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Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Report

Feasibility Study
Farwell Landfill
Cattaraugus County, New York

October 1999

Recycled Paper

DP

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February 23, 2000

Mr. David Locey
Environmental Engineer
NYSDEC Region 9
270 Michigan Avenue
Buffalo, NY 14203-2999

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Re: Farwell Landfill Site #905024
Cattaraugus County
S&W No 90180.0

Dear Mr. Locey:

We have received the Department's comments regarding the Remedial Investigation/Feasibility Study (RI/FS) Reports for the Farwell Landfill site. The following are our responses to each of your comments, presented in the same order as your February 17, 2000 letter.

I. GENERAL

1. Comment: The assumption that Ischua Creek is a long term hydraulic barrier should be subject to further verification, following the selection of a site remedy.

Response: Further verification can be provided following the selection of a site remedy. We remain confident that the creek's hydraulic influence can be verified.

2. Comment: NYSDEC reiterates that the issue of whether the groundwater below the site is either a principal or primary aquifer is not entirely relevant to site remediation. In any case, the groundwater beneath the site is a natural resource.

Response: Noted.

II. REMEDIAL INVESTIGATION REPORT

1. Comment: The background section (Section 1.1) of the RI Report should address the following:

- Were the three landfill areas isolated from each other in any manner during construction or closure?
- Was waste disposed of below the water table?

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The three landfill areas should be marked on the site map (Figure 1-2), and a figure added to show the layout of the existing leachate collection system.

Response: The landfills were generally not isolated during construction or closure, although a number of features are in place which provide some degree of separation between the Phase I, II and III areas. For example, the liner of the Phase III B area, adjacent to the Phase I and II area, runs approximately 10 feet up the side slope of Phase I and II. Further, a french drain is in place along the base of the Phase I and II slope.

It is believed that wastes were generally deposited above the water table, although it cannot be completely ruled out that some groundwater may have contacted the waste, particularly towards the center of the landfill footprint where there may have been some mounding of groundwater during its active life. In general, groundwater contact with waste is thought to be very limited. The attached Figure 1-2 identifies the Phase I, II and III areas. County figures showing the layout of the existing leachate collection system were forwarded previously

2. Comment: The risk assessment doesn't discuss the current water usage from the site's well (toilet, sink, and washing vehicles). The current usage may represent a complete exposure pathway, and perhaps the well should be taken out of service entirely.

Response: The potential exposure from the current water use patterns is considered to be very small, based on the general infrequency that water is actually used by the small group of County employees that have access to the site. Since no single individual typically spends more than a few hours a week at the site, there is only a limited exposure opportunity. Of the exposure scenarios posed above, washing vehicles is probably the most routine site water use. However, this would only occur once each day, on the average, as vehicles are rinsed with cold water. Considering the rather limited on-site water use and the limited site access to a small group of employees, taking the well out of service is unlikely to produce a significant risk reduction.

3. Comment: Figure 3-11, Water Well Survey Results, should be made easier to read, to clearly show which properties were given surveys and those who responded.

Response: This figure was revised as requested, and forwarded to you previously.

4. Comment: Figure 4-1 should not include wells that were not sampled as part of this RI.

Response: A revised Figure 4-1 is attached.

5. Comment: The first and second pages of Table 4-2 should be labeled "Total (Unfiltered)" and "Dissolved (Filtered)", respectively.

Response: A revised table is attached.

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6. Comment: Table 4-8 (VOCs in Sediment) does not include the methylene chloride and acetone (qualified as blank contaminants) for samples KW-1, LFP-1, and RRP-1. The table should include a footnote defining the "B" qualifier. The Appendix does not include the VOC results (I Forms) for samples DW-1 and FW-1, or the chain of custody forms.

Response: Methylene chloride and acetone were purposely not included on Table 4-8 for those three samples because data validation determined that those compounds should be considered below detection levels. In general, the data summary tables included in Volume I of the RI report reflected the outcome of the data validation, so that any results that were flagged "U" by the validation process were considered non-detects.

The attached Table 4-8 has been revised to include a definition of the "B" qualifier. We will pull the I Forms and Chains of Custody from our files and provide them under separate cover.

7. Comment: Table 4-8 is incorrectly referenced in the text (Page 4-6) as Table 4-7, and concentrations are incorrectly described in the text as ppm (they should be ppb).

Response: Noted.

8. Comment: Page 5-7 cites a groundwater flow velocity of 1 foot per day, whereas in Section 3 and Table 3-2 the geometric mean velocity is considerably less.

Response: The velocity of 1 foot per day was intended to be a conservative estimate, in view of the possibility that specific overburden units might transmit water at a rate somewhat higher than the geometric mean, which was only 0.1 to 0.2 feet per day.

III. FEASIBILITY STUDY REPORT

1. Comment: Page 4-4, Section 4.2 discusses capping options only for Phases I and II of the landfill. However, NYSDEC maintains that the three areas of the landfill may not be entirely isolated from one another beneath the existing cap. Even if there was isolation of the three areas, NYSDEC would expect that the Phase III cap would need to be properly maintained. The Proposed Remedial Action Plan (PRAP) therefore includes repairs to the existing cap over the entire landfill area.

Response: The County is agreeable to a maintenance and repair program for the Phase III area cap.

2. Comment: The report mistakenly refers to itself as a "preliminary" FS (Pages 1-1, 3-1).

Response: Noted. The report should be considered a final FS.

3. Comment: It is incorrectly stated that one of the objectives of the FS was to determine the nature of the source within the landfill. This was actually an objective of the RI.

Response: Noted.

4. Comment: It is stated that a thorny shrub perimeter would restrict access to the two landfill ponds on site, when there is in fact only one landfill pond. In any case, the RI Report states that the pond was not significantly affected so there is no concern for public exposure to it. It is assumed that the shrub barrier is intended primarily to protect the landfill cap from damage by trespassers.

Response: You are correct that there is only one true landfill pond, that it is not significantly impacted, and that the shrub barrier's primary function is to protect the cap.

5. Comment: On Table 2-1 note that the revised groundwater standard for benzene is 1.0 micrograms per liter.

Response: Noted.

If the responses expressed in this letter, along with the attached revised tables and figures, are acceptable to the Department the letter and attachments can be appended to the previously submitted reports. Those reports, along with this letter and attachments, would then be considered final documents for inclusion in the established document repositories.

If you have any further questions please feel free to call.

Very truly yours,

Daniel P. Ours, C.P.G.
Project Hydrogeologist

DPO/mef

Attachment

cc: Doug Baldwin, Cattaraugus County
David Rivet, Cattaraugus County
Craig Slater, Esq. Harter, Secrest, & Emery
Paul McGarvey, Stearns & Wheler

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Table 4-2
Total (Unfiltered) Metals In Surface Water
Farwell Landfill Remedial Investigation
Cattaraugus County, New York

		SAMPLE LOCATION					
	SW Std.*	Upstream	Adjacent	Downstream	Landfill pond	Railrd pond	Leachate
Total (ug/l))	ug/l	DW-1A	FW-1A	KW-1A	LFP-1A	RRP-1A	L-1
Aluminum	100	139	340	126	27.6	20400	34.1
Antimony	3 G	U	U	U	U	9.8 B	U
Arsenic	50	U	U	U	3.4	23.4	7
Barium	1000	68.8	73.2	64.8	19.6	550	455
Beryllium	3 G	U	U	U	U	3 B	U
Cadmium	10	U	U	U	U	2 B	1.7
Calcium	NA	50600	49700	48800	18200	108000	94700
Chromium	50	U	U	U	U	36.8	4.9
Cobalt	5	U	U	U	U	18.4 B	4.6
Copper	200	U	U	2.6	U	52.5	2.2
Iron	300	346	660	221	278	40200	10500
Lead	50	UJ	U	UN	UN	48.2 N	UN
Magnesium	35000	8370	8270	8260	2560	33400	88600
Manganese	300	44.8	53.6	22.5	65.6	4160	693
Mercury	2	U	U	U	U	U	U
Nickel	NA	U	U	U	U	39.3 B	23.2
Potassium	NA	1310	1330	1140	973	5500	251000
Selenium	10	U	U	U	U	3.5 B	U
Silver	50	U	U	U	U	U	U
Sodium	NA	16600	16100	14600	698	10900	233000
Thallium	4 G	U	U	UJ	UJ	U	UJ
Vanadium	14	U	U	U	U	29 B	U
Zinc	300	13.4	14	102 J	23.4 J	306	35.3 J

L-1 = leachate   KW-1A = Kent Road   LFP = Landfill Pond   U = undetected
FW-1A = Farwell Rd.   DW-1A = Dutch Hill Road   RRP = Railroad Pond   J = estimated value

*Standards persuant to 6 NYCRR Part 702

Table 4-2
Dissolved (Filtered) Metals in Surface Water
Farwell Landfill Remedial Investigation
Cattaraugus County, New York

	SW Std.*	SAMPLE LOCATION					
		Upstream	Adjacent	Downstream	Landfill pond	Railrd pond	Leachate
Dissolved	ug/l	DW-1A	FW-1A	KW-1A	LFP-1A	RRP-1A	L-1
Aluminum	100	U	NA	U	U	U	U
Antimony	3 G	U	NA	U	U	5.5	6.9
Arsenic	50	U	NA	U	U	4.9	U
Barium	1000	69.2	NA	63	19.5	174	362
Beryllium	3 G	U	NA	U	U	U	U
Cadmium	10	U	NA	U	1	1.3	1.6 J
Calcium	NA	49300	NA	49200	18600	66500	95600
Chromium	50	U	NA	U	U	U	3.7
Cobalt	5	U	NA	U	8.1	U	10.7
Copper	200	U	NA	U	U	U	U
Iron	300	288	NA	27.3	123	248	385
Lead	50	U	NA	U	U	U	U
Magnesium	35000	8240	NA	8330	2610	27700	89600
Manganese	300	43.4	NA	14.9	31.9	1380	691
Mercury	2	U	NA	U	U	U	U
Nickel	NA	U	NA	U	U	U	24.2
Potassium	NA	1250	NA	1160 B	954	3170	257000
Selenium	10	U	NA	UJ	UJ	UJ	UJ
Silver	50	U	NA	U	U	U	U
Sodium	NA	14400	NA	14800	708	10600	174000
Thallium	4 G	U	NA	UJ	UJ	UJ	UJ
Vanadium	14	U	NA	U	U	U	U
Zinc	300	21.5	NA	19.1 J	36.6 J	17.6 J	38.8

NA - Filtered sample not collected

L-1 = leachate　KW-1A = Kent Road　LFP = Landfill Pond　U = undetected

FW-1A = Farwell Rd.　DW-1A = Dutch Hill Road　RRP = Railroad Pond　J = estimated value

*Standards persuant to 6 NYCRR Part 702

Table 4-8
Volatile Organic Compounds In Sediment
Farwell Landfill Remedial Investigation
Cattaraugus County, New York

	LOCATION									
	Upstream		Adjacent		Downstream		Landfill pond		Railrd pond	
Analyte (ug/kg)	DW-1		FW-1		KW-1		LFP-1		RRP-1	
Chloromethane		U		U		U		UJ		U
Bromomethane	0.5	J		U		U		U		U
Vinyl Chloride		U		U		U		U		U
Chloroethane		U		U		U		UJ		U
Methylene Chloride		U		U		U		U		U
Acetone	3	JB	4	JB		UJ		UJ		U
Carbon Disulfide		U		U		U	1	J	4	J
1,1-Dichloroethene		U		U		U		U		U
1,1-Dichloroethane		U		U		U		U		U
1,2-Dichloroethene (total)		U		U		U		U		U
Chloroform		U		U		U		U		U
1,2-Dichloroethane		U		U		U		U		U
2-Butanone		U		U	15	J	12	J	26	J
1,1,1-Trochloroethane		U		U		U		U		U
Carbon Tetrachloride		U		U		U		U		U
Bromodichloromethane		U		U		U		U		U
1,2-Dichloropropane		U		U		U		U		U
cis-1,3-Dichloropropene		U		U		U		U		U
Trichloroethene		U		U		U		U		U
Dibromochloromethane		U		U		U		U		U
1,1,2-Trichloroethane		U		U		U		U		U
Benzene		U		U		U		U		U
Trans-1,3-Dichloropropene		U		U		U		U		U
Bromoform		U		U		U		U		U
4-Methyl-2-pentanone		U		U		U		U		U
2-Hexanone		U		U		U		U		U
Tetrachloroethene		U		U		U		U		U
1,1,2,2-Tetrachloroethane		U		U		U		U		U
Toluene		U		U	2	J		U		U
Chlorobenzene		U		U		U		U		U
Ethylbenzene		U		U		U		U		U
Styrene		U		U		U		U		U
Total Xylenes		U		U		U		U		U

L-1 = leachate
FW-1A = Farwell Rd.
KW-1A = Kent Road
DW-1A = Dutch Hill Road
LFP = Landfill Pond
RRP = Railroad Pond

U = undetected
J = estimated value
B = Contaminant detected in method blank

FEASIBILITY STUDY

FARWELL LANDFILL

CATTARAUGUS COUNTY, NEW YORK

Prepared for

CATTARAUGUS COUNTY, NEW YORK

Prepared by

STEARNS & WHELER, LLC
Environmental Engineers and Scientists
One Remington Park Drive
Cazenovia, New York 13035

October 1999

Project No. 9018070

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CHAPTER 1

INTRODUCTION

1.1 ORGANIZATION AND PURPOSE

Cattaraugus County Department of Public Works operated the Farwell Landfill from 1975 until 1989, when the last phase of the landfill was closed pursuant to a 1984 New York State Department of Conservation (NYSDEC) consent order. The site was subsequently added to the NYSDEC Registry of Inactive Hazardous Waste Sites with a classification of 2 in 1996. The basis of the listing arose from the 1984 Community Right-to-Know Survey, in which the Alcas Cutlery Corp. stated that they had disposed of TCE sludge mixed with sawdust at the landfill during the period between 1975 and 1980.

