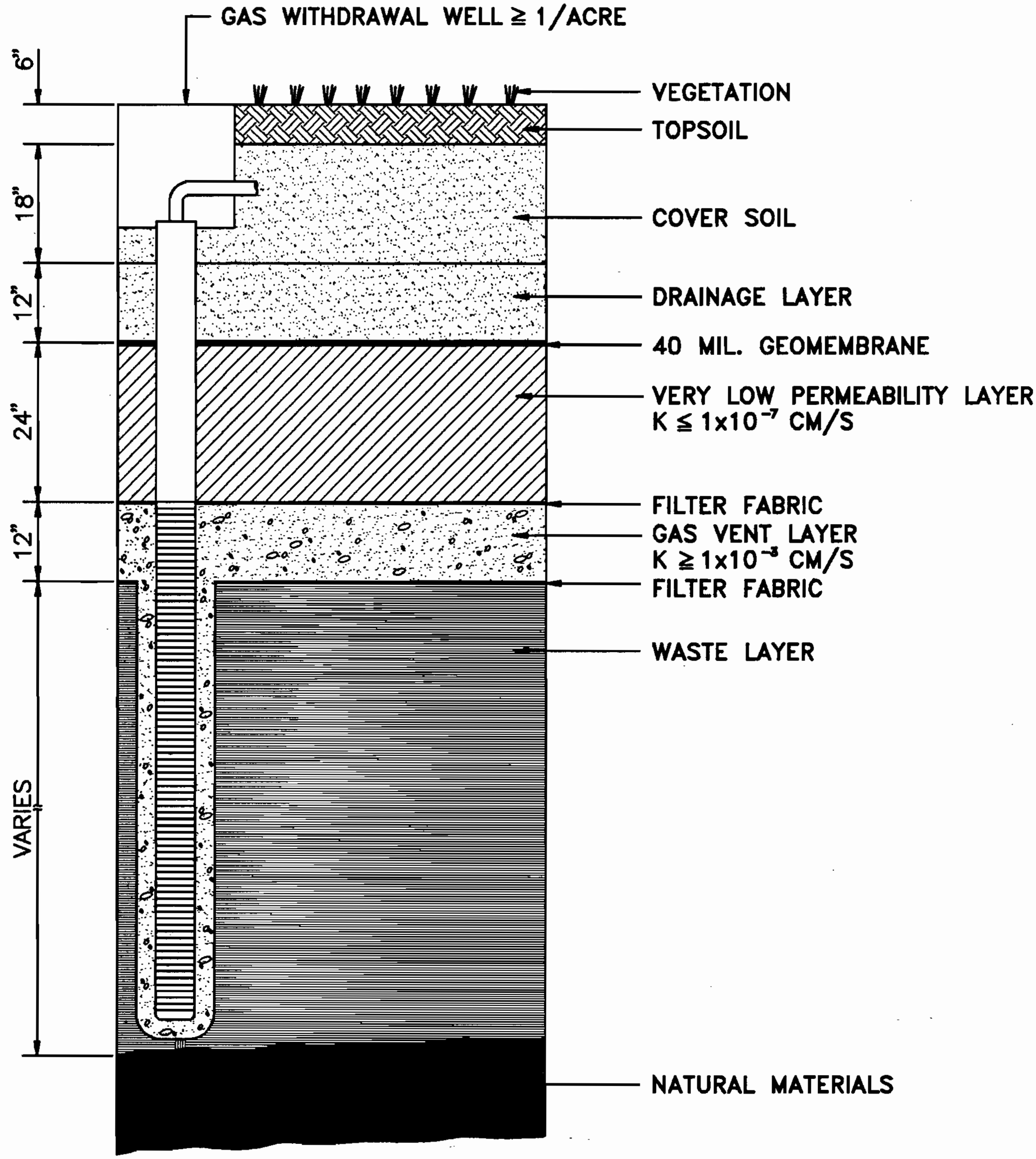


FIGURE 4-3

RCRA SUBTITLE C MULTIMEDIA CAP

CITY OF GLOVERSVILLE
MUNICIPAL LANDFILL
GLOVERSVILLE, NEW YORK

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

SCALE: NONE DATE: OCT. 1992

- The RCRA Subtitle D (or soil) cap is the minimal cap required under RCRA Subtitle D (Solid Waste Regulations). It consists of an 18-inch thick, low permeability ($<1 \times 10^{-5}$ cm/s) soil layer constructed on top of a 12-inch thick, high permeability ($>1 \times 10^{-3}$ cm/s) gas venting layer installed above the graded landfill surface. A 6-inch topsoil layer to support vegetative growth is placed on top of the low permeability soil layer. This cap is shown in Figure 4-4.

Each of the capping alternatives requires the construction of facilities to control surface runoff. To accomplish this, and reduce leachate generation at the landfill site, a network of perimeter drains will be constructed around the landfill area to direct runoff flows to a sedimentation basin which will be constructed on-site. These drains will consist of a series of interceptor and drainage ditches sized to convey runoff from a peak flow event to the basin.

One of the purposes of the sedimentation basin is to remove fine sands, silt, and other suspended solids from the landfill runoff, prior to surface water discharge. Because the runoff flows only over newly placed uncontaminated materials, additional treatment for this water is not required.

The sedimentation basins, sized to process a 2.5" peak daily flow, will consist of two basins, each approximately 35′ x 75′ and 5 feet deep. Most of the surface water runoff from the capped area will be conveyed via perimeter drains and through the sedimentation basins prior to discharge to Anthony Creek (See Figure 4-5).

As a requirement of NYCRR Part 360, a gas venting and/or collection system must be installed in conjunction with a landfill cap. Due to the large volume of gas generated by the landfill, an active gas collection system with treatment by combustion is recommended. The active venting system (see Figure 4-6) will consist of a network of piping, headers, and valves connecting all gas vents to a gas scrubber/blower system. Gas will be withdrawn from the landfill under negative pressure and passed through the scrubber

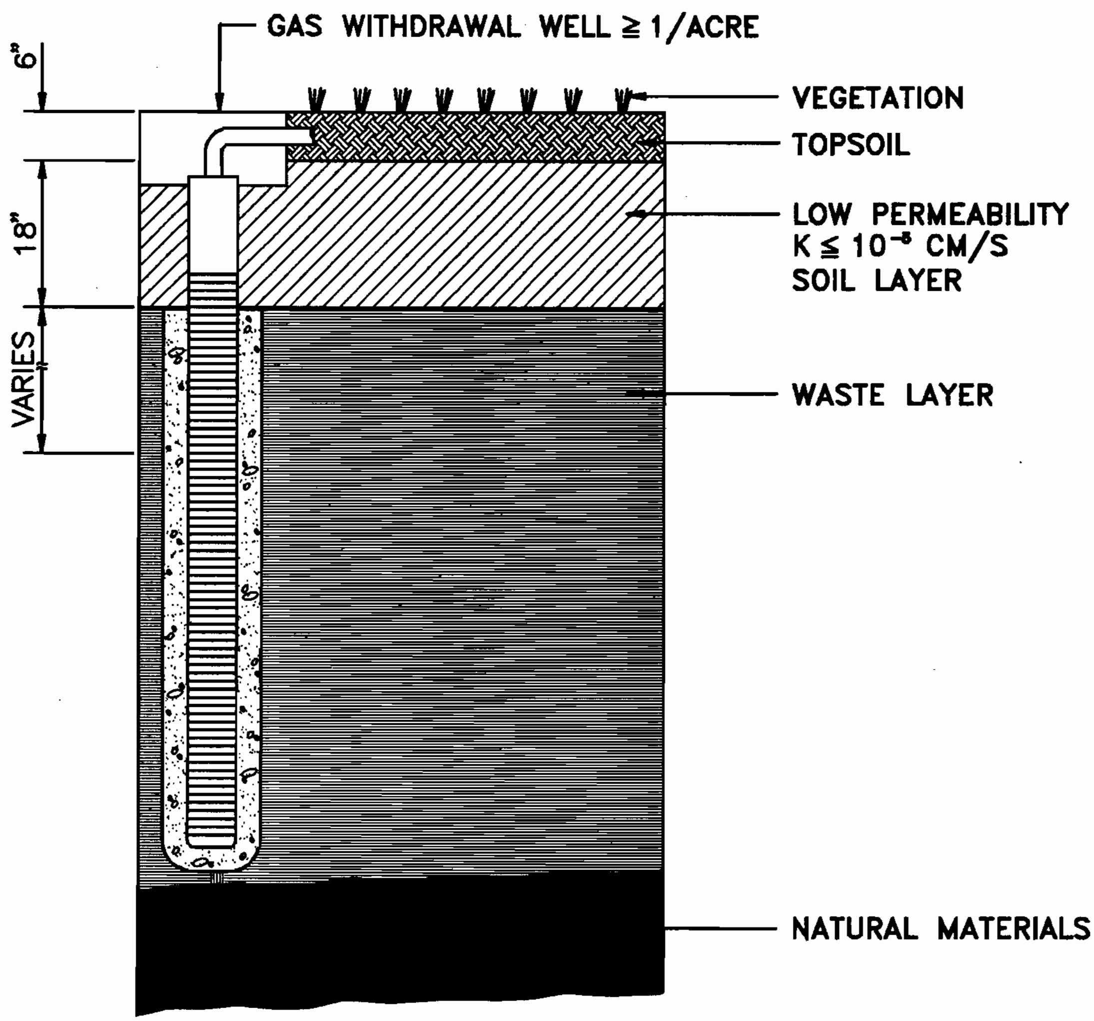
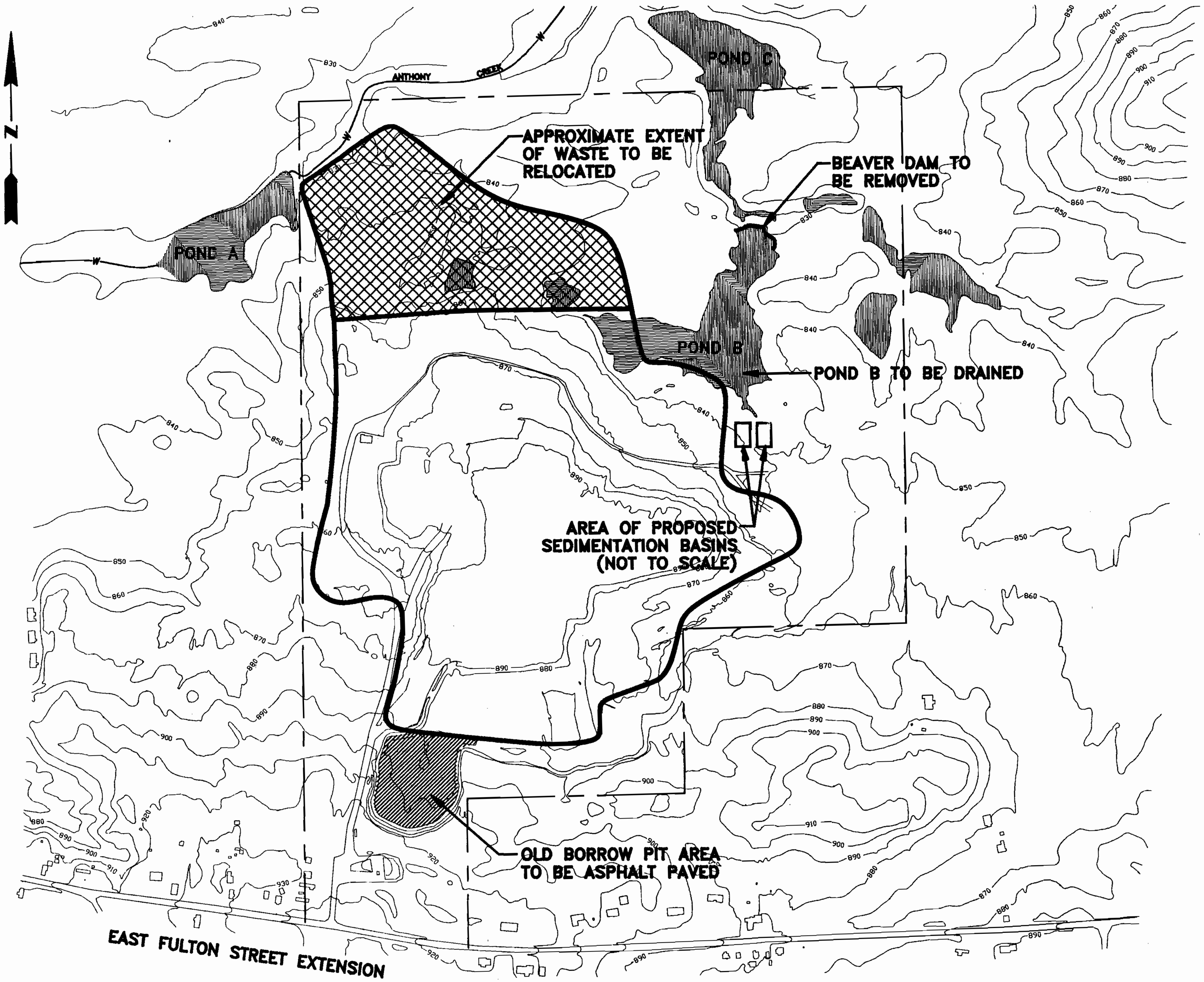


FIGURE 4-4

RCRA SUBTITLE D SOIL CAP

CITY OF GLOVERSVILLE
MUNICIPAL LANDFILL
GLOVERSVILLE, NEW YORK

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.



DRAWN BY: KJK		CHECKED BY: ESH,TMB	APPROVED BY: MRP
NO.	DATE	REVISIONS	BY
1	4/93	CORRECT DEBRIS LINE, ADD AREA TO BE RELOCATED	TMB

TIGHE & BOND
CONSULTING ENGINEERS, P.C.
WESTFIELD, MASSACHUSETTS

PROPOSED SITE MODIFICATIONS

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
GLOVERSVILLE MUNICIPAL LANDFILL
GLOVERSVILLE, NEW YORK

DATE: NOV., 1992
SCALE: 1"= 400'
FIGURE: 4-5

I:G191\F11B

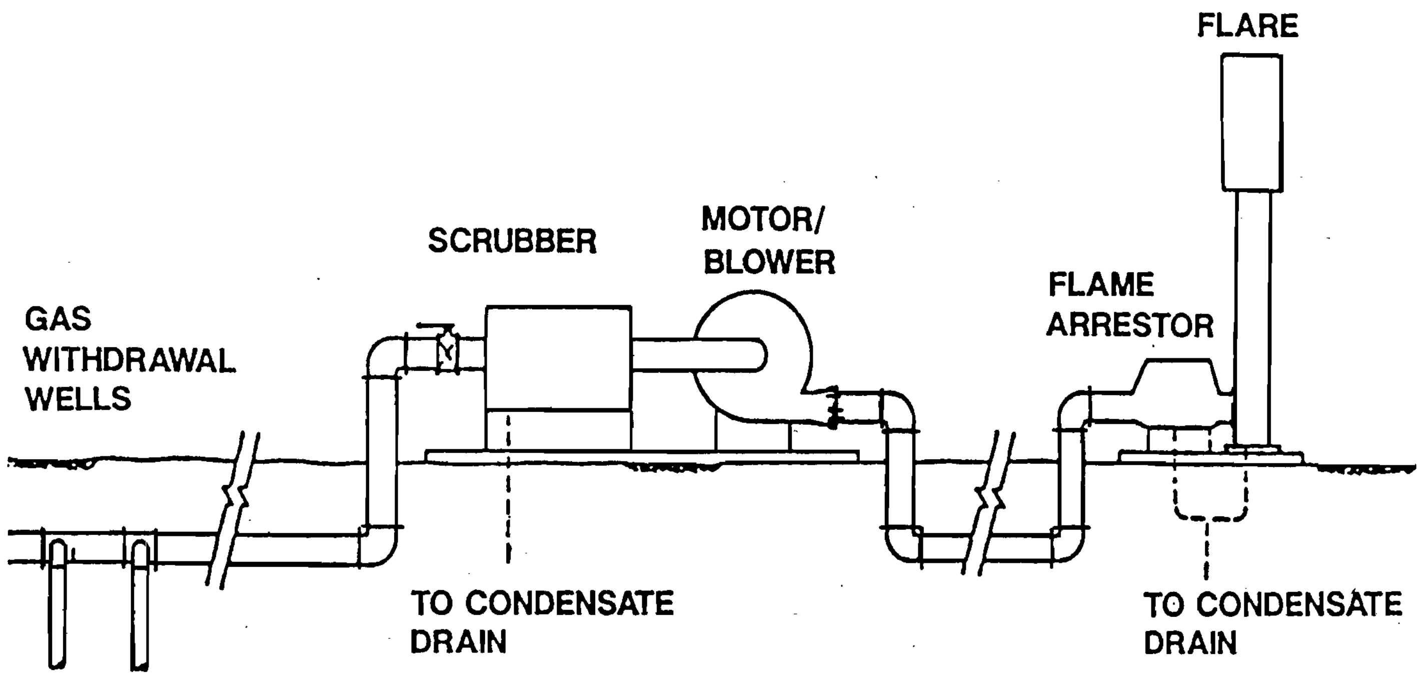


FIGURE 4-6

ACTIVE LANDFILL
GAS COLLECTION SYSTEM

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

SCALE: 1"= 2000' DATE: OCT. 1992

to remove moisture and corrosive elements. This evaluation is based on combustion in an enclosed flare unit with flame arrestor. Because the question of emissions monitoring will need to be addressed, an enclosed flare unit was chosen over an open flare unit for its ability to be accurately monitored for emissions criteria. If the gas is recovered for reuse or energy production, then the method of combustion will be modified or eliminated accordingly.