Cattaraugus County has retained Stearns & Wheler to conduct a remedial investigation/feasibility study (RI/FS) at the Farwell Landfill site. This report presents the results of the feasibility study. The remedial investigation report summarizes the results of the site investigation, characterizes site conditions, and summarizes the extent of environmental impact has been prepared and is being submitted to NYSDEC concurrently with this report.

The purpose of the FS is to identify the most appropriate method for managing site-related contamination. The alternatives for managing site-related contamination are developed by combining site-specific and appropriate remedial technologies. An alternative, then, is one option composed of one or more technologies that will satisfy remedial objectives and goals for the site. Once several alternatives are developed, the FS includes a detailed analysis of the alternatives.

The objectives of this preliminary FS report are to: (1) identify whether areas of the site, or specific media, require remediation; (2) define remedial objectives for the site, in general, and the areas of concern; (3) develop general response actions that would satisfy the remedial objectives; and (4) develop and screen remedial alternatives for the site. The report is organized into chapters that address each of these topics. The remainder of Chapter 1 presents background information on the site and summarizes the findings of the RI. Chapter 2 defines contaminants and/or areas of concern. Chapter 3 identifies remedial action objectives and standards, criteria, or guidance that are generally applicable or relevant to the site; and Chapters 4 and 5 develop general response actions, identify site-appropriate remedial alternatives, and evaluate those alternatives.

1.2 BACKGROUND INFORMATION

A. **Site Description.** The Farwell Landfill is located north of Farwell Road in the Town of Ischua, Cattaraugus County, NY. The landfill occupies the northern portion of property owned by the County located along the western wall of the Ischua Creek valley. The entire site is approximately 200 acres and is bisected by Farwell Road. The landfill is bounded on the west by a narrow strip of trees and old fields. On the north and east sides, the landfill is bounded by a bend in Ischua Creek and an active Conrail railroad line. At its closest point, the creek is approximately 400 feet from the landfill. Ischua Creek flows south into Olean Creek, which in turn discharges into the Allegheny River. A map of the site is shown in Figure 1-2.

The area surrounding the landfill is rural and sparsely populated, with only nine residences located within 1 mile of the site. Drinking water for the residences in the area is supplied by private wells or springs. The surrounding environs support a rich and diverse fish and wildlife habitat.

Over its lifetime, the landfill was operated in phases. The Phase I and II areas of the landfill, approximately 15 acres in size, were utilized from 1975 to 1985 and are unlined. The Phase III portion of the landfill was utilized until 1989 and was constructed with a compacted soil liner and leachate collection system. Following closure in 1989, the entire landfill was capped with 12 to 18 inches of compacted soil followed by a 6-inch topsoil layer. The cap has an established vegetative cover consisting of mixed grasses and herbaceous plants. During closure, leachate collection piping was added to the southeastern, eastern, and western sides of the landfill in areas where leachate outbreaks had been observed. A total of 25 gas vents were also added to the landfill during closure. Finally, an extensive network of groundwater monitoring wells has been installed around the landfill in various phases since the 1970s. Surface runoff from the landfill drains into either the landfill pond located southeast of the landfill and north of Farwell Road or a depression located southwest of the landfill, also north of Farwell Road.

Groundwater and surface water monitoring has been conducted since the 1970s. TCE and several other chlorinated aliphatic hydrocarbons have been identified in groundwater samples collected from several of the monitoring wells. In addition, benzene has been detected at low concentrations in a few monitoring wells.

Right-to-Know documentation states that hazardous wastes were potentially disposed of at the Farwell Landfill. This evidence, combined with the analytical results discussed above, resulted in the landfill being added to the NYSDEC Registry of Inactive Hazardous Waste Sites with a classification of 2 in 1996. Such a classification suggests that the site might represent a significant threat to the public health or environment, and that action is required. In 1996, Cattaraugus County and NYSDEC signed a consent order requiring the completion of an RI/FS at the site.

B. **Site Geology and Hydrogeology.** The surficial geology in the area of the site consists of a layered assortment of glacial deposits from the advance and retreat of glacial ice during the last ice age. An upper ablation till layer has been identified as the uppermost stratigraphic unit and is underlain by a coarser-grained glaciofluvial (sand-gravel) unit. Drilling activities undertaken as part of the RI indicated that the glacial till unit contained visible amounts of sand and gravel, while the glaciofluvial deposit was identified as being a silty sand and gravel. The upper till layer is reported to be greater than 70 to 80 feet thick in the western portion of the site and thins to approximately 30 feet thick along the eastern portion of the site, eventually being replaced by alluvial deposits adjacent to Ischua Creek to the east of the landfill. The glaciofluvial layer is only approximately 10 to 15 feet thick. A lower till layer was previously identified under the silty sand and gravel layer and is estimated to be 40 to 70 feet thick. The overburden layers rest on sedimentary bedrock consisting of highly fractured, fine-grained sandstone interbedded with thin layers of shale.

Hydraulic data from the site, recorded over the past several years, indicate that there is vertical flow between the overburden units at the site. Groundwater flow converges toward Ischua Creek from either side and upward from below, indicating that the creek is a hydraulic boundary and receives groundwater from the landfill. Groundwater flow direction across the landfill is from northwest to southeast. The average groundwater seepage velocity across the site is estimated to be 0.2 feet per day based on hydraulic conductivity tests in site wells.

C. **Nature and Extent of Contamination.** Groundwater monitoring undertaken prior to this RI/FS indicated the principal contaminants of concern at the Farwell Landfill are the chlorinated volatile organic chemicals (VOCs) TCE, vinyl chloride (VC), Chloroethane, 1,1-Dichloroethene

(1,1-DCE), 1,1-Dichloroethane (1,1-DCA), 1,1,1-Trichloroethane, (TCA), and the two isomeric forms of 1,2-Dichloroethene (1,2-DCE). In addition, one aromatic VOC, benzene, was detected at low concentrations in three wells during the RI. The origin of these chemicals is thought to be hazardous waste that was dumped at the landfill, although the origin could be household wastes. One of the objectives of the FS is to determine the nature of the source within the landfill. Specifically, it needs to be determined whether there is a source within the landfill responsible for the VOCs detected in the groundwater; if so, whether it is a single point source, such as a drum(s), or minor sources dispersed across the site.

1. **Groundwater Quality.** Sampling and analysis that took place during this investigation has verified the presence of VOCs identified during previous sampling events. Specifically, one or more chlorinated solvents have been detected at concentrations above regulatory standards in 11 monitoring wells, including two wells partially screened in bedrock.

Only two metals were detected in samples from downgradient/crossgradient wells at concentrations exceeding regulatory standards. Lead was detected in unfiltered samples from Wells MW-9D and MW-11S at concentrations of 55 µg/l and 33.1 µg/l, respectively, and barium was detected in a filtered sample from MW-16I at a concentration of 1,130 µg/l. However it should also be noted that although arsenic was detected (51.3 µg/l) in a filtered sample from MW-18S, this well is located on the eastern side of Ischua Creek.

2. **Surface Water Quality.** Samples of both surface water and sediment were collected from Ischua Creek to determine potential impacts from the landfill groundwater. No VOCs were detected in any of the surface water samples collected from Ischua Creek. Two VOCs were detected in samples of Ischua Creek sediments; however, neither compound (2-butanone and/or toluene) has been identified as a site-related groundwater contaminant of concern.

Samples of water and sediment were collected from the two ponds located on the County-owned property near the landfill. VOCs were not detected in the water sample from the landfill pond (pond receiving surface water runoff from landfill); however, two VOCs were detected in the sample from the railroad pond (carbon disulfide and 2-butanone). Both carbon disulfide and 2-butanone were also detected in the sediment samples from both ponds. Since carbon disulfide is a common metabolic breakdown product found in organic-rich sediments, it is not believed the presence of this compound in the ponds or the creek sediments is due to the landfill.

D. **Contaminant Fate and Transport.** As contaminants migrate in groundwater, their concentrations are almost always reduced, or attenuated, by a number of physical, chemical, and biological processes. One example of a physical attenuation process is the dispersion, or dilution, of contaminants in groundwater as it flows. However, dispersion does not reduce the mass of contaminants; it only reduces the concentration. Generally, therefore, dispersion by itself is not a popular attenuation remedy. Other physical degradation processes include volatilization, which transfers dissolved contamination to the gas phase, and sorption, which transfers dissolved contamination to the solid soil phase. Like dispersion, these other processes do not reduce the actual mass of contamination; they just change its form.

Dispersion occurs to some degree in all groundwater flow situations and can often enhance the effects of other chemical and biological forms of natural attenuation. Chemical and biological attenuation reduces the actual mass of contaminants as well as the concentrations in groundwater. That is, unlike dispersion alone, chemical and biological attenuation chemically breaks down, or degrades, the contaminants.

The principal groundwater contaminants of concern at the Farwell Landfill are chlorinated aliphatic compounds including TCE, 1,2-DCE, 1,1,1-TCA, 1,1-DCA, and VC. Numerous studies have shown that these compounds may degrade abiotically in anaerobic environments. For example, TCE is degraded by reductive dechlorination into the daughter product 1,2-DCE, which can be further degraded under reducing conditions to vinyl chloride. Reductive dechlorination involves a transfer of electrons from some electron donor to the compound being degraded. Usually, reduced forms of iron or manganese can provide the electrons needed to degrade the contaminant. Thus, reductive dechlorination is most favorable for TCE and DCE where conditions are anaerobic and there is a supply of reduced electron donor species. Although microbes are not directly involved in abiotic degradation reactions, their influence on ambient geochemistry can nonetheless make reductive degradation chemically favorable. For example, as microbes consume oxygen, conditions become increasingly anaerobic, which increases the ability for TCE to be reduced to DCE.

The above chlorinated compounds may also undergo aerobic degradation, particularly the chlorinated alkanes such as 1,1,1-TCA (Pankow and Cherry, 1996). Aerobic degradation of

1,1,1-TCA can produce alkenes such as DCE, so it is likely that DCE is being produced at the Farwell Landfill by a number of different degradation reactions for both TCE and 1,1,1-TCA. Although it may be impossible to unequivocally determine which of the many possible reactions or combinations of reactions may be occurring, such a determination is generally unnecessary for determining whether attenuation is occurring.

E. **Risk Assessment.** The baseline qualitative risk assessment of the RI report (Chapter 6) describes the potential risks to human health posed by environmental conditions at the Farwell Landfill. Under current land use conditions, all pathways of potential exposure, except via drinking water from the landfill well, are incomplete. Persons familiar with site operations do not use the water for potable purposes, so unacceptable risks associated with the landfill in the current state are considered to be manageable. Under future land use scenarios, development of County-owned property located in the area of impacted wells south of the landfill could occur. If this happened, and if drinking water supply wells were installed, then there would be a complete exposure pathway. However, it is thought that these risks could be managed given the County ownership of the land in the area of concern.

CHAPTER 2

IDENTIFICATION OF AREAS AND CONTAMINANTS OF CONCERN

Groundwater monitoring undertaken at the Farwell Landfill has established that there are low levels of some VOCs in the groundwater at the site and hydraulically downgradient from the site. Table 2-1 presents a summary of groundwater monitoring analytical results from sampling undertaken during the RI. Highest concentrations of total VOCs (354 µg/l) were detected in the sample collected from monitoring well MW-11D, located southeast of the landfill adjacent to the landfill perimeter. Compounds detected in the sample from this well include VC, chloroethane, 1,1-DCE, 1,1-DCA, 1,2-DCE, TCE, and TCA. Samples from monitoring wells MW-14S, MW-14I, and MW-9D were also found to contain total VOCs in excess of 100 µg/l. Monitoring well MW-9D is located along the northeast side of the landfill adjacent to the landfill perimeter, while monitoring wells MW-14S and MW-14I are located south of the landfill on the other side of Farwell Road. Impacts by chlorinated VOCs were also detected in the sample collected from monitoring well MW19, located approximately 500 feet south of the landfill.

The source of the VOCs has not been conclusively identified. The concentrations, however, do not suggest that anything more significant than diffuse, small amounts of waste are the source of the groundwater contaminants. Detected concentrations are historically less than 1 part per million (ppm) for individual compounds, which is generally less than 0.1 percent of the solubility limit for those compounds. Such low concentrations usually indicate that non-aqueous phase contaminants are not present. It is expected that in all cases, natural degradative processes, such as dilution, biotransformation, and dispersion, will continue to result in attenuation of these contaminants prior to the groundwater reaching Ischua Creek.

Although it is not uncommon for leachate-impacted groundwater to contain metals at concentrations exceeding New York State groundwater standards, the groundwater at the Farwell site generally does not exhibit this trend. Only two metals were detected in any samples at concentrations above regulatory standards. Concentrations of lead in unfiltered samples (total lead) from monitoring wells MW-9D and MW-11S were found to exceed the standard of 25 µg/l. However, lead was not detected in filtered samples (dissolved lead) from either well, suggesting that the analytical results for total lead were artifacts caused by the sample digestion process. Barium was detected in filtered and unfiltered samples collected from monitoring well MW-16I at concentrations exceeding groundwater standards. Because barium was detected in both the total and dissolved form, it is likely that this value is a true exceedance. Since barium was not detected above regulatory levels in samples from the other monitoring wells, and since monitoring well MW-16I is located directly adjacent to the railroad tracks, it is possible that the detected concentrations of barium are due to the railroad tracks and not the landfill.

TABLE 2-1

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER
Farwell Landfill Feasibility Study
Cattaraugus County, NY

Compound	Concentration (μg/l)												
	MW-9D	MW-10S	MW-10D	MW-11S	MW-11D	MW-13D	MW-14S	MW-14I	MW-15S	MW-15I	MW-16S	MW-16I	MW-19
Vinyl Chloride	**4**	N D	**4**	N D	**9**	**7**	**7**	**5**	N D	N D	N D	N D	N D
Chloroethane	**12**	N D	**8**	N D	**93**	7	**120**	**98**	N D	1	5	0.6	**9**
Carbon Disulfide	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D
1,1-Dichloroethene	2	N D	N D	N D	2	N D	N D	N D	N D	N D	N D	N D	0.7
1,1-Dichloroethane	**160**	**20**	**50**	**6**	**150**	**27**	**81**	55	1	4	**48**	**6**	**20**
1,2-Dichloroethene (total)	**11**	N D	3	N D	**28**	**23**	**8**	7	N D	0.5	**9**	N D	3
2-Butanone	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D	N D
1,1,1-Trochloroethane	**13**	N D	N D	N D	**27**	**7**	**5**	4	N D	N D	**15**	N D	**12**
Trichloroethene	4	N D	N D	N D	**45**	4	4	3	N D	N D	5	N D	0.7
Benzene	N D	N D	N D	N D	N D	**1**	**2**	**1**	N D	N D	N D	N D	N D
Total VOCs	206	20	65	6	354	76	227	173	1	5.5	82	6.6	45.4

Notes:
- N D indicates the compound was not detected.
- Bold entries indicates that the concentration exceeds New York State groundwater standards.
- Groundwater standards are 5 μg/l for all compounds except vinyl chloride and benzene. Standard is 2 μg/l for vinyl chloride and 0.7 mg/l for benzene.
- Only compounds that were detected in site media are listed in the table.

CHAPTER 3

REMEDIAL ACTION OBJECTIVES

3.1 INTRODUCTION

Remedial action objectives are developed by specifying contaminants and media of interest, exposure pathways, and remediation goals. The information that is required for this part of the FS evaluation includes a determination of the nature and extent of the contamination and the potential for the contamination to adversely affect a potential receptor. This information was presented in the RI report and is summarized in Chapters 1 and 2 of this preliminary FS report. Remedial technologies that are appropriate for the site characteristics are identified, with various technologies then being developed into remedial alternatives. The alternatives thus developed must comply with the scope of remediation, which includes contaminant cleanup goals, areal extent of required remediation, and performance and design standards. The cleanup goals are derived from applicable or relevant and appropriate requirements (ARARs) or site-specific risk factors. This procedure follows USEPA criteria (USEPA, 1988) for the preparation of feasibility study reports for inactive hazardous waste sites.

The overall remedial action objective for the Farwell Landfill, as it is for any for inactive hazardous waste site, is to provide for protection of human health and the environment by minimizing the migration potential of site-related contaminants. This, in turn, also minimizes the only identified exposure pathway.

This remedial action objective was further refined for the process of alternative development as required by the Environmental Conservation Law Article 27, Title 13 (State Superfund). The state Superfund Act requires remedial action alternatives to be protective of human health and the environment. Remedial actions must also conform to standards, criteria, and guidance (SCGs) that are generally applicable, consistently applied and promulgated, or that are relevant and appropriate for the site. SCGs specific to this site are discussed in Section 3.2.

Included as SCGs for the site are statutory requirements, which establish cleanup levels for protection of public health and the environment. Alternatively, a public health evaluation (or baseline risk assessment) can be used to establish risk-based cleanup goals. The risk assessment, which determines whether the existing soil, groundwater, surface water, and air contaminant concentrations pose a public health risk, is used for establishing these other cleanup goals.

Once the remedial action objectives are refined for the site, alternatives are assembled that will satisfy the objectives. The assembled alternatives should provide a range of options and sufficient information to provide comparison. Usually, alternatives encompass both source and groundwater control actions. Source control actions should, in turn, include a range of technologies that: (1) provide permanent solutions to the contaminant source so that long-term management is not required; (2) provide treatment which results in reduction in contaminant volume, toxicity, or mobility; (3) provide containment of the contaminant source; and (4) involve no action. The no action alternative is often used only as a basis of comparison.

Groundwater control actions should address both cleanup levels and the time frame within which the cleanup objectives might be achieved. Depending on site conditions, alternative should be developed which achieve chemical-specific regulatory or risk-based levels within varying time frames using different methodologies. Besides containment and active treatment options, other management options, such as institutional controls, may be possible for impacted groundwater. Furthermore, institutional measures, which ensure adequate protection against exposure, may be appropriate for the site.

The remainder of this chapter presents the specific remedial action objectives and the SCGs for the Farwell Landfill. General response actions are defined and refined according to site conditions as the remedial alternative development process continues in Chapter 4.

3.2 IDENTIFICATION OF SCGs

New York Environmental Conservation Law Article 27, Title 13, requires that remedial actions comply with all applicable laws, specifically the requirements of NYSDEC law and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act (SARA).

CERCLA and SARA mandates were developed to provide guidance for lead agencies (USEPA or state conservation agencies, such as NYSDEC) in the selection of on-site remedial actions that meet the ARARs, or SCGs, as established in the Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Clean Air Act (CAA), Toxic Substance Control Act (TSCA), and other federal and state environmental laws. CERCLA §121 requires on-site remedial actions to attain promulgated state standards that are more stringent than federal ARARs. The requirements that must be complied with are those that are legally applicable or relevant and appropriate to the substance or circumstance of release.

An SCG may be either applicable or "relevant and appropriate," but not both. Applicable requirements include 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 contaminated site. 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 directly applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a contaminated site, address problems or situations sufficiently similar to those encountered at the site. Identification of SCGs is done on a site-specific basis in two parts; the first task is to determine whether a requirement is applicable. If it is not applicable, the second task is to determine whether it is relevant and appropriate.

SCGs may be grouped into three categories:

1. Location-specific requirements are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations.

2. Ambient or chemical-specific requirements are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment.

3. Action-specific requirements are usually technology- or activity-based requirements or limitations on actions, such as performance and design, taken with respect to hazardous wastes.

The purpose of implementing a remedial action at a site is to protect human health and the environment. Cleanup goals for the chosen remedial actions are determined by risk-based standards or by standards and guidance values which are applicable or relevant SCGs for the site. Additional criteria are considered in the absence of SCGs, or if guidelines have not been established by state, federal, or local statutes for the contaminants at the site.

SCGs identified for the Farwell Landfill are presented in Table 3-1. The following paragraphs summarize the SCGs.

A. **NYSDEC TAGM 4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites.** This TAGM details the process NYSDEC uses to select remedial actions for inactive hazardous waste sites.

B. 6 **NYCRR Part 700-703, Groundwater Classifications and Standards, Quality Standards, and Effluent Standards and/or Limitations.** New York State water quality regulations have defined the following groundwater class applicable to this site:

1. **Class GA.** The best usage of Class GA water is as a source of potable water supply. GA waters are fresh groundwaters found in the unsaturated zone or unconsolidated deposits and consolidated rock or bedrock. Quality standards for Class GA waters are required to be the most stringent levels set by the following:

    a. Specifications in 6 NYCRR Part 703.5 and 703.6.
    b. Maximum contaminant levels (MCLs) promulgated in 10 NYCRR Subpart 5-
    c. MCLs promulgated by the SDWA and 40 CFR Part 141.
    d. Standards for raw water quality found in 10 NYCRR Part 170.

C. **NYSDEC TOGS 1.1.1, Ambient Water Quality Standards and Guidance Values.** The primary purpose of this document is to provide a compilation of ambient water quality guidance values and groundwater effluent limitations for use where there are no standards (in 6 NYCRR 703.5) or regulatory effluent limitations (in 6 NYCRR 703.6). The values in this document (guidance and regulatory) are used in Department programs, including the SPDES permit program.

D. **10 NYCRR Subparts 5-1 and 5-3.** The rules and regulations set forth under this code apply to current and potential sources of drinking water. Subpart 5-1 specifically addresses sampling frequency, MCLs, analytical protocols, and various other aspects of public water supplies. Subpart 5-3 addresses the protection of underground and surface sources of drinking water. MCLs are enforceable standards (SCGs) for the allowable concentrations of inorganics, organics, turbidity, coliform bacteria, and radioactivity.

E. **40 CFR Part 141-143, Safe Drinking Water Act (SDWA).** Federal MCLs have been set for 30 toxic compounds. These MCLs are enforceable standards (SCGs) for public drinking water supplies. The levels have been set at concentrations which reflect both health effects and the technical and economic feasibility of removing the contaminants from the water supply. MCL goals (MCLGs) are non-enforceable concentration limits for 49 additional chemicals set at levels that result in no known adverse health effects with adequate margins of safety.

F. **Suggested No Adverse Response Levels (SNARLs).** USEPA Health Advisories and the National Academy of Sciences (NAS) provide drinking water suppliers with guidance on contaminants that may be encountered occasionally in water systems and are believed to pose a near-term risk, yet are unregulated. These guidelines are developed by the Office of Drinking Water in the form of health advisories (SNARLs) and should be considered.

G. **NYSDEC TAGM HWR-92-4046, Determination of Soil Cleanup Objectives and Cleanup Levels.** This TAGM, dated January 1994, lists procedures for determining, and actual numerical values for, acceptable concentrations of contaminants in soil at inactive hazardous waste sites. This is not a promulgated regulation, but it can be used as a criteria for determining cleanup goals for contaminated soil.

H. **6 NYCRR Part 360, New York State Solid Waste Management Requirements.** The requirements of 6 NYCRR Part 360 regulate all aspects of solid waste management facilities, including construction, operation, and closure. Hazardous waste management facilities, however, are excluded from these regulations if operated with a valid permit for hazardous waste management.

The most pertinent requirements of 6 NYCRR Part 360 that pertain to the Farwell Landfill are those that specify closure and post-closure procedures. Part 360 requirements state that all closed facilities should have a final, multi-layer cover system installed. The layers should be graded to control surface drainage and thereby minimize the infiltration of rainfall. In addition, perimeter gas collection systems must be installed if landfill gases are found to pose a hazard to health, safety, or property. Landfill gas control systems must be designed to prevent the migration of concentrated amounts of landfill gases off-site.

The portions of the Part 360 regulations pertaining to the use of a multi-layer cover system (Part 360 cap) were initially adopted in 1988 and revised, effective October 1993. Since the final phase of the Farwell Landfill was closed in 1989, prior to the October 1993 capping requirements, use of what is currently termed a Part 360 cap may not be appropriate, and therefore may not be an SCG for the Farwell Landfill. Instead, the closure requirements of the 1984 consent order or the 1988 Part 360 requirements should be considered as the SCGs for the site. In addition to the consent order capping requirements, addition of a barrier protection layer may be appropriate to protect the low permeability soil layer from frost damage, thereby providing for long-term cap integrity. NYSDEC might also require an improved leachate collection system to control leachate migration. A 30-year post-closure monitoring and maintenance plan is also mandatory under Part 360 regulations.