A variation of the enclosed flare called an Emission Control Enclosed Flare could be implemented, if necessary, to minimize nitrogen oxides (NOx), carbon monoxide (CO) and hydrocarbon emissions and also emissions of certain aromatic compounds.

To differentiate between the different capping scenarios, the Hydrogeologic Evaluation of Liner Performance (HELP) model was run for each of the four capping options (see Table 4-3). The actual computer output is provided in Appendix A.

The evaluation of existing conditions part of the hydrogeological studies in the Phase 1 and Phase 2 Remedial Investigations showed that approximately 28″ per year of precipitation percolates through the trash, which is 68% of the average annual rainfall. This represents the baseline conditions.

Installation of a RCRA subtitle D (or soil) cap provides some additional protection from infiltration when compared to existing conditions. The HELP model indicates that 42% of the average annual precipitation (17 inches) infiltrates through to the waste mass under this scenario. The cap yields about a 40% reduction in percolation and does not meet the minimum capping criteria presented in Part 360 regulations. Therefore, it is not considered further.

A 6NYCRR Part 360 geomembrane cap provides a significant reduction in infiltration of precipitation. According to the HELP model, 7% or 2.9 inches per year of precipitation infiltrates; a reduction of about 90% from the existing conditions.

By installing a RCRA Subtitle C multimedia cap utilizing a geomembrane, the HELP model estimates an almost 100% reduction in precipitation infiltration from existing conditions. The model predicts an infiltration rate of 0.0002 inches annually.

Both the 6NYCRR Part 360 cap and the RCRA multimedia caps provide good protection with respect to reducing infiltration through the waste mass and both meet Part 360 landfill capping requirements. As shown by the HELP model, the RCRA Subtitle C Multimedia cap provides better protection from infiltration than the 6NYCRR Part 360 geomembrane cap. This added protection comes at an additional cost of over $9 million for the additional capping materials required. (Costs for both types of cap are presented in Table 4.1 and 4.2.)

As an alternative to the multimedia cap, a geosynthetic drainage net, or geonet, could be installed above the geomembrane barrier in a 6NYCRR Part 360 capping scenario. The additional cost to add the drainage net and associated filter fabric is approximately $1.6 million.

Adding the geonet will provide better drainage above the geomembrane and will, in turn, reduce the head buildup above the liner, greatly reducing the liner leakage rate. The current version of the HELP model does not include a provision to add a geonet type drain. Therefore, the lateral drainage layer was modified by increasing the hydraulic conductivity significantly. According to the model, this reduces the head on the liner to about one inch and reduces percolation through the liner to 0.5 inches per year. This allows significant leachate reduction at an increased cost of about 6%.

The evaluation of the remedial impacts of the 6NYCRR 360 geomembrane cap and the RCRA Multimedia cap is presented in Section 4.6.4. The RCRA Multimedia cap is projected to reduce contaminant concentrations in down-gradient surface waters to a slightly greater degree than the 6NYCRR 360 cap with a drainage net. However, the positive impact of the 6NYCRR 360 cap with a drainage net combined with the current attenuation and dilution of contaminants in the surface water system will provide compliance with surface water ARARs within a reasonable distance downstream of the site at significantly less cost than that for a RCRA Multimedia cap. Therefore, the remainder of this Feasibility Study is based on a 6NYCRR 360 geomembrane cap with a drainage net.

In addition to landfill capping, Alternative No. 3 involves the installation of a City water line to provide water to impacted and potentially impacted residences to replace existing private wells. A description of this aspect was given in Section 4.5.1.

4.6.2 Short-Term Effectiveness - There are several environmental and human health impacts associated with this alternative. The cut and fill work required to grade the landfill properly will uncover debris and expose workers to refuse related contaminants. Surface water runoff from the landfill will require extensive controls during cut and fill operations and permanent diversion and sedimentation control after construction of the landfill cap is completed. In addition, fugitive dust may be produced during capping operations requiring the application of dust reducing agents. Installation of the municipal water line will involve the normal hazards associated with trench excavation and pipe placement. Construction of the runoff sedimentation basin could have some impact due to its anticipated location near wetlands areas adjacent to the landfill. Controls will have to be installed to limit siltation of downstream areas. Removing the beaver dam at the outlet of Pond B will improve existing surface water and groundwater quality by lowering the water table in areas where wastes are now saturated. Because capping is a passive technology, no waste treatment residues will be produced by this alternative.

To protect workers at the site, a detailed Health and Safety plan will be prepared prior to commencing work. Highlighted in the plan will be the hazards and appropriate protective measures to be taken during excavation of existing refuse material. Due to the extensive area to be capped, the time from the ROD to completion of remedial response objectives is expected to be 24 - 36 months.

<u>**4.6.3 Long-Term Effectiveness**</u> - This alternative does not attempt to treat or eliminate any of the wastes presently at the site. Health risks are reduced from those presented by the no action (No. 1) and limited action (No. 2) alternatives, because capping eliminates the direct exposure pathways of dermal contact and ingestion of landfill wastes. Capping also greatly reduces, over time, the risks associated with exposure to landfill impacted groundwater and surface water by reducing leachate generation.

In addition, although well contamination itself is not eliminated, risks associated with consumption of area private well water are eliminated through replacement with a municipal water supply. No additional waste is produced by this alternative, thus no additional site controls are required.

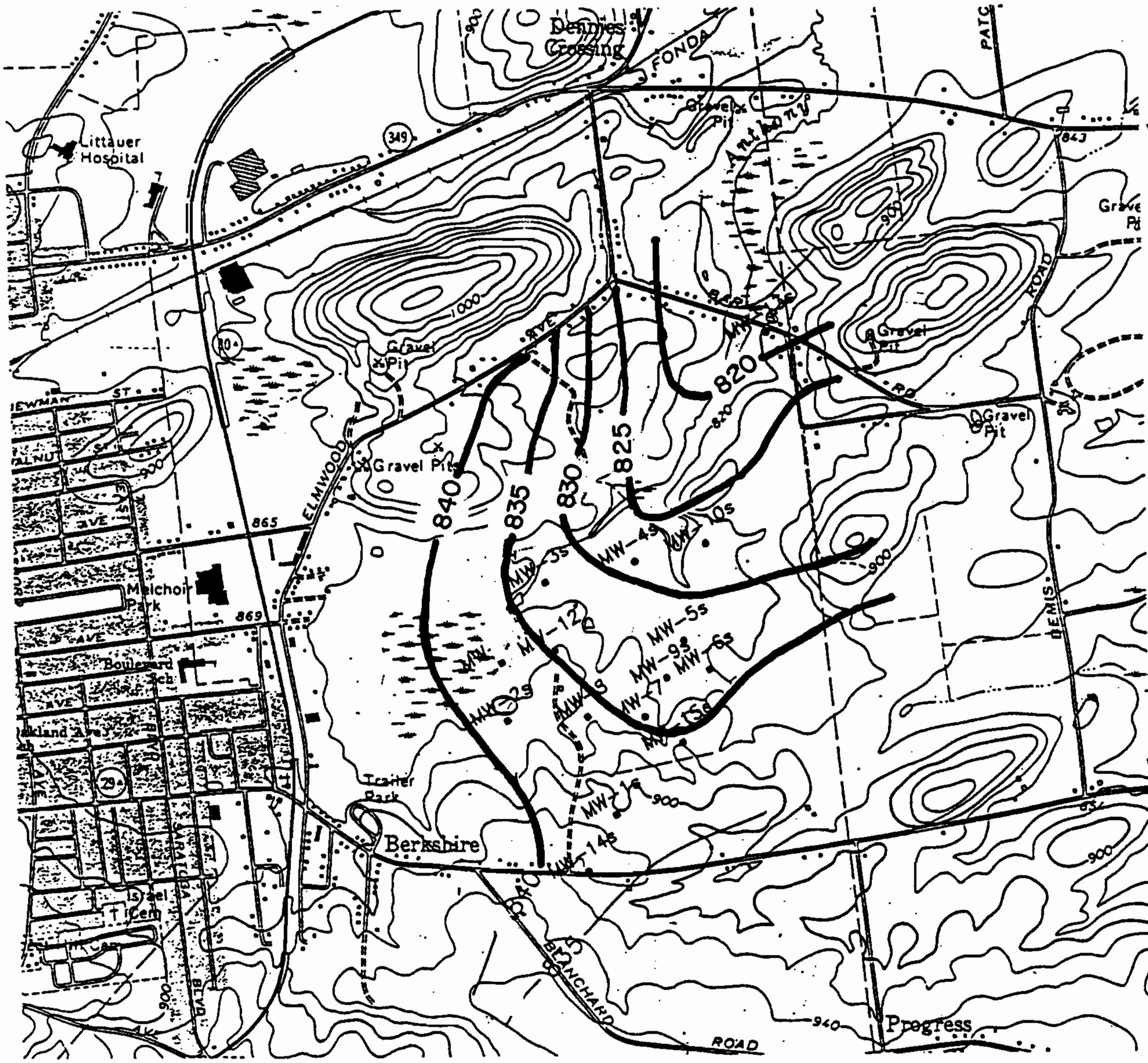
<u>**4.6.4 Reduction of Toxicity, Mobility and Volume**</u> - Replacement of private well water supplies with a municipal water supply offers a permanent elimination of exposure to groundwater contaminants through domestic usage. The toxicity and volume of the source of landfill contamination is not reduced by this alternative other than by natural processes. However, the technology of landfill capping reduces the mobility of contaminants in the landfill refuse and soils by minimizing percolation through these media. When properly implemented, this technology can reduce the production of landfill leachate by at least 90%. This translates to a reduction of contaminant loading to the groundwater and surface water bodies at the site. If properly maintained, a landfill cap offers reliable protection and, although it does not offer complete permanence, caps are generally designed with an expected lifetime of more than 30 years.

To show the effectiveness of a Part 360 landfill cap alternative at reducing the toxicity and mobility of contaminants at the site, the future water table configuration, after capping, was determined. To accomplish this, the computer model presented in the Phase 2 RI Report (23) was utilized and the infiltration of precipitation through the fill (post-capping) was reduced from the current average rate of 28 inches per year to 2.9 inches per year as determined by the HELP model. The resultant reconfigured water table is depicted on Figure 4-7.

Under the post-capping scenario the water table is projected to be below the level of the fill in most areas. Upgradient of Pond B the contours have similar orientations as before capping. Of primary importance is that the groundwater gradient has been greatly reduced and the upgradient divide has not shifted, as compared to the current conditions.

Table 4-4 summarizes the water balance for Pond B based on the inputs described above. The water balance is also described in greater detail in the following paragraphs. The flow net segments discussed below are described in greater detail in Section 3 of the Phase 2 RI Report (23).

Current Water Balance and Quality - Under current conditions, the groundwater discharge to Pond B through the flow-net Segments 3 and 4 is 130,000 gallons per day (gpd) (these flow-net segments are those that flow through the site, under the landfill, and discharge to Pond B). The water quality in Segment 3, as represented by an average of the concentrations from Monitor Wells MW-8 and MW-12, is 4,320 mg/l total dissolved solids (TDS) and 1,345 mg/l of ammonia. The water quality in Segment 4, represented by an average of the concentrations from MW-9S and MW-9I is 2,520 mg/l TDS and 496 mg/l ammonia. These two parameters were chosen for this analysis because ammonia has been identified as a primary contaminant of concern in Pond B and



LANDFILL PLUS BORROW PIT AREA CAP

LEGEND

—— 840 —— GROUNDWATER CONTOUR ELEVATION

NYSDEC SITE NO: 518001

SOURCE: GLOVERSVILLE LANDFILL PHASE 2 RI 1992 (2)
USGS GLOVERSVILLE QUADRANGLE

FIGURE 4-7

POST CAPPING
GROUNDWATER CONTOURS

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

TABLE 4-4

WATER BALANCE FOR POND B
GLOVERSVILLE MUNICIPAL LANDFILL

				Part 360 Cap (Geomembrane)						RCRA Multimedia Cap						Part 360 with Drainage Net					
	Current Conditions			Initial Conditions after Capping			Long-Term Conditions after Capping and Flushing[1]			Initial Conditions After Capping			Long-Term Condition After Capping and Flushing[1]			Initial Conditions After Capping			Long Term Conditions After Capping and Flushing		
Flow Component	Flow gpd[2]	NH_3[3] mg/l[4]	TDS[5] mg/l	Flow gpd	NH_3 mg/l	TDS mg/l	Flow gpd	NH_3 mg/l	TDS mg/l	Flow gpd	NH_3 mg/l	TDS mg/l	Flow gpd	NH_3 mg/l	TDS mg/l	Flow gpd	NH_3 mg/l	TDS mg/l	Flow gpd	NH_3 mg/l	TDS mg/l
Surface Water	52,000	0.025	130	77,500	0.025	130	77,500	0.025	130	84,800	0.025	130	84,800	0.025	130	85,800	0.05	130	85,800	0.05	130
Groundwater[6] (Segment 3)	62,000	1,345	4,320	23,700	1,234	4,320	14,800	0.025	130	23,700	1,234	4,320	23,700	0.025	130	23,700	1,345	4,320	21,700	0.05	130
Groundwater (Segment 4)	68,000	496	2,520	25,700	496	2,520	16,800	0.025	130	25,700	496	2,520	25,700	0.025	130	25,700	496	2,520	23,700	0.05	130
Leachate[7]	[8]			[9]			12,400	1,170	4,420	0			0	0.025		[9]			3,189	1,170	4,420
Total Pond B	182,000	644	2,450	126,900	331	1,397	122,000	119	584	134,200	313	1,328	134,200	0.025	130	135,200	222[10]	930	135,200	20[10]	203
Actual NH_3[10]		152			80			30			80			0.025			55			5	

[1] approximately 11 years to flush the aquifer three times.
[2] gpd - gallons per day.
[3] NH_3 - ammonia nitrogen.
[4] mg/l - milligrams per liter.
[5] TDS - total dissolved solids.
[6] Volumes derived from flow net.
[7] Average concentrations from Monitor Wells MW-7, MW-8 and MW-12.
[8] Included in groundwater flow.
[9] Included in groundwater flow.
[10] Actual ammonia concentrations in Pond B have been shown to be 25 percent of theoretical values.

G191\REPORT\SEC4.ESH

because TDS is a useful landfill leachate indicator which is conservative in nature, i.e., it is not attenuated or altered in the subsurface except by dilution.

The groundwater in the current condition mixes with surface water runoff from the surrounding watershed for Pond B (103 acres). The average runoff is estimated at 51,660 gpd. This estimate is based on a runoff rate of 11 inches per year from the non-landfilled area (63 acres) of the watershed. The landfill portion of the watershed was assumed to produce no runoff because of the current grading configuration. Based on water samples from SW-1, SW-2 and SW-4, it was assumed that the surface water runoff to Pond B currently contains 0.025 mg/l ammonia and 130 mg/l TDS. These figures were used as "background concentrations" throughout the water balance analysis.

Based on the total water input and existing water quality data, it was estimated that the water quality in Pond B should theoretically be characterized by TDS concentration of 2,450 mg/l and ammonia concentration of 645 mg/l. These theoretical values were compared to the observed concentrations in samples taken at sampling point SW-10 in Pond B to verify the basis of projected calculations. TDS concentrations in Pond B on 8/15/91 and 10/16/91 were 2,350 and 1,540 mg/l, respectively. These values average about 80% of the theoretical concentration.

The observed ammonia concentrations on the same dates were 164 mg/l and 140 mg/l, respectively. These concentrations are approximately 25% of the theoretical values and may reflect conversion of ammonia to other forms of nitrogen.

<u>Future Water Balance and Quality</u> - After construction of the Part 360 landfill cap (2.9 in/yr. infiltration), the water balance of Pond B would be altered considerably. As shown on Table 4-4, the new components of flow to Pond B would consist of 49,400 gpd of groundwater through Segments 3 and 4 and 77,500 gpd of surface water runoff. The surface water figure was derived utilizing 11 inches of runoff from the non-capped areas of the watershed and 20% of the total precipitation on the capped area (HELP model) or

8.6 inches per year. The groundwater flow would include 12,400 gpd of percolation (leachate generation) through the cap within Segments 3 and 4.