I. **NYSDEC TAGM SW-92-4004.** This NYSDEC TAGM details procedures to be used when applying for a variance pursuant to a provision in 6 NYCRR Part 360 requirements. A variance can be applied for provided the application demonstrates that economic hardship exists if the provision must be met, <u>and,</u> if the provision is not complied with, there will be no significant adverse effect on public health, welfare, safety, or the environment.

J. **6 NYCRR Parts 370-375, New York State Hazardous Waste Management System.** The requirements of 6 NYCRR Parts 370-374 regulate all aspects of hazardous waste management and are SCGs for the Farwell Landfill site.

Similar to the Part 360 regulations for solid waste management facilities, the Part 370 regulations contain requirements for closure and post-closure activities. Closure performance standards require that the facilities be closed in a manner that minimizes the need for further maintenance and controls, and minimizes or eliminates release of contaminants in the future. Included in the Part 370 closure plan are items such as an estimate of the maximum of hazardous wastes on site, a description of how each hazardous waste management unit will be closed, a description of how all hazardous waste residues are to be removed or decontaminated, and a description of how the closure performance standards are to be met.

Finally, the Part 370 regulations address releases from solid waste management units, groundwater protection standards, monitoring requirements, and standards for management of specific hazardous wastes and specific types of hazardous waste management facilities.

Part 375 of 6 NYCRR addresses remedial actions at inactive hazardous waste sites. Such items as public participation and other steps required before implementation of a remedial action, including any interim remedial measure (IRM), are detailed. A significant item of this subpart is the specification that permits are not required for remedial actions, but the actions must meet the substantial requirements of the permitting process.

K. **29 CFR Parts 1900-1999, Occupational Safety and Health Administration (OSHA) Requirements.** OSHA requirements are applicable to workers implementing the remedial alternatives at inactive hazardous waste sites and pertain to prevention of exposure to, or direct contact with, contaminated materials.

SARA requires that the Secretary of Labor promulgate standards for the health and safety protection of employees engaged in hazardous waste operations pursuant to Section 6 of the Occupational Safety and Health Act of 1970. These regulations are SCGs for all remedial activities at the landfill.

3.3 REMEDIAL ACTION OBJECTIVES – SUMMARY

To reiterate, the overall remedial action objective for the Farwell Landfill is to provide for protection of human health and the environment by minimizing the migration potential of site-related contaminants, by preventing direct contact with the landfill contents, and by controlling potential sources of contamination at the site. The following specific remedial action objectives have been developed to meet this goal:

1. Eliminate potential exposure to contaminated groundwater.

2. Eliminate the potential for direct human or animal contact with waste in the landfill.

3. Minimize erosion and control runoff from the landfill.

4. Reduce infiltration of stormwater through the refuse; thereby, minimizing control or eliminating leachate generation within the landfill mass.

5. To the extent possible, minimize or prevent the migration through groundwater of dissolved organic contaminants from the landfill.

6. Provide for attainment of SCGs for groundwater quality at the limits of an established area of concern.

The next chapter of the FS report identifies and screens options for meeting the specific remedial action objectives for the site.

TABLE 3-1

SUMMARY OF STANDARDS, CRITERIA, AND GUIDANCE (SCG) REQUIREMENTS
Farwell Landfill Feasibility Study
Cattaraugus County, NY

STATUTE	DESCRIPTION	CATEGORY
6 NYCRR Parts 700-703	New York State Groundwater Standards	Contaminant-specific Location-specific
NYSDEC TOGS 1.1.1	Ambient Water Quality Standards and Guidance Values	Action-specific Contaminant-specific Location-specific
40 CFR Parts 141-143	Safe Drinking Water Act	Contaminant-specific
USEPA SNARLs	USEPA Health Advisories	Contaminant-specific
10 NYCRR Subparts 5-1 and 5-3	NYSDOH requirements for general organic chemicals in drinking water	Contaminant-specific
NYSDEC TAGM (HWR-92-4046)	Determination of Soil Cleanup Objectives and Cleanup Levels	Action-specific Contaminant-specific Location-specific
6 NYCRR Part 360	NYSDEC Solid Waste Management Facility Requirements	Action-specific
NYSDEC TAGM (SW-92-4004)	Application for Variance to Provisions in 6 NYCRR Part 360 regulations	Action-specific
6 NYCRR Part 370-376	NYSDEC Hazardous Waste Management Facility Requirements	Action-specific
29 CFR 1900-1999	OSHA standards	Action-specific Contaminant-specific Location-specific
NYSDEC TAGM 4030	Selection of Remedial Actions at Inactive Hazardous Waste Sites	Action-specific Location-specific

CHAPTER 4

DEVELOPMENT AND SCREENING OF REMEDIAL OPTIONS

4.1 GENERAL RESPONSE ACTIONS

General response actions are actions that will satisfy the remedial action objectives for a site. General response actions established for the Farwell landfill in order to be protective of human health and the environment are as follows:

1. Prevent direct contact with contents (buried and surficial refuse) of the landfill.

2. Minimize erosion and control runoff from the landfill.

3. Reduce infiltration of stormwater through the refuse, thereby minimizing leachate generation.

4. Minimize the migration through groundwater of dissolved organic contaminants.

For most sites, in order to meet the remedial objectives, a combination of source control and groundwater control actions are typically required. Source control actions are defined as the construction or installation and startup of technologies that are necessary to prevent the continued release of hazardous contaminants into the environment. Source control actions range from activities that provide a permanent solution, such as destruction of the contaminants or removal of leaking tanks, or those that result in reduction in the toxicity, mobility, or volume of the affected areas. Both treatment and control technologies can usually be used to accomplish this reduction of toxicity, mobility, or volume.

Groundwater control, or leachate control, actions are the second type of response actions evaluated for most sites. Groundwater control actions include natural attenuation processes and also more active forms of treatment or management options that lessen the impact on the affected media.

The next step in developing remedial alternatives for the site consists of narrowing the number of potentially applicable technologies and management options by evaluating the options with respect to implementability and effectiveness. Evaluation of technology/management options for their effectiveness considers factors such as the type of contaminant present and the subsurface conditions present at the site. At the same time, this initial screening exercise for the Farwell Landfill FS has been undertaken with the knowledge that there are certain remedial options that are most practicable for municipal landfill sites. By focusing on these "presumptive remedies," the preparation of the FS can be streamlined.

To be consistent with CERCLA guidance, the initial technology evaluation focused on: (1) the history and reliability of the option with respect to the conditions at the site; (2) the potential effectiveness of the process options in handling the estimated areas or volumes of media and meeting the goals identified as one or more of the general response actions; and (3) the effectiveness of the option in protecting human health and the environment during construction and implementation. Evaluation was accomplished by reviewing site (and contaminant) characteristics identified in the RI. These were compared to design limitations of the various remedial options with the purpose of eliminating options from further consideration if the option appears unable to achieve remedial action objectives for the site, or if implementation of the option is not feasible.

While this evaluation has been focused on appropriate options for municipal landfills, NYSDEC, using USEPA criteria, gives preference to treatment technologies "that whole, or in part, result in a permanent and significant decrease in the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants" to the maximum extent practicable (NYSDEC, 1990). Based on this preference, the hierarchy of remedial options from most to least desirable is outlined as follows:

1. **Destruction.** This method irreversibly destroys or detoxifies all or most of the hazardous waste to "acceptable cleanup levels." The treated materials do not have residues containing unacceptable levels of hazardous wastes. Destruction remedies result in permanent reduction in the toxicity of all or most of the hazardous wastes to "acceptable cleanup levels."

2. **Separation and Treatment.** This method separates or concentrates the hazardous wastes, thereby resulting in a treated waste stream with acceptable levels of hazardous

wastes and a concentrated waste stream with high levels of contaminants, e.g., treatment of contaminated leachate by activated carbon. Separation and treatment remedies result in permanent and significant reduction in volume of waste mixed with hazardous wastes. In these instances where the concentrated waste stream can be destroyed or detoxified, as in "Destruction" above, preference is given to this additional treatment.

3. **Solidification and Chemical Fixation.** This method is most appropriate for a site containing predominantly inorganic hazardous wastes. Solidification and chemical fixation remedies do not result in reduction of the toxicity or volume of the inorganic hazardous waste, but do result in significant and permanent reduction in the mobility, and hence the availability, of the inorganic hazardous wastes to environmental transport and uptake.

4. **Control and Isolation Technologies.** These methods reduce the mobility of the hazardous wastes, but do not reduce the volume or toxicity of the hazardous wastes. Included in these actions are construction of physical barriers to control migration of leachate, contaminated groundwater, and surface runoff.

A preliminary screening of remedial technologies for the Farwell Landfill follows. Technology options have been classified as appropriate or inappropriate based on documented effectiveness in full-scale and pilot-scale testing, and on compatibility with contaminants and specific site conditions.

4.2 IDENTIFICATION OF AVAILABLE SOURCE COTROL TECHNOLOGIES

During this part of the FS, source control options amenable for use at municipal landfills are identified for screening. Options that are evaluated include containment (control and isolation) processes, disposal and destruction options, and cleanup (separation and treatment) options. Table 4-1 presents a summary of this initial screening of source control options.

A. **Containment Responses.** Containment responses for landfills such as the Farwell Landfill include actions or responses that isolate the refuse and thereby prevent movement of water into the waste mass (refuse) and underlying soil. By preventing the movement of water through the waste mass, the quantity of leachate produced can be minimized. The following is a brief description of containment options that were screened for use at the Farwell Landfill site.

1. **Surface Sealing or Capping.** Surface sealing or capping provides containment of residual soil contamination or refuse by preventing direct contact with the landfill contents and reducing infiltration through the landfilled areas, which may result in generation of leachate. The purpose of the cap is to prevent groundwater recharge through the waste mass by surface water infiltration, to control erosion, and to contain the refuse and any associated contaminated soil. A variety of materials can be used to construct a cap, including asphalt, cement, clay (bentonite), and geosynthetics. For municipal landfills closed after 1988, implementation of a final cover in accordance with 6 NYCRR Part 360 regulations (Part 360 cap) is required. Although the Farwell Landfill was closed after 1988, it was closed in accordance with a Consent Order, originally signed in 1984. The capping requirements of the consent order consisted of implementing a low permeability [maximum 1 x 10^{-7} cm/sec] compacted soil cover and installing gas vents placed approximately 18 inches into the refuse).

It should also be noted that the requirements of 6 NYCRR Part 360 were revised and adopted in October 1993 (see Table 4-2). All three forms of caps are feasible to construct and can be readily implemented at the site. In fact, the consent order cap has already been implemented at the site. However, since the landfill was closed prior to the adoption of the 1993 Part 360 requirements, the later regulations may not be relevant or appropriate for the site. It is also noted that for unlined landfills (such as for Phases I and II), there is generally less of a significant practical difference between the 1988 and 1993 Part 360 capping requirements than for lined landfills. Therefore, only two of the three capping options (consent order cap and 1988 Part 360 cap) have been retained for further consideration.

Finally, it is noted that the Phase III area of the landfill was not in operation at the time of the alleged disposal of chlorinated organic waste and was constructed with a compacted soil liner and leachate collection system. Thus, the capping options are being presented for the Phase I/Phase II area only.

2. **Grading.** Grading is the term for reshaping the ground surface in order to manage surface and stormwater infiltration and runoff while at the same time controlling erosion. Surface grading serves several functions (USEPA, 1985), including: (a) reduction of ponding, which minimizes infiltration and reduces differential swelling; (b) reduction in runoff velocities to reduce soil erosion; (c) preparation of soil for revegetation; and (d) aid

in reduction or elimination of leaching of waste. Grading has been done at the site as part of the consent order closure; however, the landfill has experienced some settling since the cap was constructed. Occasionally, stormwater ponds in the settled areas; therefore, at a minimum, regrading the existing cap to improve storm water runoff should be considered and retained for further consideration.

3. **Revegetation.** Establishment of a vegetative cover is an effective and low cost method to stabilize the surface of a landfill. It is readily implementable at this type of site. Revegetation can also be used to minimize infiltration of stormwater, especially when combined with grading. The final layer of the consent order cap consists of a vegetative cover layer made up of mixed grasses and herbaceous plants. Should any upgrade of the cap be undertaken, including regrading or implementation of improvements consistent with a 1988 or 1993 Part 360 cap, a vegetative cover layer would be included as the final, top layer of the cap. Therefore, this option has been retained for further consideration.

B. **Disposal/Destruction Responses.** Disposal or destruction responses for source control at a landfill include actions that result in disposal or destruction of the contaminants or waste source that have impacted the soil and subsequently created the groundwater contamination. For landfills, options for this type of response include excavation of "hot spot" areas, followed by incineration or other treatment that destroys the contaminants of concern. However, investigative evidence indicates that there are no specific source areas or hot spots at the site. The concentrations of organics in groundwater appear more indicative of diffuse areas of minor sources rather than an active small area of contamination. In order to destroy the contamination, isolation and removal of the identified source area is required. Given the size of the landfill, removal and destruction of diffuse, small source areas would not be readily implemented. Therefore, these type of responses have been eliminated from further consideration as part of a remedial alternative at this site.

C. **Cleanup Responses.** Cleanup responses for source control include technology options that remove the contaminants from the soil matrix. These types of responses do not destroy the contaminants, but result in reduction of toxicity and/or volume of contaminated soil. Similar to destruction options, most treatment processes that result in cleanup of soil require excavation of the impacted soil for the treatment to be accomplished. Since there are no defined source areas or hot spots at the Farwell Landfill, cleanup responses are not feasible or implementable, and this option has been rejected for further consideration.

D. **Institutional Responses.** Institutional controls for source control include those options that result in prevention of contact with the landfill area. For this site, access restrictions in the form of fencing to prevent trespassing would be a potential institutional control. As fencing is easily implemented, this option has been retained for further consideration.

4.3 IDENTIFICATION OF AVAILABLE GROUNDWATER CONTROL REMEDIES

During this part of the FS, groundwater control options amenable for use at municipal landfills are identified for the initial screening. Options evaluated in this phase include containment and collection options, disposal and treatment options, and institutional controls. Table 4-3 presents a summary of the results of this initial screening of groundwater control options.

A. **Containment Responses.** Containment responses for groundwater control include the use of vertical barriers, such as grout curtains, slurry walls, and sheet piling, to divert flow of groundwater away from a contaminant source or to contain a plume of dissolved contaminants in groundwater within a specific location. Because all forms of vertical barriers, if constructed or installed properly, are capable of achieving comparable low groundwater permeabilities, further use of vertical barriers has focused on slurry walls. Grout curtains require specialized equipment and training for proper installation; therefore, they are not considered as readily implementable as slurry walls. Sheet piling was also rejected from further consideration because of the need for specialized contractors and training in order to seal the joints between individual sheet pile sections to achieve a low permeability barrier. It was also rejected because the installed cost for sheet piling is higher than that of slurry walls.

Slurry walls are constructed by excavating a 2- to 4-foot wide trench around the area to be contained. The trench is extended to an underlying low permeability layer. During trench excavation, bentonite slurry is pumped into the trench to provide support and keep the sides of the trench from caving in. As the excavation proceeds, soil material is mixed with the slurry, eventually forming a low permeability wall that impedes the flow of groundwater.

Two options for use of a slurry wall are possible at a site with groundwater impacts like the Farwell Landfill. One option includes installation of the slurry wall on the upgradient side of the landfill to divert groundwater away from the landfill and thus minimize the flow of groundwater that mixes with uncollected leachate. Another option involves installation of a slurry wall around the entire perimeter of the landfill. Neither option is particularly feasible for this site, as the historic groundwater elevation data indicate there is considerable mixing between the groundwater in the different overburden layers and in the groundwater in the upper bedrock. For a slurry wall to be effective, it would have to penetrate through and form a barrier to further groundwater migration over the entire depth of known impacts. Since slurry walls cannot be installed in bedrock, some other method would be needed in the upper bedrock in the areas with bedrock groundwater impacts. In addition, along the western portion of the site, the depth of the overburden layers exceeds 85 feet, which is beyond the abilities of traditional excavating equipment used for slurry wall construction. Therefore, the use of vertical barriers for groundwater containment is rejected at this site.

B. **Collection/Hydraulic Containment Options.** Groundwater collection options include the use of recovery wells or subsurface drains to contain or recover groundwater with dissolved contaminants. For the Farwell Landfill site, recovery wells could be used to recover groundwater downgradient of the landfill before the water reaches Ischua Creek. Such a system would need to be coupled with some form of groundwater treatment or management program that could also include leachate management. A subsurface drain or collection trench would not be easily implemented due to the depth of groundwater and the fact that bedrock groundwater has also been impacted.

Although there may be some benefit to expansion of the existing leachate collection system at the landfill, it is unlikely to be successful if implemented. Presently, leachate collection is accomplished along the west, east, and southeast portion of the landfill. However, monitoring data indicate that the groundwater impacts extend to the east and south of the landfill. Installation of additional subsurface leachate collection piping is not likely to be successful because most of the landfill is unlined. For the piping to be successful in collecting leachate, an impermeable barrier would be required so that the leachate could collect or pond in the area surrounding the collection piping. Thus, to be effective, any leachate collection would have to be undertaken as part of a groundwater recovery system.

C. **Treatment Options.** Treatment of impacted groundwater can be accomplished aboveground as part of a "pump-and-treat" system, or in situ (within the aquifer). Use of both types of systems for treatment of groundwater at the Farwell Landfill is discussed below.

1. **Air Stripping/Granular Carbon Adsorption.** Air stripping and carbon adsorption are both considered conventional methods for treatment of groundwater that is

contaminated with dissolved organic compounds, such as the chlorinated solvents in the groundwater at the Farwell Landfill site. Air stripping is primarily used for treatment of dissolved VOCs. By providing contact between the impacted groundwater and air, the contaminants diffuse from the water to the air and are removed in the air stream. Air stripping achieves 90 to 98 percent removals of VOCs from groundwater. Depending on the concentration of removed contaminants, the air stream leaving an air stripper can either be discharged directly to the atmosphere or can be treated with activated carbon prior to discharge. However, operation of air strippers is hampered by the concentration of dissolved inorganics that naturally occur in groundwater. Dissolved solids, especially calcium carbonate, frequently precipitate during the air stripping process. The total dissolved solids (TDS) and hardness concentrations in the groundwater at the Farwell Landfill site range from 114 to 690 ppm (TDS) and from 113 to 843 ppm (hardness). Given these values, it is likely that implementation of air stripping will be impacted by scale formation. Despite this, chemical addition systems could be added to reduce or prevent formation of scale in the stripper.

Carbon adsorption works by making use of the attractive forces between the surface of the activated carbon and the nonpolar VOC molecules. The VOCs sorb to the surface of the carbon and become concentrated on the carbon media. Once it reaches its adsorption capacity, contaminated carbon then must be either treated or disposed of properly. In general, contaminants that sorb easily are those that are extremely insoluble in water. However, vinyl chloride, one of the groundwater contaminants at the Farwell Landfill site, is comparatively soluble in water and does not sorb to activated carbon. Therefore, use of activated carbon for impacted groundwater treatment is rejected at this time for the Farwell Landfill.

2. **UV Oxidation.** Destruction of VOCs in groundwater by UV oxidation, often coupled with hydrogen peroxide or ozone addition, is another option for treatment of dissolved VOCs in extracted groundwater. Although VOC removals in excess of 90 percent can be achieved, the systems are plagued by mineral scale formation, similar to air strippers. In UV oxidation systems, mineral scale tends to form on the light bulbs that provide the UV wavelength energy required for the oxidation reaction to occur. Therefore use of UV oxidation for treatment of extracted groundwater at the Farwell landfill has been rejected for further consideration.

3. **Air Sparging.** Air sparging, or in situ air stripping, consists of air injection into the saturated zone concurrently with operation of a soil vapor extraction system (SVES) in the overlying unsaturated zone. The air bubbles formed by air injection strip VOCs out of the groundwater into the soil gas, where they are removed using the SVES. In general, air sparging is successful at a site with sandy soils (both saturated and unsaturated). Because of the presence of the overburden till layer at the site, use of air sparging has been rejected at the Farwell Landfill site.

4. **Permeable Reactive Barrier (PRB).** Developed at the Waterloo Centre for Groundwater Research, PRBs consisting of granular iron are capable of destroying dissolved chlorinated solvents dissolved in groundwater. A PRB consists of a subsurface "wall" of permeable material, including granular iron (iron filings). The PRB is constructed in the affected aquifer perpendicular to the flow of groundwater. Because the PRB is permeable, groundwater can flow through the barrier without the need for pumping. As the groundwater flows through the PRB, it reacts with the iron and chlorinated organic compounds are dechlorinated. Research by the group at Waterloo and other work funded by the USEPA has consistently shown that removals greater than 95 percent can be achieved for the suite of contaminants found in the groundwater at the Farwell site. At the Farwell Landfill, such a treatment system could be configured around the downgradient perimeter of the landfill. As the impacted groundwater/leachate flows toward Ischua Creek, it would flow through the PRB and be remediated. However, to date, installations have been limited to treatment of groundwater at relatively shallow depths (less than 30 to 40 feet deep) with an underlying aquiclude. Thus, implementation of a PRB at the Farwell site is affected by limitations of excavation equipment similar to the implementation of slurry walls. Therefore, PRBs have been rejected for further consideration at the Farwell Landfill site.

D. **Leachate Recirculation.** As an alternative to treatment or disposal of leachate, the collected leachate could be reinjected into the waste mass of the landfill. Leachate recirculation provides moisture necessary for continued microbial activity within the waste mass. This, in turn, aids in eventual stabilization of the landfill contents. However, 6 NYCRR Part 360 regulations prohibit leachate recirculation for unlined landfills and sites where monitoring data indicate that impacts to groundwater have occurred. As the Phase I and II portions of the Farwell landfill are unlined, and as groundwater monitoring data show impacts to groundwater by chlorinated solvents, leachate recirculation has been rejected for further consideration as a remedial options for this site due to feasibility.

E. **Disposal.** Transportation and discharge to a POTW can be used in conjunction with a groundwater and/or leachate collection system for disposal of recovered groundwater and/or leachate. The POTW must be able to handle the excess loadings imposed by the additional flow and mass on a daily, monthly, and annual basis. This currently is the leachate management option being utilized by Cattaraugus County for the leachate collected at the Farwell Landfill. As this option is both effective and implementable, it is retained for further consideration.

F. **Institutional Controls.** At the present time, the groundwater within the impacted area is not used for potable purposes, and there is no immediate or projected need to utilize the groundwater. There are no sensitive receptors potentially impacted by the groundwater plume, as evidenced by the surface water and sediment quality of Ischua Creek, which acts as the discharge point for the impacted groundwater. The closest residence downgradient of the landfill and on the western side of Ischua Creek is approximately 2-1/2 miles away. This suggests that some form of institutional control may be an effective means of ensuring that there are not potential exposures to the impacted groundwater while other methods act together to restore the groundwater to regulatory standards. Options for institutional control include deed restrictions for the County-owned property and implementation of periodic groundwater user surveys that would work together to prevent installation of a well for drinking water supply within the area of concern. Such a combination of these methods, along with other formal and informal means (such as posted signs at the landfill advising against drinking the water) can be used to effectively eliminate attempted use of the groundwater for a purpose incompatible with the contaminant concentration levels. This option is thus retained for further consideration.

G. **Natural Attenuation.** Natural attenuation may be considered in three scenarios: (1) when natural processes such as adsorption, dispersion, and biodegradation will result in contaminant levels reaching cleanup goals in a reasonable time frame; (2) when it is impracticable to attain cleanup goals due to the nature of the site and the contaminants, and when protectiveness can only be achieved by providing an alternate water supply or wellhead treatment; or (3) when no exposures to the contamination exist. A natural attenuation response action generally includes long-term monitoring to track the direction and rate of movement of the impacted groundwater. For the Farwell Landfill, this may be an appropriate option because no exposures to the contamination exist. Because implementation of such an option is easily implemented, natural attenuation has been retained for further consideration.

TABLE 4-2

COMPARISON OF CAPPING REQUIREMENTS
Farwell Landfill Feasibility Study
Cattaraugus County, NY

LANDFILL CAP COMPONENT	1984 CONSENT ORDER	1988 6 NYCRR PART 360 REGULATIONS	1993 6 NYCRR PART 360 REGULATIONS
Topsoil/vegetative cover	6 inches topsoil plus interim cover to grade	6 inches (topsoil)	6 inches (vegetative support)
Barrier protection layer	None	*Options:* • 24 inches of unspecified soil (least expensive). Thickness of unspecified soil could increase to protect layer from freezing. **or** • 12 inches of sand.*	24 inches of unspecified soil, of which the bottom 6 to 12 inches should be free from large stones (to be used as drainage layer). Total depth remains at 24 inches, but thickness could increase to protect lower clay layer from freezing.
Barrier layer	18 inches (minimum) of 1 x 10^{-7} cm/sec soil	*Options:* • 18 inches of 1 x 10^{-7} cm/sec soil with filter fabric at bottom (under the 24-inch soil layer) **or** • 40 mil geomembrane (under the 12-inch sand layer)	*Options:* • Unlined landfills: a) 18 inches of 1 x 10^{-7} cm/sec soil and 40 mil geomembrane (composite) for slopes less than 25%. b) Same as 1988 regulations if underlying soils are relatively impermeable. • Lined landfills: Composite cap as described under a) above.
Gas venting layer	Gas vents extend 18 inches into refuse	*Options:* • 12-inch soil (sand) layer plus one gas vent/acre **or** • 6-inch soil (sand) layer plus four gas vents/acre extending 3 feet into refuse	12-inch soil layer (sand) plus one gas vent per acre extending 5 feet into refuse.
Interim cover		12 inches of soil	12 inches of soil
Refuse		4% minimum grade; 33% maximum grade	4% minimum grade; 33% maximum grade

*Variance possibility.