Immediately after the cap is constructed, there would be no change in groundwater quality, though the water balance would change as stated above. The projected water quality in Pond B would then be 1,397 mg/l TDS (a 43% reduction from the current theoretical concentration) and 331 mg/l of ammonia (a 49% reduction).

Analysis of the long-term post-capping (Part 360 cap) conditions indicate that a further reduction in contaminant concentrations can be expected. Specifically, after three aquifer flushes (approximately 11 years), the TDS concentration in Pond B is predicted to be 584 mg/l and the ammonia concentration is calculated at 119 mg/l. Because the observed ammonia concentrations were 25% of the theoretical values as discussed above, the actual concentration of ammonia in Pond B after 3 aquifer flushings is likely to be about 30 mg/l.

The analysis for long-term post-capping conditions assumes that groundwater concentrations of TDS and ammonia are at background concentrations because the groundwater table would no longer be in contact with the contaminated media.

A similar analysis was performed for the Part 360 cap with a drainage net. Table 4-4 shows that this results in significant reductions in ammonia and TDS below the levels predicted for the Part 360 cap alone. The projected water quality in Pond B after the flushing period would be 200 mg/L TDS and 5 mg/L ammonia.

For comparison purposes, the future water balance of Pond B after the installation of a RCRA multi-media cap was also analyzed. In this scenario, because of the use of a composite cap, leachate generation is negligible. The lack of leachate addition to the groundwater component results in TDS and NH_3 concentrations returning to background levels after three flushings of the aquifer. This is a significant improvement of water quality over the long-term conditions seen after the installation of a Part 360 cap.

However, as indicated on Table 4-1 and 4-2, the cost of the RCRA cap is considerably more than the Part 360 cap. Further, as discussed in Section 4.6.1, the performance of a Part 360 cap can be significantly improved by the addition of a synthetic drainage layer over the impermeable geomembrane to reduce the buildup of a hydraulic head. Therefore, the RCRA Multi-media cap is not considered further.

4.6.5 Implementability - The construction technologies associated with the landfill capping and waterline installation are all established, proven, refined and reliable. The operation of these technologies is maintenance oriented, with the cap requiring frequent inspection to spot subsidence and erosion problems, and mowing to control vegetation. Runoff controls for the cap also require periodic inspection and cleanout. Operation of the water main involves the standard maintenance procedures used for other municipal water mains within the Gloversville water system. All the technologies associated with this alternative are capable of meeting their performance goals based on past performance data at numerous other installations. The only technical problems with this alternative are the logistics and road use aspects of trucking in the extensive quantities of fill and capping materials required. Consideration will have to be given with regard to fill source area and preferred low impact truck routes to the site.

Administratively, this alternative will require acceptance by state and local agencies with regard to cap design, landfill regrading, and water main installation. In addition, state solid waste and land use regulations are applicable to the removal of waste from wetlands buffer areas and construction of the runoff sedimentation basin. Local agencies will also be involved in regulating the heavy truck traffic necessary to import capping materials.

Because this alternative uses proven, readily available materials, competitive bids can easily be obtained. The costs of this alternative presented in Section 4.6.8 are substantial. The City has a limited ability to bond for projects because of its budget, bond rating and tax base. In the absence of recoveries from potentially responsible parties (PRP's), the city would not be able to fund 25% of this remedial action. With substantial PRP recoveries, the option may be implementable.

4.6.6 Compliance with ARARs - As with Alternative No. 2, this alternative will comply with the chemical specific ARARs of the SDWA and the NYS DOH drinking water standards by supplying a new, uncontaminated source of potable water to the affected residences.

Wetland and all other location specific ARARs will be complied with, provided proper construction management practices are employed to prevent encroachment into adjacent wetland areas.

The discharge of surface water runoff from the impermeable cap will require SPDES permit coverage (either Individual or General) under the new stormwater permitting regulations of the Clean Water Act. A permit application will need to be submitted and a Stormwater Pollution Prevention Plan for the site will have to be prepared for the construction phase of the capping project. Once the landfill has been capped properly stormwater permit coverage is no longer required.

Compliance with other chemical specific ARARs, RCRA and DEC groundwater standards and DEC surface water standards, is difficult to predict. However, based on the discussion presented previously in Section 4.6.4 (Reduction of Toxicity and Mobility) a significant improvement in groundwater and surface water quality can be expected. It is anticipated that groundwater concentrations will return to background levels as a result of lowering the water table to prevent contact with the contaminated media for groundwater flow-net segments 3 and 4. Also, the post-capping water balance described previously indicated that the expected TDS concentrations in Pond B after 3 flushing of the aquifer (11 years) would be near the 500 mg/l surface water standard. The expected ammonia concentration in Pond B in the long-term conditions is 30 mg/l. This remains above the typical Class C (TS) ammonia standards (1-5 ug/l). However, with further dilution as the water moves downstream, it is likely that ammonia concentrations will rapidly improve, similar to current conditions.

<u>**4.6.7 Protection of Human Health and the Environment**</u> - The overall impacts imposed by this alternative on human health and the environment are a reduction in direct contact exposure pathways with solid waste, a reduction in the generation of landfill leachate and thus, reduced contamination of groundwater and surface waters. Impacts on area residents are minimized by the installation of a municipal water supply.

<u>**4.6.8 Cost**</u> - Alternative No. 3 is capital intensive with the majority of costs related to capping of the landfill. Costs associated with this alternative are presented below and a detailed cost breakdown is presented in Tables 4.1 and 4.2 at the end of this section.

- Capital Costs $25,950,000
- Annual O&M Costs $193,000
- Present Worth Cost $28,340,000

4.7 ALTERNATIVE NO. 4 - IMPERMEABLE CAP WITH WATER LINE AND GROUNDWATER PUMP AND TREAT SYSTEM

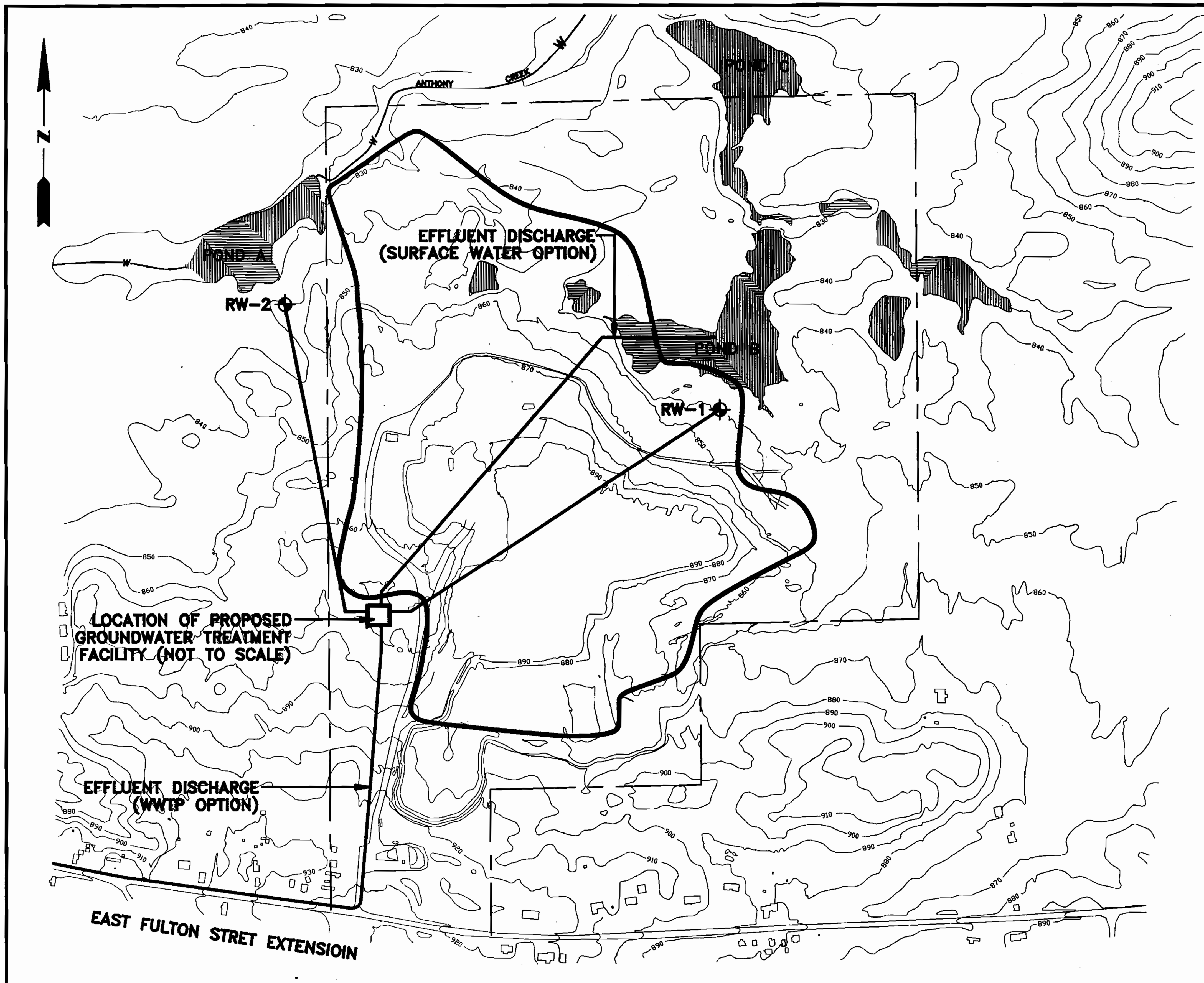
4.7.1 Description - This Alternative applies the same technologies as Alternative No. 3 (an impermeable cap and the City water main), with the addition of a pump and treat groundwater remediation system to both inhibit further plume migration and treat contaminated, leachate impacted groundwater at the site.

Landfill capping options as well as the water supply line installation are described in detail in Sections 4.6 and 4.5, respectively.

As mentioned, in addition to capping the landfill to minimize leachate production, this Alternative utilizes a groundwater collection and treatment system to minimize landfill contaminant plume migration. The recovery and treatment system design is based on pump test data and leachate sampling data collected during the Phase 2 Remedial Investigation (23).

The groundwater collection system (see Figure 4-8) consists of two 8-inch recovery wells located so as to intercept, based on groundwater modelling results, the bulk of the contaminated plume prior to migration off the landfill site. The wells will be pumped at a combined maximum rate of 150 gpm with the majority of flow coming from RW-1 which, according to pump tests and modelling results, should produce a capture area with a diameter of more than 1,000 feet. The location of the proposed groundwater treatment facility as shown is tentative and is provided for conceptual purposes only.

Based on leachate well sampling results presented in the Phase 2 RI (23), extensive treatment of leachate impacted groundwater will be required prior to using any of the discharge options presented below. For the purposes of the Feasibility Study, proposed treatment systems and their effectiveness will be evaluated based on the data collected during the Phase 1 and Phase 2 Remedial Investigations. In actuality, when the construction of a treatment plant of the magnitude required for this site is implemented, bench scale and/or pilot scale tests should be conducted to ensure operational effective



LEGEND

⊕ GROUND-WATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL

— — — PROPERTY LINE

——— LIMIT OF DEBRIS

NYSDEC SITE NO. 518001

DRAWN BY: KJK		CHECKED BY: ESH,TMB	APPROVED BY: MRP
NO.	DATE	REVISIONS	BY
1	4/93	CORRECT LIMIT OF DEBRIS	TMB

TIGHE & BOND
CONSULTING ENGINEERS, P.C.
WESTFIELD, MASSACHUSETTS

GROUNDWATER PUMP AND TREAT SYSTEM

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
GLOVERSVILLE MUNICIPAL LANDFILL
GLOVERSVILLE, NEW YORK

DATE: NOV., 1992
SCALE: 1" = 400'
FIGURE: 4-8

I:G191\F11C

ness of the system. It is assumed that the results of these pilot scale tests will lead to minor process modifications with few major process changes.

The contaminants to be treated in the leachate impacted groundwater are summarized in Table 4-5 and consist of a series of metals including: aluminum, arsenic, chromium, copper, lead, zinc and cyanide; volatile compounds including: benzene, xylene, toluene, and chloroethane; semi-volatiles including: 4-methylphenol, benzoic acid, and naphthalene; pesticides including: 4,4-DDD and 4,4-DDE; and miscellaneous parameters including: BOD, ammonia and TSS.

Two treated groundwater discharge alternatives are being considered for this study: surface water discharge and discharge to a WWTP. The treatment required for surface water discharge is more extensive than that for WWTP discharge. The primary disadvantages of WWTP treatment are that a pipeline is required to convey treated groundwater to the existing sewerage system (See Figure 4-8, 4-9) and sewer use fees must be paid.

The physical discharge of treated groundwater to surface water is straight forward involving installation of an outfall to Anthony Creek. However, an extensive level of treatment is required. Two parameters associated with the influent are especially difficult to remove: ammonia and dissolved solids. Ammonia levels in the leachate-impacted groundwater are expected to be generally high (500-2000 mg/l range). Anthony Creek is classified as a Class C surface water body with trout stream specification (TS) for portions of the stream down stream of the landfill. Ammonia surface water discharge standards are in the 0.001 - 0.005 mg/L range, for unionized ammonia, depending on pH and temperature, requiring a removal efficiency of 99.999%.

The proportion of ionized versus un-ionized ammonia in water increases as temperature and pH increases, i.e., the lower the pH the lower the percentage of unionized ammonia. Given the pH (6-8) and temperature (2-25°C) ranges measured in Anthony Creek, unionized ammonia is not expected to comprise more than 5% of total ammonia and in

TABLE 4-5
ALTERNATIVE NO. 4 - PUMP & TREAT

METALS	INFLUENT CONCENTRATION[1] IN UG/L	SURFACE WATER DISCHARGE EFFLUENT LIMIT IN UG/L	WWTP EFFLUENT LIMIT IN UG/L
ALUMINUM	18,000	100	
ANTIMONY	70		8600
ARSENIC	160	190	200
BARIUM	480		
CALCIUM	160,000		
CHROMIUM	6,000	300	14000
COBALT	25	5	
COPPER	360	16	200
IRON	30,000	300	
LEAD	330	6	100
MAGNESIUM	123,000		
MANGANESE	540		
MERCURY	6.2		30
NICKEL	160	120	350
POTASSIUM	290,000		
SODIUM	1,500,000		
VANADIUM	45	14	
ZINC	560	30	2000
CYANIDE	30	5.2	80
VOLATILES			
BENZENE	10	5[2]	13000
XYLENE	600	5[2]	
TOLUENE	400	5[2]	150
CHLOROBENZENE	26	5	1200
4-METHYL 2-PENTANONE	84	5[2]	
1,2 DICHLOROPROPANE	7	5[2]	
ACETONE	70	5[2]	
CHLOROETHANE	55	5[2]	
SEMIVOLATILES			
4-METHYLPHENOL	2,300	5[2]	
BENZOIC ACID	1,100	5[2]	
NAPTHALENE	1,400	5	250
1,2 DICHLOROBENZENE	9	5	
2-METHYLPHENOL	18	5[2]	60 TOTAL
2,4-DIMETHYLPHENOL	140	5[2]	
1,2,4-TRICHLOROBENZENE	6	1.0	
PESTICIDES			
4,4-DDD	1.4	0.001	
4,4-DDE	5.3	0.001	
HEPTACHLOR EPOXIDE	0.07	0.001	
MISCELLANEOUS	**INFLUENT CONCENTRATION IN MG/L**	**SURFACE WATER DISCHARGE EFFLUENT LIMIT IN MG/L**	**WWTP EFFLUENT LIMIT IN MG/L**
BOD	400	30	
COD	1,600		
TKN	2,000	100[3,4]	500
PHOSPHATE	6		
TOTAL AMMONIA	2,000	100[4]	
TDS	6,000	500	
TSS	1,200	30	
CHLORIDE	3,000		
SULFATE	90		

1 -CONCENTRATIONS REPORTED BASED ON WORST CASE VALUES OBTAINED FROM MW-7,8 AND 12
2 - NOT BASED ON STANDARDS: LEVELS SIMILAR TO ESTABLISHED STANDARDS FOR OTHER COMPOUNDS
3 -TKN MADE UP MOSTLY OF AMMONIA
4 -ASSUMES 1% UNIONIZED AMMONIA

L:\G191\PTCS.WK3

most cases, will not exceed 1% of the total ammonia. If the Class A standard surface water without the TS specification were to apply, rather than the Class C (TS) standard, then the limits of the discharge would be raised to 2 mg/L total ammonia. Removal efficiency for ammonia treatment would then need to be about 99.6%.

Achieving a large reduction in total dissolved solids to meet the discharge limit of 500 mg/l will require the use of removal processes, such as reverse osmosis and ion exchange, which require a great deal of maintenance and operator supervision. In addition, the residuals produced by these removal processes consist of a concentrated brine solution which must be properly disposed of. This disposal process is expensive, involving solidification with concrete and subsequent landfilling.