TABLE 4-1

SUMMARY: INITIAL SCREENING OF PROCESS: SOURCE CONTROL OPTIONS
Farwell Landfill Feasibility Study
Cattaraugus County, NY

GENERAL RESPONSE ACTION	PROCESS OPTION	EVALUATION	RETAINED FOR CONSIDERATION?
No action	No action	Existing cap prevents contact with landfill and promotes some runoff. This option is both feasible and implementable, as no additional actions are required.	Yes
Prevent contact	Institutional controls (fencing)	Feasible and implementable. Relatively easy to install. Does not require special contractors.	Yes
Prevent direct contact; minimize erosion; reduce stormwater infiltration; control/eliminate leachate generation	Consent Order cap	Implementable (already constructed).	Yes
	1988 Part 360 cap	Implementable; requires more effort than existing cap. More effective than existing cap.	Yes
	1993 Part 360 cap	Implementable; requires more effort than existing cap. Similar in effectiveness to 1988 cap.	No
	Regrade site and revegetate	Easily implementable. Would improve effectiveness of existing cover system.	Yes
Source removal and/or treatment	Hot spot removal; treatment/disposal on or off site	Not effective on diffuse source areas. Not readily implementable.	No

TABLE 4-3

SUMMARY: INITIAL SCREENING OF PROCESS: GROUNDWATER CONTROL OPTIONS
Farwell Landfill Feasibility Study
Cattaraugus County, NY

GENERAL RESPONSE ACTION	PROCESS OPTION	EVALUATION	RETAINED FOR CONSIDERATION?
Prevent groundwater use/ institutional measures	Deed restrictions	Implementable, feasible	Yes
Control groundwater/leachate migration	Vertical barriers	Slurry walls, sheet piling	No
	Leachate/groundwater collection	Recovery trench/wells in areas of impact	Yes
	Natural attenuation	Allow natural process to continue, concentrations diminish with time	Yes
	Recirculation	Leachate circulation	No
Control groundwater/leachate migration by reducing volume of impacted groundwater	In situ treatment/destruction of VOCs	Air sparging	No
		PRB	No
	Ex situ treatment	Air stripping	Yes
		Carbon adsorption	No
		UV oxidation	No
	Disposal	Transport to POTW	Yes

CHAPTER 5

DEVELOPMENT OF REMEDIAL ALTERNATIVES

5.1 INTRODUCTION

After remedial objectives and SCGs have been established and general response actions and appropriate technology options have been identified, the next step of the feasibility study consists of combining the technology options into remedial alternatives. The remedial alternatives from this step are discussed below and presented in Table 5-1. Each alternative addresses the goals of environmental restoration to the best practicable extent without consideration of timing or costs.

5.2 DESCRIPTION OF REMEDIAL ALTERNATIVES

As shown in Table 5-1, the media-specific technology options that passed the initial screening have been combined into alternatives for the site. The following paragraphs present a brief description of the alternatives that will go through detailed analysis.

A. **Alternative 1: No Action.** Alternative 1 consists of allowing the landfill site to remain as it currently is. Natural attenuation will gradually result in groundwater contaminant concentrations reaching background levels over time. This alternative projects that natural biodegradative processes, combined with volatilization, dispersion, adsorption, and dissolution (stormwater infiltration) will result in restoration of groundwater over time. Besides being a viable remedial alternative for the Farwell Landfill, this alternative is developed to serve as a baseline of comparison for the other remedial alternatives. Although this alternative is termed no action, existing operation and maintenance activities will continue. These practices include quarterly groundwater monitoring as part of the closure plan, leachate collection and disposal (both current practices at the landfill), and monthly inspections. The current practice of mowing the cover once every two years will also continue.

B. **Alternative 2: Institutional Measures.** Alternative 2 also relies upon natural processes to attenuate the dissolved organic contaminants in the groundwater to background levels. However, to help preserve the integrity of the low permeability soil cap, the existing fence along Farwell Road and the railroad right-of-way would be supplemented with a hedge consisting of thorny shrubs to limit access to the landfill. By providing access restrictions, the potential for trespassers to damage the existing cover on the landfill and cause potential erosion problems would be minimized. Access restrictions would also minimize the potential for exposure to the two ponds on the site.

Also included in Alternative 2 is continued implementation of the ongoing post-closure operation and maintenance activities, including the long-term quarterly groundwater monitoring program developed following closure of the landfill, continued leachate collection and disposal at a POTW, and periodic cap inspections and mowing. Continued groundwater monitoring will enable verification that attenuation of the dissolved organic contaminants is occurring as anticipated.

Finally, additional institutional controls may be warranted to prevent future exposure to impacted groundwater, both on the landfill property and in the area hydraulically downgradient from the landfill. First, signs could be posted on the landfill property advising that the water from the existing site well is not for potable purposes and that bottled water should be used for drinking. Two other options for institutional controls are also available for preventing future exposure. For the purposes of the FS, it has been assumed that the County would enact deed restrictions on their property south of the landfill, preventing future installation of drinking water wells within the area of impacted groundwater. Alternatively, the County could implement a monitoring program should installation of a well be warranted in the area of concern. Should VOCs be detected at concentrations above MCLs, then the County could provide and maintain bottled water for drinking or point-of-use treatment systems for each affected well.

C. **Alternative 3, Improved Consent Order Cap.** Alternative 3 is similar to Alternative 2 in that both include access restrictions (thorny hedge to supplement the existing fence), continued groundwater monitoring, continued leachate collection and off-site disposal, cap inspections and mowing, and implementation of institutional controls for the site. However, additional actions in the form of regrading and revegetating portions of the Phase I and II landfill are included. Some areas of settlement have occurred since the site was closed and the soil cap installed. The low areas collect ponded stormwater, resulting in localized areas with higher amounts of recharge.

Settlement is common for closed landfills and occurs as waste loads decompose, shift, or are compressed, resulting in surface depressions. Very often, some degree of periodic cap maintenance is necessary to maintain the effectiveness of the cap as waste compression and settlement continues. Settlement usually stops or slows significantly after a few years, so that an initial cap repair several years after closure is often all that is required. By regrading and reseeding specific areas where settlement has occurred, ponding is minimized and rainwater runoff is promoted. This, in turn, prevents infiltration of water through the cap. Thus, Alternative 3 would involve an initial repair of the existing cap followed by a periodic cap inspection and maintenance program.

Cap repairs can be undertaken by scraping the existing topsoil layer from depressed areas and filling in the depressed area with compacted soils that match the characteristics of the original barrier layer. Once regrading is complete, topsoil can be replaced and revegetated to ensure adequate protection from erosion which could damage the soil cap. If an inexpensive supply of topsoil is available, the repairs could be made on top of the existing cap without salvaging the topsoil.

For the purposes of the FS, it was assumed that approximately one third of the Phase I and II portions of the landfill have been affected by the settlement and approximately 15,000 cubic yards of clean fill would be required to regrade the site. It was also assumed that this site work would not adversely impact the gas vents in place in the existing cap. In practice, the amount of regrading would have to be evaluated during the remedial design phase of the project. It would then be determined whether gas vent extensions are required.

Two separate monitoring options are possible as part of this improved consent order cap alternative. Alternative 3A includes continued implementation of the existing post-closure quarterly groundwater monitoring plan. The current plan consists of three rounds/year of Part 360 routine parameters from nine wells and one sampling round/year of Part 360 baseline parameters from the same nine wells.

In contrast, Alternative 3B includes an expanded quarterly monitoring plan designed to collect data required to monitor natural attenuation of the VOCs detected in the area of groundwater impacts. This monitoring plan includes three quarters/year of routine parameters and one quarter/year of baseline parameters from three wells. This is supplemented by quarterly sampling from an additional 11 monitoring wells for baseline parameters and dissolved gases (CO_2, O_2, and CH_4). Finally, annual samples will be collected from three private wells for baseline parameters. Table 5-2 summarizes the monitoring programs for both alternatives.

D. **Alternative 4, 1988 Part 360 Cap.** Similar to Alternative 3B, this alternative consists of implementation of a monitoring program designed to monitor the progress of natural attenuation, continued leachate collection and off-site disposal, and periodic cap inspections and mowing. However, the perimeter hedge is not required, but may be added later if evidence of significant use of the site by trespassers occurs. In addition to the use of institutional controls, this alternative includes source containment in the form of construction of a multi-media cap in the Phase I and II areas consistent with 1988 6 NYCRR Part 360 regulations. Figure 5-1 illustrates the requirements of the 1988 Part 360 cap. Although a 12-inch gas venting layer is required over the soil covering the refuse, the adequacy of the existing gas venting trenches and vent system could be evaluated to determine if it needs to be upgraded to the 1988 requirements. Overlying this gas venting layer is an 18-inch soil barrier layer, normally consisting of clay, or an equivalent geomembrane layer (40 mil). Overlying the geomembrane is a 24-inch barrier protection layer (two 12-inch layers separated by geotextile) with a final 6-inch topsoil layer. Construction of this cap may require some site grading. Similar to Alternative 3, the existing layers of the cap may be scraped from the landfill and stockpiled for use in construction of the Part 360 cap.

E. **Alternative 5, 1988 Part 360 Cap and Groundwater Collection and Disposal.** Alternative 5 consists of implementation of Alternative 4 with the addition of groundwater recovery using collection wells and/or a trench. The wells and/or trench would be placed downgradient of the landfill in the southern and eastern direction. Groundwater would be pumped to storage tanks located on County owned property and managed along with the collected leachate from the existing system. This alternative would also include implementation of a revised monitoring program designed to verify the capture efficiency of the groundwater collection system. For the purposes of this FS, it was assumed that two recovery wells are sufficient for groundwater collection and that each well would recover groundwater at 10 gal/min. It is noted, however, that the naturally low permeability of area till will probably minimize the influence of individual recovery wells to the point that adequate groundwater control could only be achieved by an excessive number of wells. Thus, it is highly probable that more than two wells would be needed. This would be determined during remedial design. Recovered water would be transported to a POTW for disposal with the leachate under the existing contract and price. During remedial design, the actual recovery system size would be determined. Should the cost increase for disposal of combined leachate and groundwater in the future, the County could then evaluate options, such as air stripping, for on-site treatment of the combined flows could be done in the future, once flows and loadings have stabilized.

5.3 SCREENING CRITERIA

Once remedial alternatives are established for a site, a detailed evaluation of each alternative is undertaken with the goal of selecting a preferred remedial alternative for the site in question. The detailed evaluation is conducted using evaluation criteria specified by 6 NYCRR Part 375, which are consistent with criteria specified in CERCLA. The evaluating criteria are as follows:

1. Overall protection of human health and the environment.
2. Compliance with SCGs.
3. Long-term effectiveness and permanence.
4. Reduction of toxicity, mobility, or volume.
5. Short-term effectiveness.
6. Implementability.
7. Cost.

Two additional criteria, state and community acceptance, are also evaluated before the Record of Decision process finalizes the selection of a remedial alternative. However, these issues are not addressed as part of the preliminary FS report. Once public comments are received on this report and the Preliminary Remedial Action Plan (PRAP) prepared by NYSDEC based on recommendations in the final FS, these last two criteria are addressed in the ROD for the site.

5.4 DETAILED EVALUATION OF ALTERNATIVES

A. **Overall Protection of Human Health and the Environment.** The qualitative risk assessment done as part of the Remedial Investigation did not identify any current risks to human health associated with the landfill given the current land use in the surrounding area. Although contaminants are present in the groundwater, there are no complete exposure pathways by which humans can be exposed to the contaminants. The only well in the area is the landfill supply well, which is not used for potable water and is posted accordingly. There are no wells located hydraulically downgradient from the landfill. Because there is no chance for exposure to the groundwater contaminants, all of the remedial alternatives can be thought of as being protective of human health. In the future, however, if the county owned land in the vicinity of the groundwater plume is developed, it is likely that unacceptable risks would be associated with ingestion of the water or inhalation and dermal contact during showering and/or bathing. Therefore, alternatives which include long-term monitoring of the groundwater, especially at the downgradient edge of the plume (Alternatives 3B, 4, and 5), provide a greater degree of assurance that natural attenuation of the contaminants is occurring over time.

With respect to protection of the environment, Alternatives 4 and 5 can be considered to be most protective of the environment, as both provide for an upgraded cap over the entire Phase I and II portions of the landfill. Presumably the low concentration of organic contaminants in the groundwater results from percolation of stormwater through the refuse disposed in the landfill. Because upgrading the cap to 1988 Part 360 requirements includes a barrier protection layer, it is likely that the improved cap would result in reduced opportunities for stormwater infiltration. This in turn would reduce dissolution of waste-related contaminants and associated leachate production. However, both Alternatives 3A and 3B will result in reduced infiltration because the regraded cap will promote stormwater runoff instead of the current situation of ponding in areas where the landfill has settled. By reducing the opportunity for stormwater to pond, Alternatives 3A and 3B may achieve almost the same degree of protectiveness toward the environment. The no action alternative (Alternative 1) will not provide any additional measures to protect the environment beyond what the existing cap provides. Alternative 2, institutional controls, provides some additional protection over existing conditions by reducing access to the site, thereby preventing damage to the existing cap. However, stormwater ponding will not be reduced or eliminated.

B. **Compliance with SCGs.** This criterion is used to evaluate how each remedial alternative complies with applicable or relevant and appropriate standards, criteria, and guidance documents, as required by NYCRR Part 375 regulations. SCGs for the Farwell Landfill are identified in Chapter 3 of this report. Five of the SCGs refer to concentration limits for contaminants in groundwater. Only Alternative 5 provides for active remedial options associated with the current levels of groundwater contamination. However, because there is some evidence that the organic contaminants in the groundwater are degrading, it is likely that this natural attenuation will eventually result in each of the alternatives achieving contaminant specific SCGs given enough time. Because Alternatives 3B, 4, and 5 each include a monitoring program to assess the water quality in off-site private wells, it is likely that all these options can be considered as being the only alternatives that will verify over time that compliance with SCGs has been accomplished through natural attenuation.

Two of the SCGs identified in Chapter 3 refer to closure requirements for landfills. Only Alternatives 4 and 5 address the 1988 NYCRR Part 360 requirements for landfill closure.

However, since the landfill was closed in accordance with requirements detailed in a Consent Order imposed by NYSDEC, it is assumed that the Consent Order requirements are considered to be SCGs for the site. Because of the degree of settlement in portions of the landfill, the current condition of the cap is not considered adequate, and, therefore, Alternatives 1 and 2 do not meet all SCGs for landfill closure.

All the alternatives can be considered to be in compliance with the remainder of the SCGs identified in Chapter 3 of this report.

C. **Long-Term Effectiveness and Permanence.** This criterion addresses the results of a remedial alternative in terms of its permanence and the quantity and/or nature of the waste or residual remaining after the alternative has been implemented. Because the source of the groundwater contaminants remains present in the landfill with each of the alternatives, none of the alternatives are considered permanent solutions. Because long-term monitoring is specified as part of all the alternatives, should contaminant concentrations increase in the future, additional actions may become necessary. However, the low concentrations of contaminants do not indicate the presence of a large, active source of contamination within the landfill that must be removed or treated in place. Because it is likely that natural attenuation of contaminant levels will continue, all alternatives can be considered as providing for long-term effectiveness. Alternative 5, which includes groundwater recovery and off-site disposal, may be considered the most effective long-term option. However, it is believed that permeabilities of site soils may be too low to practically implement groundwater recovery, as noted previously. Remedial design would need to address this. Alternatives 3A, 3B, and 4 are also apt to be more cost effective long term than Alternatives 1 and 2 because of the improvements to the cap.

D. **Reduction of Toxicity, Mobility, or Volume of Contaminants.** Although none of the alternatives address the reduction in toxicity portion of this screening criterion, the current site information does not affirm the need for active source reduction or treatment. Alternative 5, which includes recovery of groundwater within the contaminant plume, provides for actions that will reduce both the volume and mobility of the contaminants in the groundwater.

It should be remembered that groundwater chemistry monitored during the RI indicates that natural attenuation of the groundwater contaminants is occurring at the site. The collective processes termed "natural attenuation" include processes that result in degradation, often coupled with retardation, of the contaminants of concern identified at the site. If this continues to be the case, then, all alternatives can be thought of as including passive options for reducing toxicity, volume, and mobility of the contaminants.

The mobility of the contaminants is influenced by the amount of continued infiltration of stormwater through the refuse mass in the landfill. Alternatives 3 (both A and B), 4, and 5 all include actions that will restore appropriate grades to the site and therefore reduce ponding of stormwater by promoting runoff. Consequently, these alternatives will likely result in a reduction in the mobility of the contaminants, while Alternatives 1 and 2 will not likely impact the mobility of the contaminants in the groundwater. Because Alternatives 4 and 5 include the addition of a significant barrier protection layer to the landfill cap in addition to the existing 6-inch topsoil layer, these alternatives will likely be associated with less stormwater recharge than Alternatives 3A and 3B, and will therefore result in a greater reduction in mobility of contaminants. A quantitative assessment of the ability of each of the alternatives to prevent stormwater recharge is not possible at this time.

E. **Short-Term Effectiveness.** This criterion assesses the effects of the alternative during construction and implementation of the remedial actions. Because Alternatives 1 and 2 could be implemented almost immediately, there are no adverse short-term effects associated with either of these options. Alternatives 3A and 3B include regrading portions of the cap. If the existing topsoil is removed and stockpiled as part of the implementation of these alternatives, storm events could result in erosion of the stockpiled soil. Construction of a 1988 Part 360 cap (Alternatives 4 and 5) could also result in erosion of stockpiled soil if a significant storm occurred during the construction period. Stormwater pollution prevention plans should be implemented during construction of these alternatives to prevent environmental impacts associated with erosion and transport of solids. Should the existing gas vents need to be supplemented or improved upon during construction of Alternatives 4 or 5, there is the possibility that some of the refuse could become exposed to stormwater. If so, there would be short-term impacts on the environment associated with increased production of leachate and mobility of contaminants. Construction worker exposure to exposed refuse would be managed by implementation of a site health and safety plan.

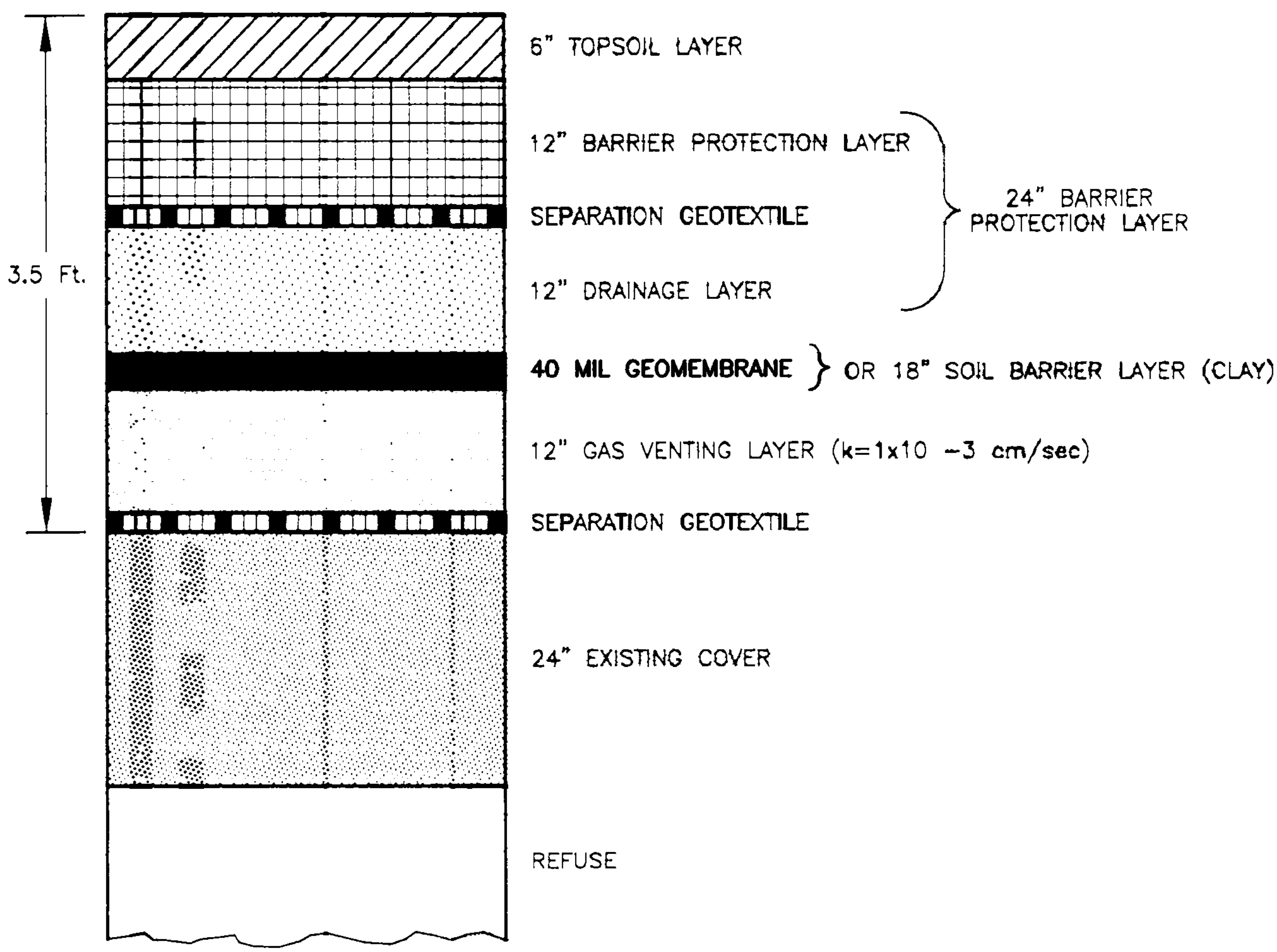
F. **Implementability.** Obviously the most easily implemented alternative is the no action alternative (Alternative 1). Similarly, Alternative 2, which includes only institutional controls, is easily implemented. Alternatives 3A and 3B require more time to implement, but do not require any specialized contractors or construction equipment. Alternative 5 would be the most difficult to implement. It should be noted that since all of the remedial alternatives can be implemented using standard equipment and simple construction practices, extensive pilot testing, or other specialized pre-design and construction techniques, are not required. Therefore, all alternatives are readily implemented.

G. **Cost.** Cost estimates were prepared for each of the remedial alternatives identified for the Farwell landfill site (refer to Appendix A for details). Capital costs include installation of the perimeter hedge for Alternative 2, and the hedge combined with grading and seeding for Alternatives 3A and 3B. The cost estimate for Alternative 4 includes reworking the existing cap with a geomembrane and 18 to 24 inches of barrier protection layer. Unit costs are based on average contractors bid prices for landfill closure projects that occurred during the past five years. The cost for Alternative 5 include the same costs for Alternative 4 and additional costs associated with groundwater recovery and disposal. Contractors' bids for recently installed groundwater collection systems were used to estimate the costs for groundwater collection at the Farwell site. Capital costs for Alternatives 3B, 4, and 5 also include installation of additional monitoring wells needed for the natural attenuation monitoring plan. Table 5-3 presents a summary of the information in the detailed cost estimates. Capital costs range from $12,000 for institutional measures (Alternative 2); $380,000 to $420,000 for Alternatives 3A and 3B, respectively; $1,000,000 for Alternative 4; and $1,200,000 for Alternative 5. However, as noted previously, the capital cost for Alternative 5 may well be much higher in the event that many groundwater recovery wells are needed to achieve hydraulic control.

Operation and maintenance (O&M) costs for Alternatives 2 through 5 include groundwater monitoring, annual site inspections, five-year reporting, and mowing. Periodic cap repairs are included in Alternatives 3A, 3B, 4, and 5. Alternative 5 also includes O&M costs associated with groundwater collection, disposal, and associated monitoring. Table 5-3 also summarizes the O&M costs for each of the alternatives and the present value of each alternative, assuming a 30-year project life and a 5 percent discount rate. As expected, Alternative 5 is the most expensive alternative, with a present value of $4,000,000.

H. **Summary**. Table 5-4 presents a summary of the detailed evaluation of the remedial alternatives for the Farwell Landfill site. In general, the no action and institutional measure alternatives have been eliminated from consideration because they inadequately address the objectives for the site. Neither alternative includes measures that will reduce continued stormwater recharge in the areas of the landfill that have settled. Although Alternatives 4 and 5 provide for more protection against further contaminant mobility and leachate production, the additional costs associated with the upgraded cap may not justify the selection of either alternative in a rural area such as Cattaraugus County where pressures to develop the adjacent property are negligible. As Alternatives 3A and 3B include measures to reduce stormwater infiltration, but are less costly than constructing a new cap over the entire Phase I and II areas of the landfill, selection of Alternative 3A or 3B appears to be more appropriate for long-term management of the site and the site impacts. Because Alternative 3B includes implementation of a monitoring plan designed to assess the progress of natural attenuation at the site, including evaluation of natural attenuation at the downgradient portion of the plume, and sampling of off-site private wells to verify impacts are not migrating toward groundwater users, Alternative 3B provides more assurance for long-term protection of human health and the environment. Therefore, Alternative 3B is recommended as the preferred remedy for the site.