Stream gauge data reported in the Phase 1 and 2 Remedial Investigations indicate flow rates through the Barker Road culvert are in the 0.4 to 1.0 cfs range, depending upon season. The additional flow produced as a result of a groundwater pump and treat system is expected to be in the 0.20 to 0.33 cfs range. This represents a significant increase in the flow of Anthony Creek in this area but is not expected to have any adverse impact downstream.

While discharge of treated groundwater to the WWTP demands a less intensive pretreatment process, it does require installation of a pipeline to convey treated groundwater to the existing sewerage system. The only existing WWTP in the vicinity of the Gloversville Landfill is the Gloversville/Johnstown WWTP. Approximately 4,000 feet of 8-inch gravity sewer pipe and 2,000 feet of 4-inch pressure line will need to be installed, starting at the corner of Hollywood and Fulton Streets, extending down East Fulton Street Extension and up the landfill access road to the treatment facility (See Figure 4-5). Approximately two thirds of the line can be gravity flow with one sewage pump station required to pump the treated groundwater from the treatment facility to the gravity pipe on East Fulton Street Extension.

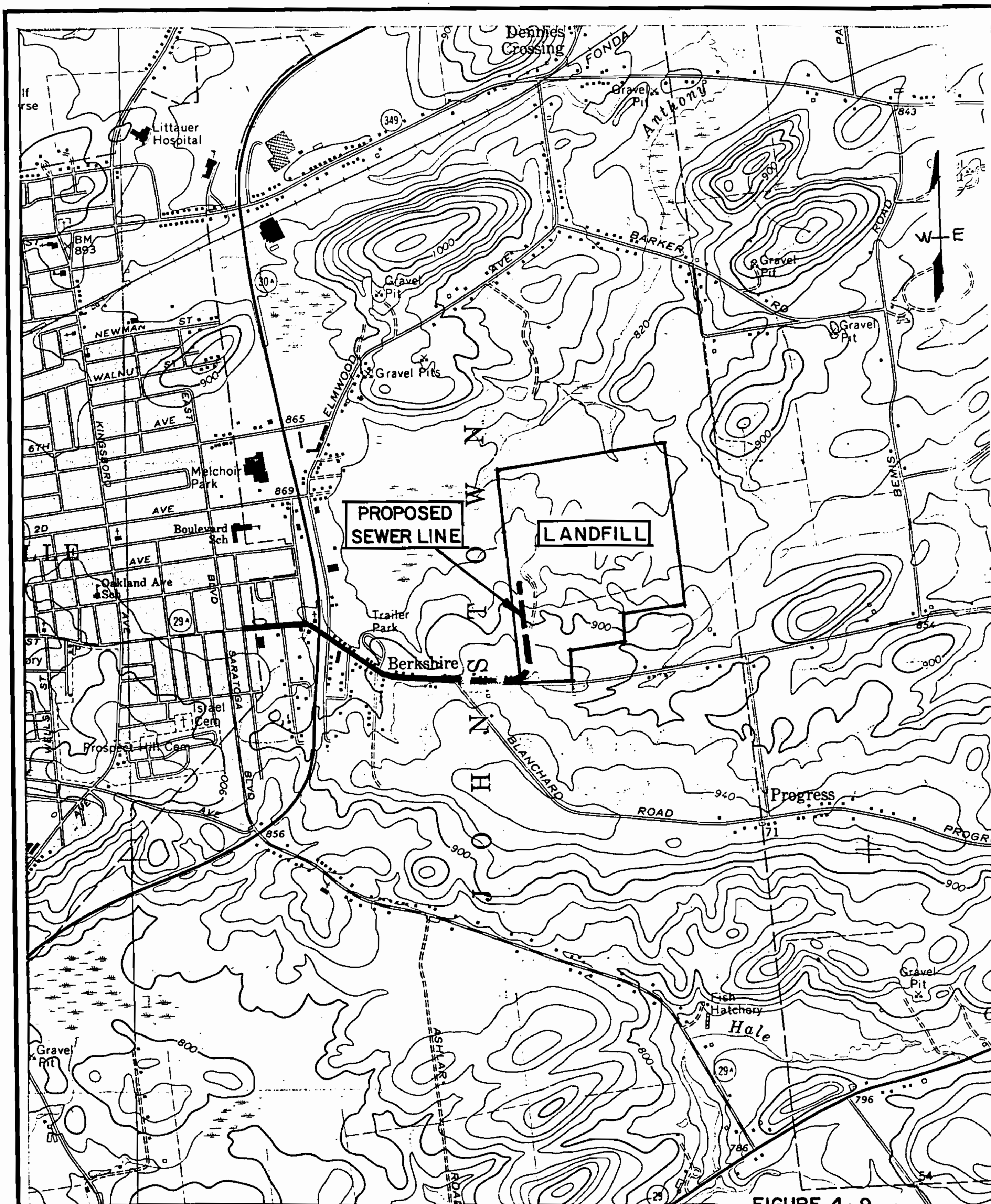


FIGURE 4-9

SOURCE: USGS GLOVERSVILLE QUADRANGLE

8" GRAVITY LINE

4" PRESSURE LINE

NYSDEC SITE NO. 518001

PROPOSED
SEWER LINE ROUTING

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

SCALE: 1"= 2000' DATE: OCT. 1992

Another consideration is the user fee associated with the quantity and quality of the discharge to the WWTP. Due to plant loading limitations, pretreatment of the leachateimpacted groundwater is necessary. Because user fees are based on pollutant loadings (in addition to flow rates), costs associated with pretreatment would be partially offset by lower WWTP user fees. Both solids and total kjeldahl nitrogen (TKN) contribute significantly to WWTP treatment costs. The TKN loading of untreated groundwater from the landfill would exceed existing plant capacity. Approximate fees associated with the Gloversville/Johnstown WWTP are presented in Table 4-6.

While there are many different treatment trains that will provide the desired effluent quality for surface water and WWTP discharge, three have been selected based on equipment vendor responses to meeting the treatment goals. Details of each treatment system are presented in Table 4-7 and Figures 4-10 - 4-14. Descriptions of these three (3) systems follow.

L&T Technologies - The first system for treatment to surface water discharge standards submitted by L&T Technologies consists of a metals removal process followed by an activated sludge extended aeration process for removal of biodegradable contaminants. Following the extended aeration process is a tertiary effluent polishing process consisting of a closed loop air stripping tower, carbon adsorption and ion exchange.

To comply with WWTP discharge limits, L&T Technologies recommends eliminating the tertiary effluent polishing processes from the previously described systems. These include: VOC stripping, carbon adsorption and ion exchange. The system also requires a less elaborate extended aeration process and less extensive metals removal process.

Simon WTS - The system submitted by Simon WTS consists of a metals removal unit, sludge dewatering equipment, a closed loop air stripper utilizing an ammonia absorber, breakpoint chlorination, a chlorine destruct unit, ion exchange and granular activated carbon for final effluent polishing to achieve surface water discharge standards. To achieve WWTP standards, Simon WTS recommends eliminating the breakpoint

TABLE 4-6

GLOVERSVILLE / JOHNSTOWN WWTP
INDUSTRIAL USER FEES

FEES BASED ON ALLOCATION REQUESTED:*	
Flow	$0.13/Gal.
Solids	$48.55/1000 pounds
BOD	$30.60/1000 pounds
TKN	$252.76/1000 pounds
* Apply whether or not allocation is fully utilized.	
FEES BASED ON ACTUAL QUANTITY DISCHARGED:	
Flow	$0.29/Gal.
Solids	$260.62/1000 pounds
BOD	$217.03/1000 pounds
TKN	$603.72/1000 pounds
ADDITIONAL ANNUAL FEES	
Infiltration/Inflow Fee:	$21.70/connection
Monitoring Fee:	$1,240/YEAR

Discharge fees are based on the sum of the allocation fee and the fee for actual quantity discharged.

TABLE 4–7
SUMMARY OF GROUNDWATER TREATMENT SYSTEMS
(SURFACE WATER DISCHARGE OPTION)

SUBMITTED BY:

L & T TECHNOLOGIES, INC.
W. BRIDGEWATER, MA

Process	Parameters	Comments
Metals Removal+		
Equalization	10 – 12,000 gallons	Removal of metals by precipitation
Chrome Reduction	3,500 gallons	
Cyanide Oxidation	6,000 gallons	
pH Neutralization	6,000 gallons	
Flocculation	2,000 gallons	
Gravity Plate Settler	580 sq. ft.	Sedimentation
Multi Media Sand Filter	15 sq. ft.	Filtration
Selective Metal Ion Exchange	60 cubic ft.	Ion exchange
Adsorption Extraction for Semivolatiles	65 cubic ft.	
Sludge Handling (Filter Press)	25 cubic ft.	Metals sludge to waste
Activated Sludge Extended Aeration Process+		
Flow	250,000 GPD	Biological removal of organic contaminants
BOD5 Loading	500 lb / day	
Overflow Rate at Clarifier	550 GPD / sq. ft.	
Square Feet of Clarifier	453 sq. ft.	
Diameter of Clarifier	25 feet	
Depth of Clarifier	11 feet	
Volume of Clarifier	37,400 gallons	
Detention Time in Clarifier	3.6 hours	
Air Requirement	1,000,000 cu. ft. / day	
Air Requirement	695 c.f.m.	
Blower HP	40 HP	
Blower RPM	1,600 RPM	
Aeration Volume	250,000 gallons	
Aeration Surface Area (S.W.D. = 13.5")	2,460 sq. ft.	
Waste Sludge Area	184 sq. ft.	Biological solids and contaminants
Digester Area	--	
Filtration Area	174 sq. ft.	
(Ave. 174 GPM @ 2 GPM / ft^2 2 filters)		
Filter Back Wash Area	150 sq. ft.	
Chlorine Contact Area	--	
Total Plant Area	3,421 sq. ft.	
Outside Diameter of Plant	66 feet	
Final Effluent Polishing*		
VOC Stripping Tower		Air stripping of ammonia
Carbon Adsorption		Adsorption of organics
Ion Exchange		Ammonia polishing

+ Unit process would be downsized for WWTP discharge option.

* Not used for WWTP discharge option.

TABLE 4–7 (Cont.)
SUMMARY OF GROUNDWATER TREATMENT SYSTEMS
(SURFACE WATER DISCHARGE OPTION)

SUBMITTED BY:

SIMON – WTS, INC.
SANTA CLARA, CA

Process	Parameters	Comments
Pretreatment / Metals Removal		
Reaction and pH adjustment chamber		Metals and solids removal
Flocculation		
Clarification		
Sludge Thickening		Concentrated metals and solids to waste
Effluent clearwell and final pH adjust		
Automatic backflush sand filter		
Influent Equalization		
Holding Tanks	24,000 gallons	
Closed Loop Air Stripping+		
FRP Tower	10'd X 20'h	Ammonia removal
with Packing	2.3"d packing media	
Sump chamber	500 gallon	
Absorber		
Brine tank	10'd X 20'h	FRP tower to remove ammonia
Evaporator*		from discharge air stream
Crystalizer*		
Filter Press*	10 ft^3	Dewater concentrated ammonia salts
Breakpoint Chlorination*		
Holding vessels	2 @ 9,000 gallons ea.	Further removal of ammonia
Sodium hypochlorite feed system		
Chlorine Destruct System*		
Holding vessel	2,000 gallons ea.	Removal of chlorine from breakpoint chlorination process
Sodium bisulfate feed system		
Sulfuric acid feed system		
Ion Exchange*		
Vessel containing cationic resin	2 @ 150 ft^3 ea.	Removal of remaining ionic contaminants
Granular Activated Carbon		
Vessel containing activated carbon	2 @ 150 ft^3 ea.	Effluent polishing, removal of organic substances
Sludge Dewatering		
Filter press	80 ft^3 ea.	Dewatering of metals and salts, precip. sludge
Sludge age tanks	2 @ 15,000 gal. ea.	Additional breakdown of sludge constituents
Chemical Holding Tanks+		
Sodium hypochlorite (base)	2,000 gallons	pH adjustment
Acid tank	500 gallons	Chemicals

+ Unit process would be downsized for POTW discharge option.

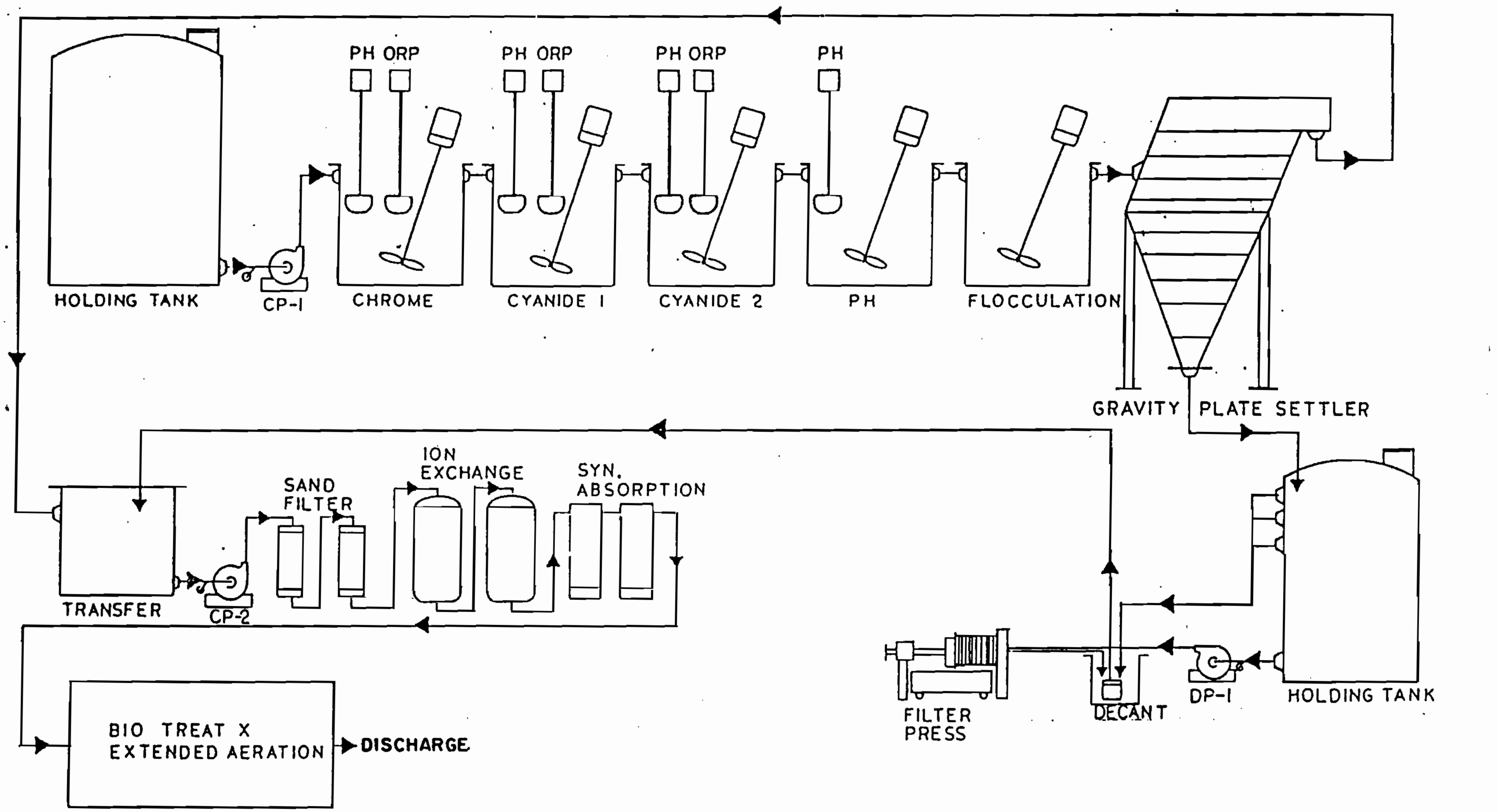
* Not used for WWTP discharge option.

TABLE 4-7 (Cont.)
SUMMARY OF GROUNDWATER TREATMENT SYSTEMS
(WWTP DISCHARGE ONLY)

SUBMITTED BY:

U.S. FILTER
WARRENDALE, PA

Process	Parameters	Comments
Pretreatment / Metals Removal		
pH Adjustment Module	180 gpm	Removal of metals by precipitation
Sodium Carbonate Bulk Storage & Feed Silo	50 tons	
Flocculation Module	180 gpm	Raise pH for biological nitrification of ammonia
Polymer Day Tank and Feed Pump	500 gallon & 0-18 gph	in bio-tower process.
Solids Separator with Tube Modules	180 gpm	
Diaphragm Sludge Transfer Pumps	2 @ 20 gpm ea.	
Upper Fixed Film Biological Contactors		
Lift Station with Duplex Horizontal Pumps	150 gpm	Aerobic biotower, biological removal of organic contaminants, ammonia.
Boiler/Steam Generator	2,500 lbs/hr.	Maintain sufficient temperature for degradation.
Aerobic Bio-Towers	2 @ 25' dia. x 25' high ea.	
Three Aeration Blowers	2,800 cfm ea.	Excess biomass discharged with effluent to POTW.
Recirculation Pump (intermittent use)	1,500 gpm	
Inoculum Bio-Seeder (preparation & transfer)	200 gallons	Insures high active bacteria count.
Sludge Handling/Effluent Monitoring		
Sludge Thickener & Storage Tanks	2 @ 7,500 gal. ea.	Metals and solids precipitation sludge.
Air Diaphragm Sludge Transfer Pump	55 gpm	
Recessed Plate Pressure Filter	75 cubic feet	
Filtrate Sump with Duplex Vertical Pumps	75 gpm ea.	
Air Comrpessor & Air Dryer	50 cfm	
Effluent Monitoring Tank	150 gpm	Effluent monitoring equipment
Effluent Composite Sampler		
Effluent Flow Meter & Recorder		



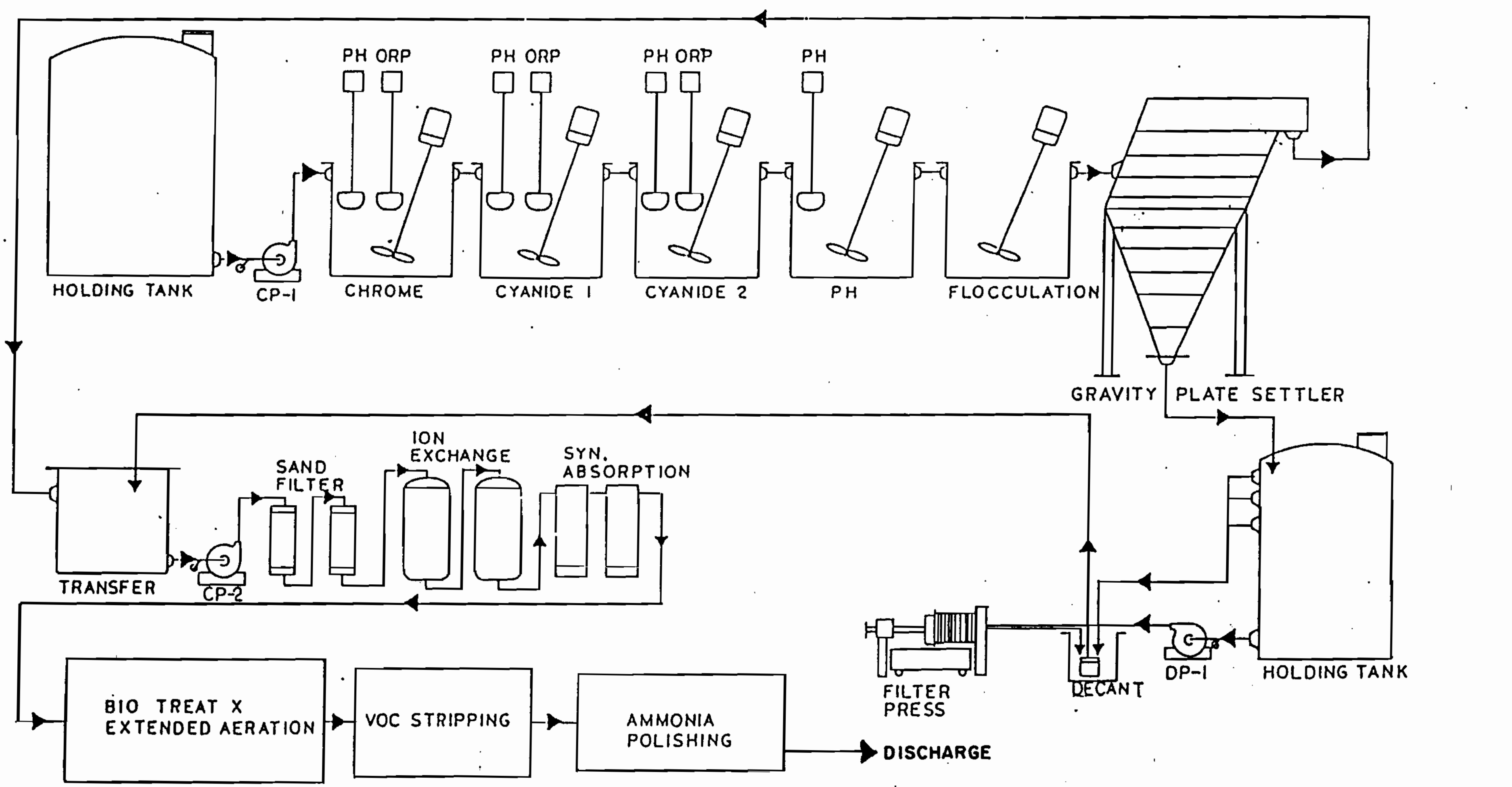
L&T TECHNOLOGIES

FIGURE 4-10

GROUNDWATER TREATMENT SYSTEM
WWTP DISCHARGE

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND, INC. CONSULTING ENGINEERS
WESTFIELD, MASS.
SCALE: NONE
DATE NOVEMBER 1992



L & T TECHNOLOGIES

FIGURE 4-11

GROUNDWATER TREATMENT SYSTEM
SURFACE WATER DISCHARGE

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND, INC. CONSULTING ENGINEERS
WESTFIELD, MASS.
SCALE: NONE DATE NOVEMBER 1992

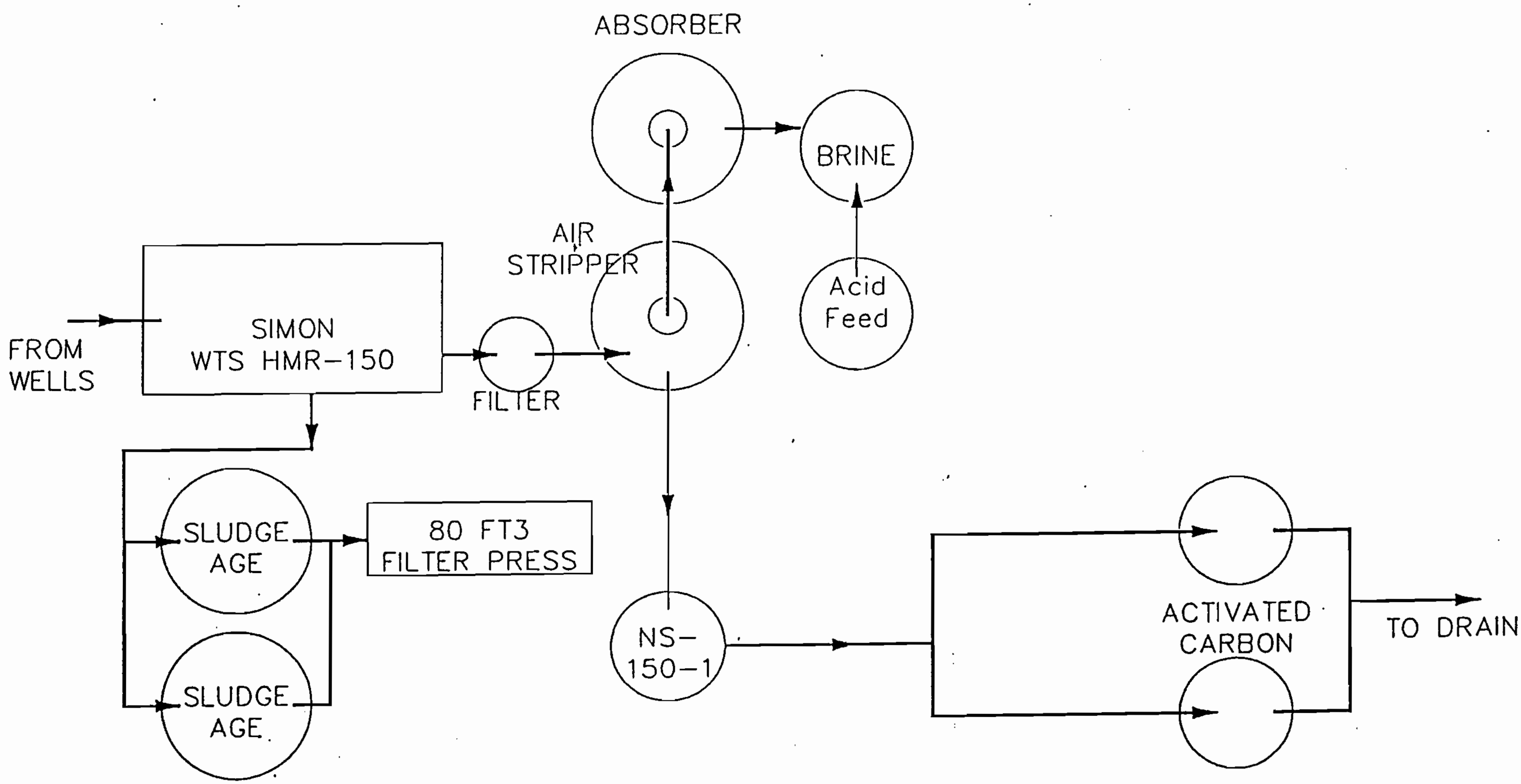


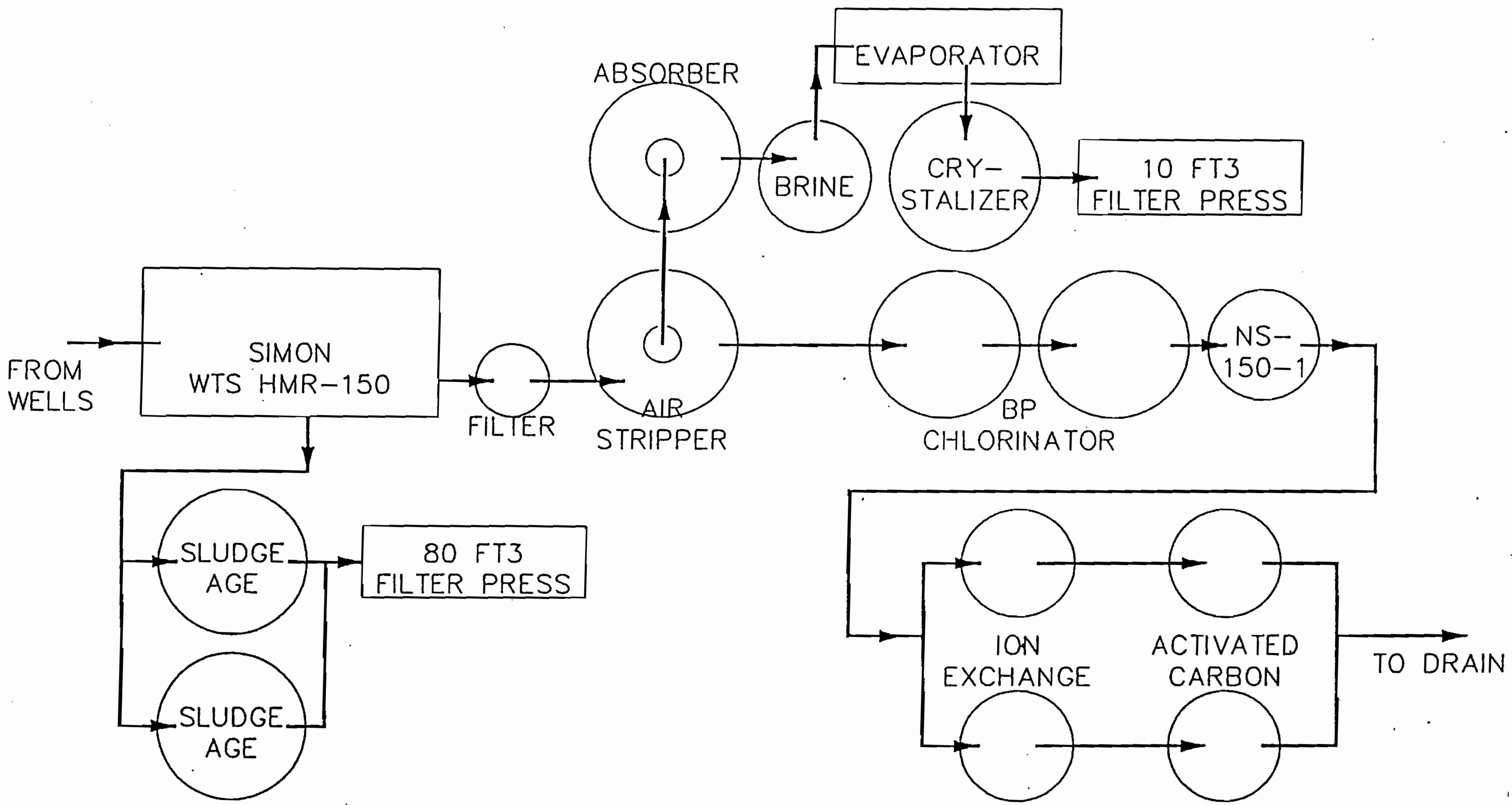
FIGURE 4-12

GROUNDWATER TREATMENT SYSTEM
WWTP DISCHARGE

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND, INC. CONSULTING ENGINEERS
WESTFIELD, MASS.
SCALE: NONE DATE NOVEMBER 1992

SIMON-WTS



SIMON-WTS

FIGURE 4-13

GROUNDWATER TREATMENT SYSTEM
SURFACE WATER DISCHARGE

MUNICIPAL SANITARY LANDFILL
GLOVERSVILLE, N.Y.

TIGHE & BOND, INC. CONSULTING ENGINEERS
WESTFIELD, MASS.
SCALE: NONE DATE NOVEMBER 1992

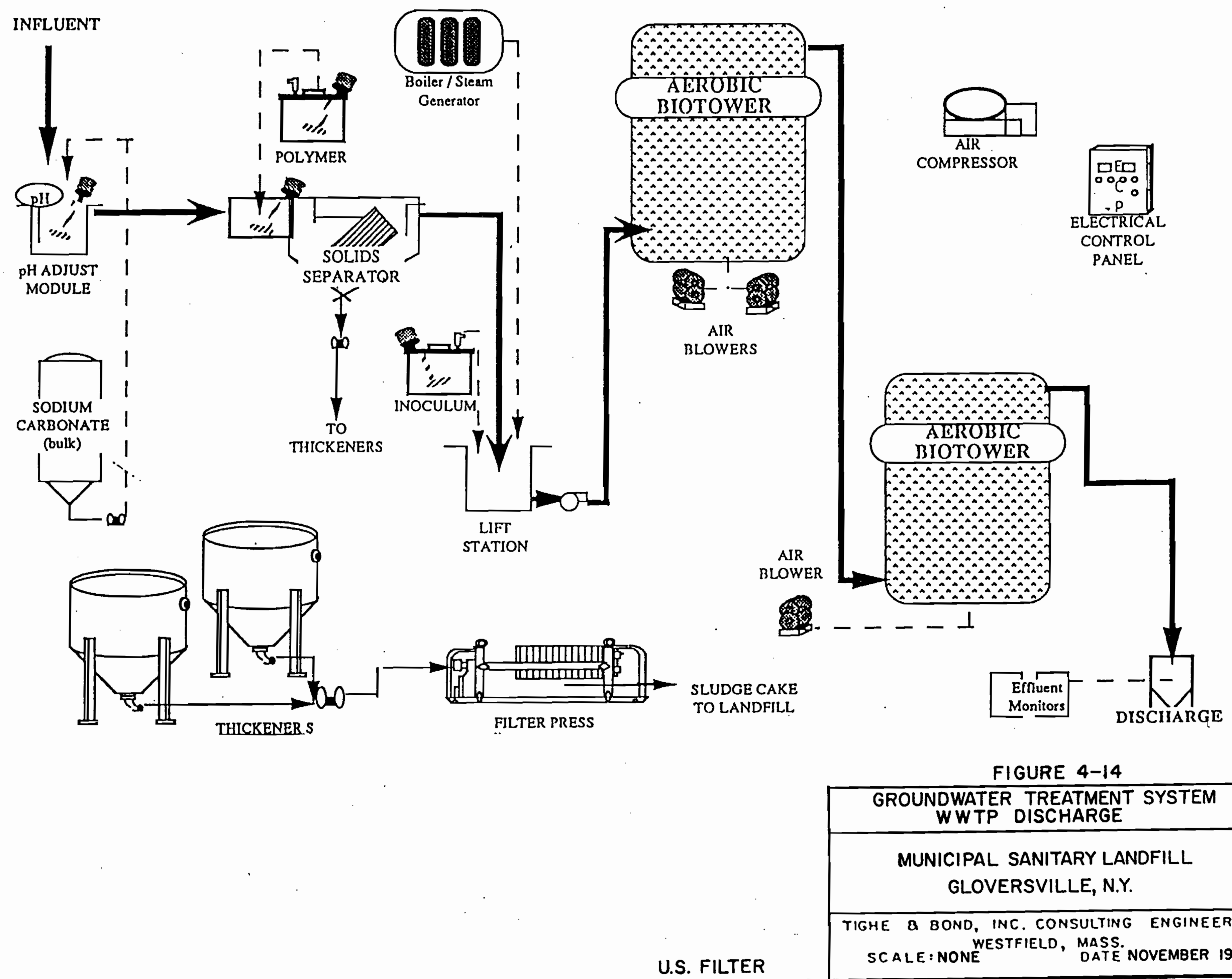


FIGURE 4-14

GROUNDWATER TREATMENT SYSTEM WWTP DISCHARGE
MUNICIPAL SANITARY LANDFILL GLOVERSVILLE, N.Y.
TIGHE & BOND, INC. CONSULTING ENGINEERS WESTFIELD, MASS. SCALE: NONE DATE NOVEMBER 1992

<u>4.7.2 Short-Term Effectiveness</u> - The human health and environmental impacts associated with this alternative include those of Alternative No. 3 with additional impacts related to the groundwater treatment system. Specifically, residuals from the closed loop air stripping tower and the temporary storage of sludge generated by the metals precipitation and/or activated sludge processes will have potential human health and environmental impacts. Should the option to discharge treated groundwater to Anthony Creek be chosen, flow related impacts could result due to the additional flow produced by the groundwater treatment system. These impacts would be less significant further downstream where treatment discharge flow would constitute a lesser percentage of total flow. Other possible impacts include those associated with construction of the groundwater treatment facility and the installation of the sewer discharge line if the WWTP discharge option is utilized in place of the surface water discharge option. As with Alternative No. 3, due to the large area to be capped, the time from the ROD to completion of the Remedial Response Objectives is expected to be 24-36 months. The additional construction required for the groundwater treatment system can occur simultaneously with the cap construction.

<u>4.7.3 Long-Term Effectiveness</u> - This alternative offers the highest level of long-term effectiveness of any of the alternatives proposed in this study due to the fact that contaminants will actively be removed from the site through the groundwater pump and treat system. Continued plume migration will be minimized by both the landfill cap and the groundwater pumping system. This will reduce, over time, the contaminant loadings on groundwater and surface water downgradient of the landfill. The contaminant generating source will remain in place beneath the impermeable cap. The majority of contaminant concentration reduction will only occur in the groundwater and surface water downgradient of the landfill.

<u>4.7.4 Reduction of Toxicity, Mobility, and Volume</u> - This alternative offers the greatest potential to reduce the toxicity, mobility and volume of contaminants at the Gloversville Landfill. Mobility of contaminants is greatly reduced through capping. Major exposure pathway reductions occur through capping, which eliminates dermal contact and direct ingestion of soil and waste related contaminants. Another major exposure pathway, ingestion of contaminants through private well use, is also eliminated through installation of the City water main.

The mobility of contaminants is reduced two ways. The first is through limiting infiltration, percolation, and the resultant leachate by installing a landfill cap. The second is a reduction in the mobility of leachate contaminated groundwater by interception of the contaminant plume by the pump and treat system.

4.7.5 Implementability - This alternative is the most difficult to implement of those presented in this Feasibility Study. Because it involves capping, the large size of the landfill presents the same difficulties as those associated with Alternative No. 3. The construction of the groundwater recovery wells can easily be implemented at the site. Testing conducted in the proposed well placement area during the Phase 2 RI indicated that a yield of 150 GPM can be obtained through the installation of an 8-inch recovery well.

Regardless of the discharge option chosen, construction of the groundwater treatment plant uses proven, packaged treatment processes to achieve the desired effluent quality. Pilot testing is required to ensure that the selected treatment process will effectively reduce contaminant levels. The complexity of this alternative is related to the operation of the plant. Although mostly automated, treatment plants such as these require skilled personnel to operate and maintain them. If the surface water discharge option is chosen, the treatment equipment required will require a higher operator skill level than for the WWTP option, involving more metals precipitation, a more complex biological treatment process, and ammonia removal. To discharge to the WWTP, a sewer line and pump station will need to be constructed between the treatment facility and the existing City sewerage system. Construction of this type of line utilizes proven construction techniques.

Administratively, both of the discharge options are somewhat difficult to implement. WWTP discharge involves meeting WWTP influent guidelines (see Table 4-5) and user fees must be paid based on influent loadings. In addition, the sewer discharge line installation will require permits and traffic control typical of a municipal sewer line installation along a public roadway.

The surface water discharge option is physically easier to implement, involving only the installation of a discharge outfall pipe to Anthony Creek. Administratively, this option will be more difficult to implement because it involves addressing several environmental issues related to flow and contaminant impacts to Anthony Creek.

This option is not implementable due to excessive costs. Not only would the city not be able to bond for their portion of the capital costs, but operational costs of about $1,000,000 per year would either require legislative approval to raise tax rates or require cutting essential City services.

<u>4.7.6 Compliance with ARARs</u> - As with the previous two alternatives, Alternative No. 4 provides compliance with chemical specific ARARs for drinking water by providing a new, uncontaminated supply of potable water.

Compliance with location specific ARARs will be attained provided proper construction practices are employed to prevent alteration to adjacent wetlands.

A SPDES permit and Stormwater Pollution Prevention Plan will be required for the discharge of runoff from the capped landfill to surface waters during construction. A separate SPDES discharge permit will be required if treated groundwater is discharged to Anthony Creek. The treatment capabilities of the various discharge systems will ensure compliance with the permit discharge limitations.

Other chemical specific ARARs - groundwater and surface water standards will be complied with in a similar fashion and timeframe as Alternative No. 3. However, the effect of the pump and treat system will be to intercept contaminant plume migration, thus providing compliance with ARARs (groundwater and surface water) more quickly for areas downgradient of the landfill.

4.7.7 Protection of Human Health and the Environment - The same impacts related to capping and surface water runoff apply to this alternative as did in Alternative No. 3. Additional impacts on the environment are imposed if the surface water discharge option is chosen. The anticipated 150 GPM discharge rate will impact the existing flow rate of Anthony Creek at the point of discharge. Lesser flow related impacts will result further downstream where effluent discharge represents a smaller percentage of total flow.

4.7.8 Cost - Alternative No. 4 is the most expensive of the alternatives presented. The cost breakdown is similar to that of Alternative No. 3 with additional costs associated with the groundwater pump and treat system. The costs associated with his alternative are presented below and a detailed cost breakdown is presented in Tables 4-1 and 4-2 at the end of this section.

- Capital Costs $31,950,000
- Annual O&M Costs $ 1,012,000
- Present Worth Costs $44,510,000

G191\REPORT\SEC4.ESH

TABLE 4–1
COST COMPARISON OF ALTERNATIVES
(Refer to Table 4–2 for detailed cost estimates)

OPTION	CAPITAL COST	ALTERNATE			
		1 NO ACTION	2 WATER	3 WATER + CAP	4 WATER + CAP + P&T
Environmental Monitoring	$190,000	X	X	X	X
Private Well Monitoring	$0	X			
Public Awareness Program	$0	X	X	X	X
Access Restrictions	$250,000		X	X	X
Alternate Water Supply	$3,110,000		X	X	X
Reports	$0	X	X	X	X
Impermeable Barrier[1]	$22,400,000			X	X
Groundwater Pump & Treat[2]	$5,990,000				X
Treated Water Discharge[3]	$10,000				X
	TOTAL	$190,000	$3,550,000	$25,950,000	$31,950,000

OPTION	O&M COST	ALTERNATE			
		1 NO ACTION	2 WATER	3 WATER + CAP	4 WATER + CAP + P&T
Environmental Monitoring	$111,000	X	X	X	X
Private Well Monitoring	$95,000	X			
Public Awareness Program	$8,000	X	X	X	X
Access Restrictions	$0		X	X	X
Alternate Water Supply	$0		X	X	X
Reports	$15,000	X	X	X	X
Impermeable Barrier[1]	$59,000			X	X
Groundwater Pump & Treat[2]	$819,000				X
Treated Water Discharge[3]	$0				X
	TOTAL	$229,000	$134,000	$193,000	$1,012,000

	ALTERNATE			
	1 NO ACTION	2 WATER	3 WATER + CAP	4 WATER + CAP + P&T
PRESENT WORTH[4]	$3,030,000	$5,210,000	$28,340,000	$44,510,000

1 – BASED ON 6NYCRR PART 360 LANDFILL GEOMEMBRANE CAP

2 – BASED ON TREATMENT FOR SURFACE WATER DISCHARGE, P&T = PUMP AND TREAT

3 – BASED ON DISCHARGE TO SURFACE WATER

4 – 7% OVER 30 YEARS

G191\4–1.WK3

TABLE 4–2
REMEDIAL ACTIVITIES

A. ENVIRONMENTAL MONITORING	ESTIMATED COSTS	
	CAPITAL	O&M
INSTALL ADDITIONAL 2" MONITOR WELLS 20 @ $7000.	$140,000	
SAMPLING		
BASELINE 1/YR		
SAMPLE MONITOR WELLS (30)		
LABOR		$5,700
ANALYSIS @ $979.		$29,400
SAMPLE SURFACE WATER (5)		
LABOR		$600
ANALYSIS @ $979.		$4,900
QUARTERLY 3/YR		
SAMPLE MONITOR WELLS (30)		
LABOR		$17,000
ANALYSIS @ $392.		$35,300
SAMPLE SURFACE WATER (5)		
LABOR		$1,900
ANALYSIS @ $392.		$5,900
SUBTOTAL	$140,000	$100,700
ENGINEERING & CONTINGENCY	$42,000	$10,070
LEGAL & ADMINISTRATIVE 5%	$7,000	$504
TOTAL	$189,000	$111,274

B. PRIVATE WELL MONITORING	ESTIMATED COSTS	
	CAPITAL	O&M
BASELINE 1/YR		
SAMPLE PRIVATE WELLS (30)		
LABOR		$5,270
ANALYSIS @ $979.		$29,370
QUARTERLY 3/YR		
SAMPLE PRIVATE WELLS (30)		
LABOR		$15,810
ANALYSIS @ $392.		$35,280
SUBTOTAL	$0	$85,730
CONTINGENCY 10%	$0	$8,573
LEGAL & ADMINISTRATIVE 5%	$0	$429
TOTAL	$0	$94,732

TABLE 4-2 (CONT'D)
REMEDIAL ACTIVITIES

C. PROGRAM OF PUBLIC AWARENESS	ESTIMATED COSTS CAPITAL	O&M
PUBLIC PARTICIPATION (1 meeting & 2 mailings/yr)		$7,000
SUBTOTAL	$0	$7,000
CONTINGENCY 10%	$0	$700
LEGAL & ADMINISTRATIVE 5%	$0	$35
TOTAL	$0	$7,735

D. SITE ACCESS RESTRICTIONS	ESTIMATED COSTS CAPITAL	O&M
PERIMETER FENCING – 9,000 FEET @ $20./FOOT	$180,000	
SECURITY GATE	$2,000	
SUBTOTAL	$182,000	$0
ENGINEERING & CONTINGENCY 30%	$54,600	$0
LEGAL & ADMINISTRATIVE 5%	$9,100	$0
TOTAL	$245,700	$0

E. ALTERNATE WATER SUPPLY	ESTIMATED COSTS CAPITAL	O&M
12-INCH WATER MAIN – 30,000 FEET @ $65./FOOT	$1,950,000	
CONNECTIONS – 140 @ $2,000 ea	$280,000	
JACKING FOR HIGHWAY CROSSING	$70,000	
SUBTOTAL	$2,300,000	$0
ENGINEERING & CONTINGENCY 30%	$690,000	$0
LEGAL & ADMINISTRATIVE 5%	$115,000	$0
TOTAL	$3,105,000	$0

TABLE 4–2 (CONT'D)
REMEDIAL ACTIVITIES

F. REPORTS	ESTIMATED COSTS CAPITAL	O&M
QUARTERLY SAMPLE RESULTS – 3/YR @ $2,600 (40 hrs @ $65./hr)		$7,800
ANNUAL SUMMARY – 1/YR @ $3,900 (60 hrs @ $65./hr)		$3,900
SITE STATUS REPORT– 1/5YR @ $10,400 (160 hrs @ $65./hr)		$2,080
SUBTOTAL	$0	$13,780
CONTINGENCY 10%	$0	$1,378
LEGAL & ADMINISTRATIVE 5%	$0	$69
TOTAL	$0	$15,227

TABLE 4–2 (CONT'D)
REMEDIAL ACTIVITIES

G. IMPERMEABLE BARRIER / 6NYCRR PART 360 CAP	ESTIMATED COSTS CAPITAL	O&M
SITE REGRADING		
–CUT – 100,000 CY @ $9/CY	$900,000	
–RELOCATE – 175,000 CY @ 17/CY	$2,975,000	
–FILL – 175,000 CY @ $10./CY	$1,750,000	
–LOAM & SEED – 10 AC	$186,333	
SEDIMENTATION BASIN		
–2 @ $25,000 ea	$50,000	
–CLEANOUT		$5,000
NYCRR PART 360 LANDFILL CAP– 70 ACRES		
–6" TOPSOIL @ $20./CY	$1,129,333	
–24" BARRIER PROTECTION @ $10./CY	$2,258,667	
–40 MIL GEOMEMBRANE LINER @ $0.75/SQFT	$2,286,900	
–FILTER FABRIC @ $0.15/SQFT	$457,380	
–12" GAS VENT LAYER @ $16./CY	$1,806,933	
–GAS COLLECTION AND FLARING @ $15,000/ACRE	$1,050,000	$5,000
–HYDRO–SEED @ $2500./ACRE	$175,000	
–DRAINAGE DITCH @ $20./FT 100 FT/ACRE	$140,000	
–SITE IMPROVEMENT @ $2500./ACRE	$175,000	
–ASPHALT PAVING OF OLD BORROW PIT AREA @ $8./SQYD	$35,556	
–MOWING		$5,000
–DRAINAGE CLEANOUT		$5,000
–INSPECTION		$25,000
SUBTOTAL	$15,376,102	$45,000
ENGINEERING & CONTINGENCY 30%	$4,612,831	$13,500
LEGAL & ADMINISTRATIVE 5%	$768,805	$675
TOTAL	$20,757,738	$59,175
AVERAGE CAPPING COST/ACRE (does not include site regrading or sedimentation basin)	$135,925	$571

TABLE 4-2 (CONT'D)
REMEDIAL ACTIVITIES

G2. IMPERMEABLE BARRIER / 360 WITH DRAINAGE NET	ESTIMATED COSTS CAPITAL	O&M
SITE REGRADING		
-CUT - 100,000 CY @ $9/CY	$900,000	
-RELOCATE - 175,000 CY @ 17/CY	$2,975,000	
-FILL - 175,000 CY @ $10./CY	$1,750,000	
-LOAM & SEED - 10 AC	$186,333	
SEDIMENTATION BASIN		
-2 @ $25,000 ea	$50,000	
-CLEANOUT		$5,000
NYCRR PART 360 LANDFILL CAP-- 70 ACRES		
-6" TOPSOIL @ $20./CY	$1,129,333	
-24" BARRIER PROTECTION @ $10./CY	$2,258,667	
-FILTER FABRIC @ $0.15/SQFT	$457,380	
-DRAINAGE NET @ $0.25/SQFT	$762,300	
-40 MIL GEOMEMBRANE LINER @ $0.75/SQFT	$2,286,900	
-FILTER FABRIC @ $0.15/SQFT	$457,380	
-12" GAS VENT LAYER @ $16./CY	$1,806,933	
-GAS COLLECTION AND FLARING @ $15,000/ACRE	$1,050,000	$5,000
-HYDRO-SEED @ $2500./ACRE	$175,000	
-DRAINAGE DITCH @ $20./FT 100 FT/ACRE	$140,000	
-SITE IMPROVEMENT @ $2500./ACRE	$175,000	
-ASPHALT PAVING OF OLD BORROW PIT AREA @ $8./SQYD	$35,556	
-MOWING		$5,000
-DRAINAGE CLEANOUT		$5,000
-INSPECTION		$25,000
SUBTOTAL	$16,595,782	$45,000
ENGINEERING & CONTINGENCY 30%	$4,978,735	$13,500
LEGAL & ADMINISTRATIVE 5%	$829,789	$675
TOTAL	$22,404,306	$59,175
AVERAGE CAPPING COST/ACRE (does not include site regrading or sedimentation basin)	$153,349	$571

TABLE 4-2 (CONT'D)
REMEDIAL ACTIVITIES

H. IMPERMEABLE BARRIER / RCRA MULTIMEDIA CAP	ESTIMATED COSTS CAPITAL	O&M
SITE REGRADING		
-CUT - 100,000 CY @ $9/CY	$900,000	
-RELOCATE - 175,000 CY @ 17/CY	$2,975,000	
-FILL - 175,000 CY @ $10./CY	$1,750,000	
-LOAM & SEED - 10 AC	$186,333	
SEDIMENTATION BASIN		
-2 @ $25,000 ea	$50,000	
-CLEANOUT		$5,000
RCRA MULTIMEDIA LANDFILL CAP- 70 ACRES		
-6" TOPSOIL @ $20./CY	$1,129,333	
-18" COVER SOIL @ $10./CY	$1,694,000	
-12" DRAINAGE LAYER @ $10./CY	$1,129,333	
-24" LOW PERMEABILITY (1E-7) BARRIER @ $20./CY	$4,517,333	
-40 MIL FML @ $0.75/SQFT	$2,286,900	
-FILTER FABRIC @ $0.15/SQFT	$914,760	
-GAS VENT LAYER @ $16./CY	$1,806,933	
-GAS COLLECTION AND FLARING @ $15,000/ACRE	$1,050,000	$5,000
-HYDRO-SEED @ $2500./ACRE	$175,000	
-DRAINAGE DITCH @ $20./FT 100 FT/ACRE	$140,000	
-SITE IMPROVEMENT @ $2500./ACRE	$175,000	
-ASPHALT PAVING OF OLD BORROW PIT AREA @ $8./SQYD	$35,556	
-MOWING		$5,000
-DRAINAGE CLEANOUT		$5,000
-INSPECTION		$25,000
SUBTOTAL	$20,915,482	$45,000
ENGINEERING & CONTINGENCY 30%	$6,274,645	$13,500
LEGAL & ADMINISTRATIVE 5%	$1,045,774	$675
TOTAL	$28,235,901	$59,175
AVERAGE CAPPING COST/ACRE (does not include site regrading or sedimentation basin)	$215,059	$571

TABLE 4-2 (CONT'D)
REMEDIAL ACTIVITIES

I. IMPERMEABLE BARRIER / RCRA SUBTITLE D (SOIL) CAP	ESTIMATED COSTS CAPITAL	O&M
SITE REGRADING		
-CUT - 100,000 CY @ $9/CY	$900,000	
-RELOCATE - 175,000 CY @ 17/CY	$2,975,000	
-FILL - 175,000 CY @ $10./CY	$1,750,000	
-LOAM & SEED - 10 AC	$186,333	
SEDIMENTATION BASIN		
-2 @ $25,000 ea	$50,000	
-CLEANOUT		$5,000
RCRA SUBTITLE D LANDFILL CAP- 70 ACRES		
-6" TOPSOIL @ $20./CY	$1,129,333	
-18" LOW PERMEABILITY (1E-5) BARRIER @ $15./CY	$2,541,000	
-FILTER FABRIC @ $0.15/SQFT	$457,380	
-12" GAS VENT LAYER @ $16./CY	$1,806,933	
-GAS COLLECTION AND FLARING @ $15,000/ACRE	$1,050,000	$5,000
-HYDRO-SEED @ $2500./ACRE	$175,000	
-DRAINAGE DITCH @ $20./FT 100 FT/ACRE	$140,000	
-SITE IMPROVEMENT @ $5000./ACRE	$35,000	
-ASPHALT PAVING OF OLD BORROW PIT AREA @ $8./SQYD	$35,556	
-MOWING		$5,000
-DRAINAGE CLEANOUT		$5,000
-INSPECTION		$25,000
SUBTOTAL	$13,231,536	$45,000
ENGINEERING & CONTINGENCY 30%	$3,969,461	$13,500
LEGAL & ADMINISTRATIVE 5%	$661,577	$675
TOTAL	$17,862,573	$59,175
AVERAGE CAPPING COST/ACRE (does not include site regrading or sedimentation basin)	$105,289	$571

TABLE 4-2 (CONT'D)
REMEDIAL ACTIVITIES

J. GROUNDWATER PUMP AND TREAT			ESTIMATED COSTS CAPITAL	O&M
GROUNDWATER COLLECTION				
2- WELLS, 8" GRAVEL PACKED TO 30 FEET @ $20,000			$40,000	
2- PUMPS @ $5,000			$10,000	
FLOW EQUALIZATION BASIN (1 day detention)			$180,000	
GROUNDWATER TREATMENT EQUIPMENT Costs include construction estimates @ 50% of equipment cost & estimated cost of $1,000,000. to house treatment works (5000 SF @ $200./ SF).				
ACTIVATED SLUDGE SYSTEM L & T TECHNOLOGIES, INC.	CAPITAL	O & M		
WWTP DISCHARGE	$1,975,000	$620,000		
SURFACE WATER DISCHARGE	$3,347,500	$650,000		
BIOTOWER SYSTEM U.S. FILTER, INC.	CAPITAL	O & M		
WWTP DISCHARGE	$2,455,000	$1,186,250		
SURFACE WATER DISCHARGE	NB	NB		
PHYSICAL TREATMENT SIMON-WTS, INC.	CAPITAL	O & M		
WWTP DISCHARGE	$2,087,500	$372,900		
SURFACE WATER DISCHARGE	$5,072,500	$563,200		
AVERAGE GROUNDWATER TREATMENT EQUIPMENT COST (does not include discharge costs/fees)				
WWTP			$2,172,500	$726,383
SURFACE WATER			$4,210,000	$606,600
SUBTOTAL				
WWTP			$2,402,500	$726,383
SURFACE WATER			$4,440,000	$606,600
ENGINEERING & CONTINGENCY 30%				
WWTP			$720,750	$217,915
SURFACE WATER			$1,332,000	$181,980
LEGAL & ADMINISTRATIVE 5%				
WWTP			$120,125	$36,319
SURFACE WATER			$222,000	$30,330
TOTAL				
WWTP			$3,243,375	$980,618
SURFACE WATER			$5,994,000	$818,910

TABLE 4–2 (CONT'D)
REMEDIAL ACTIVITIES

K. TREATED DISCHARGE	ESTIMATED COSTS CAPITAL	O&M
SURFACE WATER DISCHARGE		
OUTFALL	$5,000	
SUBTOTAL	$5,000	$0
ENGINEERING & CONTINGENCY 30%	$1,500	$0
LEGAL & ADMINISTRATIVE 5%	$250	$0
TOTAL – SURFACE WATER DISCHARGE	$6,750	$0
WWTP DISCHARGE		
SEWER LINE – 7,000 FEET @ $65./ FOOT	$455,000	
PUMP STATION	$40,000	
USER FEES @ $750./DAY (Worst case with treatment to meet minimum discharge standards.)		$275,000
SUBTOTAL	$495,000	$275,000
ENGINEERING & CONTINGENCY 30%	$148,500	$82,500
LEGAL & ADMINISTRATIVE 5%	$24,750	$4,125
TOTAL – WWTP DISCHARGE	$668,250	$361,625

SECTION 5.0
SUMMARY AND COMPARISON OF ALTERNATIVES

5.1 INTRODUCTION

This Section, while not required by the CERCLA guidance document, compares the advantages and disadvantages of all alternatives by considering the balance between protection of human health and environment and cost. The four alternatives are compared with respect to short-term effectiveness, long-term effectiveness, reduction of toxicity, mobility and volume, implementability, administrative feasibility, compliance with ARARs, overall protection of human health and the environment and cost. A summary comparison of the alternatives is included in Table 5-1 at the end of this Section.

5.2 DESCRIPTION OF ALTERNATIVES

Alternative No. 1 involves monitoring of the site and a program of public awareness. Consideration of this alternative is required by CERCLA and does not proactively reduce any of the risks associated with the landfill. It also fails to meet any of the remedial action objectives set for the site.

Alternative No. 2 consists of site monitoring, a public awareness program, site access restrictions, and installation of a City water main to provide City water to private residences impacted by the landfill. This alternative offers a reduction in risk to human health through water supply replacement.

Alternative No. 3 involves site monitoring, a public awareness program, implementation of site access restrictions, the installation of a City water main, and construction of a 6NYCRR Part 360 landfill cap. This alternative reduces risk to human health through replacement of downgradient public water supplies with City water and reduces environmental impacts by reducing groundwater and surface water contamination through capping.

Alternative No. 4 includes the technologies included under Alternative No. 3 with additional groundwater contaminant reduction provided by a groundwater pump and treat system. This system will limit any remaining contaminant plume migration off-site by pumping groundwater from the downgradient side of the landfill, treating it to remove contaminants and then discharging it to either the City wastewater treatment plant or a nearby surface water body.

At this point in the Feasibility Study evaluation, both discharge options, WWTP and surface water, have been retained due to the fact that neither is clearly a preferred alternative. To determine which discharge option will be appropriate for the groundwater pump and treatment system, several factors should be considered. The first is cost. Based on budgetary quotations received from equipment vendors, the present net worth of the WWTP treatment option exceeds that of the surface water option by approximately $6 million or about 40% as indicated in Table 5-2. While the WWTP treatment process requires less equipment, the associated user fees offset the higher capital and O&M costs of treatment to surface water discharge standards.

TABLE 5-2

COST COMPARISON OF SURFACE WATER VS. WWTP DISCHARGE[1]

Discharge Alternative	Capital	O&M	Present Worth
WWTP	$3,912,000	$1,342,000	$20,568,000
Surface Water	$6,001,000	$819,000	$16,163,000

NOTES: 1. Sum of treatment facility and discharge costs.

The second is protection of human health and the environment. Both options are reliable methods of discharging treated effluent from the landfill site. Discharge to the WWTP has no adverse impacts on human health and the environment, while the surface water option impacts the environment through an addition to the flow of Anthony Creek. There are not expected to be any adverse human health impacts associated with surface water discharge.

Another consideration, and a major drawback to the WWTP option, is the fact that the discharge of treated landfill leachate will present a significant increase in wastewater load to the Gloversville/Johnstown wastewater treatment facility in terms of both flow (0.22 MGD) and nitrogen and solids loading. This new load would increase the total plant influent load to a point where it might not be possible to allow new industries to tie into the existing sewer system. This would limit the ability of the Gloversville/Johnstown area to attract new industry, or necessitate an enlargement of the existing treatment plant.

Because of the costs and impact levels associated with the two options, and the additional negative impacts of WWTP discharge, which outweigh the flow and operational impacts of a plant to treat to surface water standards, it is recommended that the surface water option be chosen over the WWTP discharge option. This will eliminate dependence and loading demands on the Gloversville/Johnstown WWTP as well as provide an option with a lower present worth.

5.3 SHORT-TERM EFFECTIVENESS

The four alternatives offer varying degrees of short-term effectiveness. Alternative Nos. 1 and 2 will impact the surrounding community the least, with Alternatives Nos. 3 and 4 impacting the community the most during installation of a landfill cap. Capping impacts will include exposure to nuisance odors during cut and fill and regrading as well as dust produced by regrading and cap construction. Protection of site workers will be most critical during cut and fill operations related to capping in Alternatives Nos. 3 and 4. The construction of the landfill cap will also generate a substantial amount of truck traffic related to importing soil borrow material.

Environmental impacts are minimal if Alternative Nos. 1 or 2 are implemented. Alternative No. 3 and 4 will potentially impact the environment through runoff generated during site regrading operations as well as cap construction. In addition, when completed, the two capping alternatives will discharge all runoff from the 80-acre site to Anthony Creek after passing through a sedimentation basin. The treated groundwater discharged under Alternative No. 4 will also impart an additional 150 gpm flow to

Anthony Creek. These impacts to the creek will be flow related as opposed to contaminant related.

Time to meet the remedial response objectives varies. Alternative No. 1 does not propose to meet any remedial response objectives. Alternative No. 2 will require an estimated 18 to 24 months and Alternative Nos. 3 and 4 will require 24 to 36 months due to the extensive capping required.

5.4 LONG-TERM EFFECTIVENESS

All four alternatives leave the waste mass and its associated risks in place. Alternative No. 1 does not attempt to alter the magnitude of risk remaining at the site. Alternative No. 2 limits contact with waste through site access restrictions. Alternative Nos. 3 and 4 limit contact with the waste through landfill capping. In addition, Alternative Nos. 3 and 4 reduce the risk associated with surface water contact by reducing surface water contaminant concentrations through a reduction in leachate production. Alternative No. 3 will provide a gradual reduction of contaminants released from the site, whereas Alternative No. 4 will provide a faster, more positive reduction of contaminants.

Alternative Nos. 1, 2 and 3 do not treat surface water or groundwater and therefore, do not produce any treatment residuals. Alternative No. 4 produces treatment residuals in the form of waste sludge from metals precipitation and biological processes. This sludge will only be temporarily stored on site and will be properly disposed of off-site as required.

Alternative Nos. 2, 3 and 4 all eliminate the human health risks associated with private well water consumption through installation of a City water main.

5.5 REDUCTION OF TOXICITY, MOBILITY AND VOLUME

Alternative Nos. 1 and 2 do not proactively reduce the toxicity, mobility or volume of contaminants at the landfill site; any reductions will result from natural decomposition of the waste. Alternative No. 3 reduces the mobility of contaminants in the landfill by limiting percolation of precipitation through the waste mass, but does not proactively reduce the toxicity or volume of waste. Alternative No. 4 limits contaminant mobility as in Alternative No. 3 and, in addition, reduces the volume and greatly limits the mobility of contaminants in the subsurface through pumping and treatment of contaminated groundwater.

5.6 IMPLEMENTABILITY

The implementability of each Alternative is divided into technical and administrative portions. Alternative No. 1 involves sampling, reports and meetings. Alternative No. 2 contains these items plus construction of a City water main. Administratively, the supply of municipal water to residences outside City limits is somewhat complicated. The Gloversville Water Board, which is independent of City government, has adopted resolutions that require annexation of any lands to which water service is extended. These administrative concerns also apply to Alternates No. 3 and 4. All of these items utilize proven technologies and can be readily implemented with several sources available for each item.

Alternative No. 3 (an impermeable barrier) can be implemented without technical difficulty using proven reliable technologies. There will be some difficulties associated with the magnitude (70 acres) of the capping operation, but construction techniques and materials remain the same as with smaller capping operations. The affordability of this option is dependent on recoveries from PRP's. In the absence of substantial PRP recoveries, the City would be unable to bond for their 25% share of this alternative.

Alternative No. 4 is technically and administratively the most difficult to implement. It contains all the items of the other alternatives and, in addition, requires construction and operation of a 0.22 mgd groundwater treatment plant. While package plants of this size are not technically difficult to construct or operate, it is a significant step above the other alternatives in terms of operations and maintenance requirements. Administratively, Alternative No. 4 is more difficult than the other three due to the fact that a permit must be obtained for the discharge of treated groundwater to Anthony Creek. Alternative No. 4 is not implementable due to excessive costs. Not only would the City be unable to bond for their portion of the capital costs, but operational costs of about $1,000,000/year would either require legislative approval to raise tax rates or require cutting essential City services.

5.7 COMPLIANCE WITH ARARs

Alternative No. 1 does not provide compliance with any of the ARARs. Alternative No. 2 provides a new uncontaminated source of drinking water to affected private residences, thereby complying with the chemical specific ARARs.

Alternative Nos. 3 and 4 both provide a landfill cap. These two alternatives attempt to meet chemical specific ARARs for groundwater and surface water through a reduction in leachate generation and, thus, groundwater contamination. Preliminary estimates of contaminant concentrations calculated through the use of groundwater models suggest that compliance with ARARs will be approached after three flushings of the aquifer which is expected to take a minimum of 11 years. The groundwater pump and treat system of Alternative No. 4 should shorten this time frame.

5.8 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative No. 1 does not attempt to add any levels of protection for the conditions already existing at the site. The no action alternative only monitors the status of site conditions. Alternative No. 2 protects human health by eliminating the major human health risk, private drinking water wells. In addition, Alternative No. 2 imposes site restrictions to limit access to the site and potential contact with wastes.

Alternative Nos. 3 and 4 both involve capping of the landfill. A cap will serve two purposes. First it will serve to contain the wastes, eliminating accidental contact. Second, and most importantly, it will serve to reduce percolation of precipitation through the landfill and subsequent leachate generation. It will also lower the water table to below the bottom of the waste mass. This will essentially eliminate the bulk of further groundwater contamination. Alternative Nos. 3 and 4 also include the installation of a City water main as in Alternative No. 2, which will eliminate risk to human health through the ingestion of contaminated drinking water. Alternative No. 4 also eliminates the bulk of further contaminant plume migration and its associated risks by installing a pump and treat system to intercept the plume before it flows off site.

5.9 COSTS

The costs associated with each Alternative are divided into Capital, O&M, and Present Worth costs and are presented in Table 5-3. These costs are presented in Section 4.

TABLE 5-3

SUMMARY OF COSTS

	ALTERNATIVE NO.			
	1	2	3	4
Capital	$190,000	$3,550,000	$25,950,000	$31,950,000
O&M	$229,000	$134,000	$193,000	$1,012,000
Present Worth	$3,030,000	$5,210,000	$28,340,000	$44,510,000

Table 5-3 shows that the present worth costs of the Alternatives cover a wide range of values, from $3 million for Alternative No. 1 to $44.5 million for Alternative No. 4. The different costs offer varying degrees of protection of both human health and the environment.

The present worth of Alternative No. 1 is primarily O&M based, Alternative Nos. 2 and 4 are mostly capital based, and Alternative No. 3 is almost exclusively capital based. Detailed cost breakdowns for each Alternative are presented in Tables 4-1 and 4-2, located at the end of Section 4.

TABLE 5–1
SUMMARY OF ALTERNATIVES

	ALTERNATIVE No. 1 No Action	ALTERNATIVE No. 2 Water Main	ALTERNATIVE No. 3 Water Main, Impermeable Barrier	ALTERNATIVE No. 4 Water Main, Barrier, P & T
SHORT–TERM EFFECTIVENESS				
–PROTECTION OF SURROUNDING COMMUNITY	Little construction involved, no adverse construction impacts on surrounding community	Only impacts are those associated with water main installation	Odors and dust generated during capping	Odors and dust generated during capping
–PROTECTION OF SITE WORKERS	No adverse impacts on site workers	Basic construction involved in water main installation, no adverse impacts on site workers	Requires Health & Safety Plan when excavating waste mass	Requires Health & Safety Plan when excavating waste mass
–RELIABILITY OF PROTECTION MEASURES	Protection measures not required	Protection measures not required	Reliable, proven measures required	Reliable, proven measures required
–ENVIRONMENTAL IMPACTS	Few impacts, only monitoring done	Few impacts, water main installed along street	Possible runoff impacts during construction of cap	Possible runoff impacts during construction of cap
–TIME TO MEET REMEDIAL RESPONSE OBJECTIVES	No response objectives proposed	18–24 months	24–36 months	24–36 months
LONG–TERM EFFECTIVENESS				
–MAGNITUDE OF REMAINING RISK	Same risk as presently at site	Same risk as presently at site; risks to residents reduced by providing City water supply	Same risk as presently at site; contact limited through capping; risks to residents reduced by providing City water supply; reduction in GW, SW contamination	Same risk as presently at site; contact limited through capping; risks to residents reduced by providing City water supply; reduction in GW, SW contamination
–PROTECTION OF UNTREATED CONTAMINANTS LEFT ON SITE	No additional protection implemented	No additional protection implemented	Cap reduces percolation, lowers water table below waste mass	Cap reduces percolation, lowers water table below waste mass
–PROTECTION OF TREATMENT RESIDUALS GENERATED BY REMEDIAL ACTION	No treatment residuals generated	No treatment residuals generated	No treatment residuals generated	Off–site disposal of residuals required
REDUCTION OF TOXICITY, MOBILITY AND VOLUME				
–TREATMENT PROCESSES USED	None	None	None	See Table 4–7
–MATERIALS TREATED	None	None	None	Groundwater; Surface water bodies indirectly
–DEGREE OF REDUCTION EXPECTED	None actively	None actively	Capping reduces mobility of contaminants	High reduction of contaminants in pump and treat capture area; capping reduces mobility of contaminants
–PERMANENCE OF REDUCTION	No active reduction	No active reduction	No active reduction	Contaminants in groundwater treated are permanently removed
–TREATMENT RESIDUALS PRODUCED BY REMEDIAL ACTION	None	None	None	Metals and solids sludge; possibly ammonia salts and concentrated brine
IMPLEMENTABILITY				
– TECHNICAL FEASIBILITY	Very easily implemented	Easily implemented	Readily implemented, proven technologies	Readily implemented, proven technologies, treatment technologies are are packaged systems
–ADMINISTRATIVE FEASIBILITY	Very easily implemented	Easily implemented	Readily implemented, proven technologies	Possible administrative difficulty related to discharge of treated groundwater
–AVAILABILITY OF SERVICES AND MATERIALS	All readily available	All readily available	All readily available	All readily available
PRESENT WORTH COST	$3,030,000	$5,210,000	$28,340,000	$44,510,000
COMPLIANCE WITH ARARs	Does not meet any ARARs	Meets all drinking water ARARs	Meets all drinking water ARARs; attempts to meet groundwater and surface water ARARs through reduction in GW contamination	Meets all drinking water ARARs, attempts to meet groundwater and surface water ARARs through reduction in GW contamination
PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	Does not provide any additional protection over existing conditions	Eliminates risk associated with ingestion and contact with contaminated water through private well use	Eliminates risk associated with ingestion and contact with contaminated water through private well use; minimizes continued groundwater contamination	Eliminates risk associated with ingestion and contact with contaminated water through private well use; minimizes continued groundwater contamination and continued plume migration

L:\G191\COMPALT.WK3

SECTION 6
CONCLUSIONS AND RECOMMENDATIONS

This Feasibility Study presents four potential alternatives to address the conditions present at the Gloversville Municipal Landfill Site. The alternatives were selected to provide a range of options with respect to protecting human health and the environment at varying costs. While selection of the final alternative will be based upon NYSDECs review of this document, a remedial alternative is recommended. Based upon data collected at this site, risk, cost and regulatory requirements, the following recommendation is being made to remediate the Gloversville Municipal Landfill.

Alternative No. 3, installation of a city water main and construction of a landfill cap is the recommended remedial alternative for this site for the following reasons. Alternative No. 1 (no action), while being the least expensive, does not address any of the human health or environmental concerns that were identified in the Phase 1 and 2 Remedial Investigation Reports. It also does not comply with 6NYCRR Part 360 regulations for landfill capping.

Alternative No. 2 addresses human health concerns through water supply replacement and site access restrictions. It does not attempt to alleviate any of the environmental concerns related to groundwater and surface water contamination. This alternative also fails to meet 6NYCRR Part 360 landfill requirements because no cap is involved.

Alternative No. 4 addresses human health concerns through replacement of the present drinking water supply, and addresses environmental concerns through installation of a landfill cap and groundwater pump and treat system. The landfill cap greatly reduces leachate production and dewaters the bottom trash layer by lowering the groundwater table. Groundwater contamination is thus greatly reduced. In addition, the majority of groundwater and contaminants leaving the site are in the overburden. This off-site migration will be eliminated by the pump and treat system for the most part with the exception of migration in bedrock. Bedrock migration of contaminants, although reduced by capping, will not be affected by the groundwater pump and treat system. The additional capital and O&M costs associated with the groundwater pump and treat system are nearly equivalent to the cost of the capping alternative alone, with only a small decrease in negative environmental impact, namely the halting of any remaining plume migration.

Alternative No. 3 incorporates all of the aspects of Alternative No. 4 with the exception of the groundwater pump and treat system. Groundwater flow analyses indicate that capping alone will be sufficient to minimize leachate production and dewater the waste mass to such an extent that contaminant plume generation and migration will be greatly reduced from its present state.

Alternative No. 3 includes extension of the current city water supply to impacted residences surrounding the landfill. This technology will eliminate all potential risks associated with ingestion and/or contact with contaminated private well supplies; the major landfill impact on human health. This large reduction in risk is provided at a relatively minimal cost and high level of reliability when compared with other technologies. By supplying an alternate source of water, all drinking water ARARs will be met upon completion of the water system installation.

Landfill capping is a long-term, proven technology for reducing contaminant loading to groundwater. As mentioned previously, capping greatly reduces leachate protection through elimination of percolation of precipitation through the waste mass. Conservative estimates indicate that leachate production will be reduced by over 90% with implementation of an 6NYCRR Part 360 cap. In addition to leachate reduction, groundwater modelling indicates that a cap of this type will serve to lower the groundwater table below the waste mass. By eliminating saturation of the bottom of the waste mass, groundwater flowing on-site from upgradient locations will receive a decreased contaminant loading through elimination of contact with the waste mass as it flows beneath the landfill. Through these actions, over time, this alternative attempts to meet groundwater ARARs. Based on groundwater modeling calculations the estimated time to flush the overburden and achieve equilibrium is a minimum of 11 years.

By reducing contaminant loading to groundwater, surface water bodies downgradient of the landfill will receive lower contaminant loadings also. Flow nets generated by field data indicate that substantial quantities of groundwater within the overburden layer are discharging into the surface water bodies immediately downgradient of the landfill, specifically Anthony Creek and Pond B. With groundwater contaminant concentrations greatly reduced, accompanied by a reduction in groundwater flow and an increase in clean surface water runoff, contaminant concentrations will be greatly reduced in these water bodies. Through these actions, Alternative No. 3 will attempt to meet surface water ARARs. However, the estimates of future containment loadings and the resultant surface water concentrations indicate that Alternative No. 3 will not meet surface water ARARs until some distance downstream of the site.

The operation and maintenance requirements for Alternative No. 3 are straight forward and involve cap inspections and repairs to insure cap integrity and proper drainage, operation of the gas collection and flaring unit, periodic mowing, and drainage cleanout. No wastes or treatment residuals are produced by this alternative.

In summary, Alternative No. 3 eliminates all current human health risks identified in the Phase 2 RI Risk Assessment and provides a large reduction of negative landfill impacts to the surrounding environment. This alternative utilizes only proven, reliable technologies that are all readily implemented and that have only basic operations and maintenance requirements. The above benefits are provided at a moderate cost considering the large size of the landfill.

G191\REPORT\SEC6.ESH

REFERENCES

(1) Tighe & Bond, Inc., May 1991, "Report on Remedial Investigation/Feasibility Study, Gloversville Municipal Landfill- Draft."

(2) Tighe & Bond, Inc., October 1992, "Remedial Investigation Report, Gloversville Municipal Landfill, Gloversville, New York - Draft."

(3) Title 6, New York Code of Rules and Regulations, Part 257, "New York Ambient Air Quality Standards."

(4) Title 6, New York Code of Rules and Regulations, Part 360, "Solid Waste Management Facilities."

(5) Title 6, New York Code of Rules and Regulations, Part 364, "New York Waste Transport Permit Regulations."

(6) Title 6, New York Code of Rules and Regulations, Part 372, "New York Hazardous Waste Manifest System Regulations."

(7) Title 6, New York Code of Rules and Regulations, Part 662-665, "Freshwater Wetland Regulations."

(8) Title 6, New York Code of Rules and Regulations, Part 703, "Classifications, Surface Waters and Ground Waters."

(9) Title 10, New York Code of Rules and Regulations, Subpart 5-1, "Public Water Supplies."

(10) Title 29, Code of Federal Regulations, Part 1904, Occupational Safety and Health Administration (OSHA) Regulations Pertaining to Labor, "Recording and Reporting occupational injuries and illnesses."

(11) Title 29, Code of Federal Regulations, Part 1910, OSHA Regulations Pertaining to Labor, "Occupational Safety and Health Standards."

(12) Title 29, Code of Federal Regulations, Part 1926, OSHA Regulations Pertaining to Labor, "Safety and Health Regulations for Construction."

(13) Title 33, Code of Federal Regulations, Part 320-330, "Regulatory Program of the Corps of Engineers."

(14) Title 40, Code of Federal Regulations, Part 6, Appendix A, "EPA National Environmental Policy Act Procedures."

(15) Title 40, Code of Federal Regulations, Part 50, "National Ambient Air Quality Standards."

REFERENCES (Cont.)

(16) Title 40, Code of Federal Regulations, Parts 122-123

(17) Title 40, Code of Federal Regulations, Part 141, "EPA National Primary Drinking Water Standards."

(18) Title 40, Code of Federal Regulations, Part 143, "EPA National Secondary Drinking Water Standards."

(19) Title 40, Code of Federal Regulations, Part 261, "EPA Regulations for Identifying Hazardous Wastes."

(20) Title 40, Code of Federal Regulations, Part 264, "Resource Conservation and Recovery Act, Maximum Contaminant Levels."

(21) Title 40, Code of Federal Regulations, Part 268, "RCRA Land Disposal Regulations."

(22) Title 40, Code of Federal Regulations, Part 300 et seq., "National Contingency Plan."

(23) U.S. EPA, March 1988, Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA."

(24) Wehran Engineering, P.C., April 1986, "Engineering Investigations at Inactive Hazardous Waste Sites in the State of New York, Phase I Investigations. Gloversville Landfill, Johnstown, Fulton County, New York, Site Code # 518001."

(25) 16 U.S.C., Section 1271, "Fish and Wildlife Coordination Act."

(26) 33 U.S.C., Section 1251 et seq., "Federal Water Pollution Control Act." (also known as the Clean Water Act).

(27) 42 U.S.C., Section 300f et seq., "Safe Drinking Water Act."

(28) 42 U.S.C., Section 7401 et seq., "Clean Air Act."

(29) 42 U.S.C., Section 9601 et seq., "Comprehensive Environmental Response, Compensation and Liability Act."

(30) 42 U.S.C., Section 9601 et seq., as amended by PL 99-499, "Superfund Amendment and Reauthorization Act."

APPENDIX A

HELP MODEL OUTPUT

Revised
HELP Output

****
****

GLOVERSVILLE, NEW YORK
NETRAIN.OUT
MAY 11, 1993

****
****

FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1157 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001100999885 CM/SEC

LAYER 2

LATERAL DRAINAGE LAYER

THICKNESS	=	2.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0454 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	2.230000019073 CM/SEC
SLOPE	=	4.00 PERCENT
DRAINAGE LENGTH	=	400.0 FEET

LAYER 3

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.4800 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC
LINER LEAKAGE FRACTION	=	0.00010000

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1309 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	79.01
TOTAL AREA OF COVER	=	3360000. SQ FT
EVAPORATIVE ZONE DEPTH	=	20.00 INCHES
UPPER LIMIT VEG. STORAGE	=	3.6120 INCHES
INITIAL VEG. STORAGE	=	1.4828 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	9.2936 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR ALBANY NEW YORK

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	137
END OF GROWING SEASON (JULIAN DATE)	=	278

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.10	23.40	33.80	46.60	57.50	66.70
71.40	69.20	61.20	50.50	39.30	26.50

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						

TOTALS	3.30	2.36	3.46	2.74	3.11	3.99
	4.15	4.25	4.22	3.99	2.78	2.81
STD. DEVIATIONS	1.95	0.98	1.48	0.82	1.15	1.00
	1.88	1.21	1.97	1.85	1.64	1.01

RUNOFF

TOTALS	0.021	0.003	0.037	0.019	0.001	0.027
	0.039	0.023	0.041	0.168	0.000	0.000
STD. DEVIATIONS	0.046	0.007	0.081	0.024	0.002	0.061
	0.048	0.037	0.077	0.254	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	0.486	0.840	1.623	1.932	2.454	3.125
	3.110	3.077	2.727	1.787	1.142	0.629
STD. DEVIATIONS	0.120	0.261	0.150	0.363	1.018	0.422
	1.339	0.355	0.434	0.289	0.133	0.205

LATERAL DRAINAGE FROM LAYER 2

TOTALS	1.7345	2.0035	2.7045	1.1708	0.5697	0.4426
	1.3277	0.8949	1.5578	1.9677	1.3170	1.3341
STD. DEVIATIONS	1.3550	0.9927	1.7100	0.7925	0.3117	0.4568
	0.8421	0.9081	1.3400	1.4312	1.0858	1.5902

PERCOLATION FROM LAYER 3

TOTALS	0.1004	0.0818	0.0810	0.0281	0.0135	0.0104
	0.0106	0.0088	0.0255	0.0655	0.0566	0.0774
STD. DEVIATIONS	0.0049	0.0117	0.0268	0.0100	0.0106	0.0071
	0.0088	0.0044	0.0126	0.0211	0.0252	0.0359

PERCOLATION FROM LAYER 4

TOTALS	0.0426	0.0474	0.0579	0.0536	0.0448	0.0365
	0.0322	0.0285	0.0253	0.0290	0.0333	0.0398
STD. DEVIATIONS	0.0260	0.0269	0.0293	0.0248	0.0191	0.0148
	0.0123	0.0104	0.0085	0.0097	0.0110	0.0133

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	41.16	(5.315)	11525921.	100.00
RUNOFF	0.379	(0.279)	106107.	0.92
EVAPOTRANSPIRATION	22.934	(1.526)	6421439.	55.71
LATERAL DRAINAGE FROM LAYER 2	17.0247	(4.7481)	4766929.	41.36
PERCOLATION FROM LAYER 3	0.5596	(0.0832)	156693.	1.36

PERCOLATION FROM LAYER 4	0.4710	(0.1920)	131877.	1.14
CHANGE IN WATER STORAGE	0.356	(1.451)	99567.	0.86

****

****

PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.45	686000.0
RUNOFF	0.437	122492.6
LATERAL DRAINAGE FROM LAYER 2	1.3499	377963.6
PERCOLATION FROM LAYER 3	0.0037	1037.3
HEAD ON LAYER 3	1.3	
PERCOLATION FROM LAYER 4	0.0028	771.3
SNOW WATER	3.33	933480.1

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3776
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0884

****

****

FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	1.58	0.2635
2	0.13	0.0662
3	6.24	0.5200
4	2.01	0.1678
SNOW WATER	1.10	

****
****