1988 PART 360 CAP



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DATE: 1/99 JOB No.: 80189FA

FARWELL LANDFILL SITE – CATTARAUGUS COUNTY
DEPARTMENT OF PUBLIC WORKS
PRELIMINARY FS

FIGURE 5-1
DETAIL: 1988 PART 360 CAP (TYPICAL)

TABLE 5-1
Farwell Landfill Remedial Alternatives
Farwell Landfill Feasibility Study
Cattaraugus County, NY

TECHNOLOGY TYPE/PROCESS OPTION		REMEDIAL ALTERNATIVES					
		1	2	3		4	5
Option	Portion of Site			A	B		
No Action	Entire Site	*					
Natural Attenuation	Area of Impacted Groundwater	*	*	*	*	*	
Access Restrictions	North, West, South Landfill Perimeter		*	*	*		
Monitoring program	Existing monitoring program	*	*	*			
	Modified monitoring program				*	*	*
Deed Restrictions	Area of Impacted Groundwater		*	*	*	*	*
Regrade/Revegetate Cap	Depressed areas of settlement			*	*		
1988 Part 360 Cap	Phase I and II area					*	*
Leachate Collection	Existing System	*	*	*	*	*	*
Groundwater Collection	Downgradient of landfill in plume						*
Disposal at POTW	Leachate only	*	*	*	*	*	
	Leachate and Collected Groundwater						*

TABLE 5-2
Alternative 3 Monitoring Program Details
Farwell Landfill Feasibility Study
Cattaraugus County, NY

Alternative	Sampling Locations	Sampling Frequency	Parameters: Part 360 Baseline	Parameters: Part 360 Routine	Parameters: Dissolved Gases[1]
Alternative 3A (Existing Monitoring Plan)	Monitoring wells 14S, 14I, 15S, 15I, 16S, 16D, 17S, 17I, 13D	3 rounds/yr (Quarterly basis)		X	
		1/yr (Quarterly basis)	X		
Alternative 3B (N.A. Monitoring Plan)	Monitoring wells 17S, 17I, 13D	3 rounds/yr (Quarterly basis)		X	
		1/yr (Quarterly)	X		
	MWs 14S, 14I, 15S, 15I, 16S, 16D, 19S, 20D, 21S, 22S, 23S	4 rounds/yr (Quarterly basis)	X		X
	3 private wells	1/yr (Annual)	X		X

[1] Dissolved Gases include carbon dioxide, oxygen, and methane.

TABLE 5-3
Remedial Alternative Cost Summary
Farwell Landfill Feasibility Study
Cattaraugus County, NY

ALTERNATIVE	CAPITAL COST	ANNUAL O&M COST	PRESENT VALUE[1]
Alternative 1: No Action	0	$23,000	$350,000
Alternative 2: Institutional Controls	$12,000	$23,000	$360,000
Alternative 3A: Improved Consent Order Cap, Institutional Controls	$380,000	$30,000	$800,000
Alternative 3B: Improved Consent Order Cap, NA Monitoring	$420,000	$60,000	$1,300,000
Alternative 4: 1988 Part 360 Cap	$1,500,000	$60,000	$3,000,000
Alternative 5: 1988 Part 360 Cap and Groundwater Recovery/Disposal	$1,900,000	$170,000	$5,000,000

[1] Present Value is calculated using 5% discount rate and 30 year project life.
Refer to detailed cost estimate tables in Appendix A for specific components of each cost estimate.

TABLE 5-4
Summary - Detailed Evaluation of Alternatives
Farwell Landfill Feasibility Study
Cattaraugus County, NY

REMEDIAL ALTERNATIVE	CRITERIA	EVALUATION SUMMARY
Alternative 1: No Action	Protection of Health and Environment	Provides no additional protection to environment beyond natural attenuation
	Compliance with SCGs	Does not comply with all SCGs
	Long-term Effectiveness / Permanence	Unknown, may require action in future
	Reduction of Toxicity, Volume, etc.	No additional reduction in toxicity, mobility, or volume of waste beyond natural attenuation
	Short-term Effectiveness	No short-term effects
	Implementability	Most easily implemented
	Cost (Present Value)	$350,000
Alternative 2: Institutional Measures	Protection of Health and Environment	Access and deed restrictions provide some additional protection to health and environment
	Compliance with SCGs	Does not comply with all SCGs
	Long-term Effectiveness / Permanence	Unknown, may require action in future
	Reduction of Toxicity, Volume, etc.	No additional reduction in toxicity, mobility, or volume of waste beyond natural attenuation
	Short-term Effectiveness	No short-term effects
	Implementability	Very easy to implement
	Cost (Present Value)	$360,000
Alternative 3A: Improved Consent Order Cap, Current Monitoring Plan	Protection of Health and Environment	Repairs to cap will provide some additional protection to the environment.
	Compliance with SCGs	Complies with some SCGs
	Long-term Effectiveness / Permanence	Unknown, may require action in future
	Reduction of Toxicity, Volume, etc.	Will reduce volume of leachate produced and the mobility of groundwater contaminants
	Short-term Effectiveness	Potential stormwater impacts during construction
	Implementability	Easy to implement
	Cost (Present Value)	$800,000

TABLE 5-4, continued

REMEDIAL ALTERNATIVE	CRITERIA	EVALUATION SUMMARY
Alternative 3B: Improved Consent Order Cap, Natural Attenuation Monitoring	Protection of Health and Environment	Repairs to cap and NA monitoring will provide some additional protection to health and the environment.
	Compliance with SCGs	Complies with some SCGs
	Long-term Effectiveness / Permanence	Unknown, may require action in future
	Reduction of Toxicity, Volume, etc.	Will reduce volume of leachate produced and the mobility of groundwater contaminants
	Short-term Effectiveness	Potential stormwater impacts during construction
	Implementability	Easy to implement
	Cost (Present Value)	$1,300,000
Alternative 4: 1988 Part 360 Cap	Protection of Health and Environment	Provides most protection to environment
	Compliance with SCGs	Complies with SCGs
	Long-term Effectiveness / Permanence	Will be more effective over time than Alt. 1 - 3
	Reduction of Toxicity, Volume, etc.	Will reduce volume of leachate produced and the mobility of groundwater contaminants
	Short-term Effectiveness	Potential stormwater impacts during construction
	Implementability	Easy, requires more effort than Alternatives 1 - 3
	Cost (Present Value)	$3,000,000
Alternative 5: 1988 Part 360 Cap, Groundwater Collection and Disposal	Protection of Health and Environment	Provides most protection to environment
	Compliance with SCGs	Complies with SCGs
	Long-term Effectiveness / Permanence	Will be more effective over time than Alt. 1 - 4
	Reduction of Toxicity, Volume, etc.	Will reduce volume of leachate produced and volume and the mobility of groundwater contaminants
	Short-term Effectiveness	Potential stormwater impacts during construction
	Implementability	Easy, requires more effort than Alternatives 1 - 4
	Cost (Present Value)	$5,000,000

TABLE A-1
COST ESTIMATE
Remedial Alternative 1 - No Action
Farwell Landfill Feasibility Study
Cattaraugus County, NY

ALTERNATIVE 1, No Action

Direct Capital Cost
There are no capital costs associated with implementation of this alternative.

Operating and Maintenance Costs

	Quantity	Units	Unit Cost	Total Cost
Monthly Site Inspections[1]	12	Man-day	$ 400	$4,800
Annual Site Inspection	2	Man-day	600	$1,200
Mowing (1 per every 2 years)	1	Lump Sum	1,000	$1,000
Leachate collection and disposal[2]	16,500	Gallons/mo	0.01	$2,000
Quarterly Monitoring - Labor/Analytical[3]	1	Lump Sum	9,585	$9,585
Annual Review	1	Lump Sum	3,000	$3,000
Five Year Review (annual escrow)	1	Lump Sum	1,000	$1,000
ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS				$23,000
Present Worth of Annual Operating Cost (30 Year Project life, i = 5%)				$350,000
REMEDIAL ALTERNATIVE 1 TOTAL ESTIMATED COST				$350,000

[1] Assumes monthly inspections require one person and one 8-hr. day.

[2] Assumes leachate disposal cost will remain constant over time (13,000 - 20,000 gal/mo.)

[3] Cost estimate assumes Quarterly Monitoring for 30 years per 6 NYCRR Part 360 Regulations. Monitoring plan and reporting will be same as is currently undertaken for site.

TABLE A-2

COST ESTIMATE

Remedial Alternative 2 - Institutional Controls

Farwell Landfill Feasibility Study

Cattaraugus County, NY

ALTERNATIVE 2, Institutional Controls

Direct Capital Cost

	Quantity	Units	Unit Cost	Total Cost
Perimeter Hedge	4	per 1000	$ 280	$1,100
Labor for installation of hedge	2	Man week	2,000	$4,000
Signage	1	LS	1500	$1,500
Total Direct Capital Costs				$7,000
Indirect Capital Cost				
Enact Deed Restrictions	1	LS	5,000	$5,000
Total Indirect Capital Costs				$5,000
Total Estimated Capital Cost				$12,000

TABLE A-2 (Continued)
ALTERNATIVE 2, **Institutional Controls**

Operating and Maintenance Costs

	Quantity	Units	Unit Cost	Total Cost
Monthly Site Inspections	12	Man-day	$ 400	$4,800
Annual Site Inspection	2	Man-day	600	$1,200
Mowing (1 per every 2 years)	1	Lump Sum	1,000	$1,000
Leachate collection and disposal[1]	16,500	Gallons/mo	0.01	$2,000
Quarterly Monitoring - Labor/Analytical[2]	1	Lump Sum	9,585	$9,585
Annual Review	1	Lump Sum	3,000	$3,000
Five Year Review (annual escrow)	1	Lump Sum	1,000	$1,000

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS $23,000

Present Worth of Annual Operating Cost (30 Year Project life, i = 5%) $350,000

Total Estimated Capital Cost $12,000

REMEDIAL ALTERNATIVE 2 TOTAL ESTIMATED COST** $360,000

[1] Assumes leachate disposal cost will remain constant over time (13,000 - 20,000 gal/mo.)

[2] Cost estimate assumes Quarterly Monitoring for 30 years per 6 NYCRR Part 360 Regulations. Monitoring plan and reporting will be same as is currently undertaken for site.

TABLE A-3

COST ESTIMATE

Remedial Alternative 3A - Improved Cap / Institutional Controls

Farwell Landfill Feasibility Study

Cattaraugus County, NY

ALTERNATIVE 3A: Improved Consent Order Cap / Institutional Controls

Direct Capital Cost

	Quantity	Units	Unit Cost	Total Cost
Off-site Fill	15,000	CY	$ 12	$180,000
Backfill, Grade	15,000	CY	6	$90,000
Finish Grading, 6-in. Topsoil, and Seeding	5	Acre	10,000	$50,000
Perimeter Hedge	4	per 1000	$ 280	$1,100
Labor for installation of hedge	2	Man week	2,000	$4,000
Total Direct Capital Costs				$320,000

Indirect Capital Cost

Engineering, Administrative (7%)	$22,000
Legal (Enact Deed Restrictions)	$5,000
Contingency (10%)	$32,000
Total Indirect Capital Costs	$60,000
Total Estimated Capital Cost	$380,000

TABLE A-3 (Continued)
ALTERNATIVE 3A: Improved Consent Order Cap / Institutional Controls

Operating and Maintenance Costs

	Quantity	Units	Unit Cost	Total Cost
Monthly Site Inspections	12	Man-day	$ 400	$4,800
Annual Site Inspection	2	Man-day	600	$1,200
Mowing (1 per every 2 years)	1	Lump Sum	1,000	$1,000
Leachate collection and disposal[1]	16,500	Gallons/mo	0.01	$2,000
Control Misc. areas of Erosion	1	Lump Sum	2500	$3,000
Quarterly Monitoring - Labor/Analytical[2]	1	Lump Sum	9,585	$9,585
Annual Review	1	Lump Sum	3,000	$3,000
Five Year Review (Annual Escrow)	1	Lump Sum	1,000	$1,000

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS $30,000

Present Worth of Annual Operating Cost (30 Year Project life, i = 5%) $460,000

Total Estimated Capital Cost $380,000

REMEDIAL ALTERNATIVE 3A TOTAL ESTIMATED COST $800,000

[1] Assumes leachate disposal cost will remain constant over time (13,000 - 20,000 gal/mo.)

[2] Cost estimate assumes Existing Quarterly Monitoring Program (9 wells) for 30 years per 6 NYCRR Part 360 Regulations. Monitoring plan and reporting will be same as is currently undertaken for site.

TABLE A-4
COST ESTIMATE
Remedial Alternative 3B - Improved Cap / Natural Attenuation /Modified Monitoring Program
Farwell Landfill Feasibility Study
Cattaraugus County, NY

ALTERNATIVE 3B: Improved Consent Order Cap, Natural Attenuation, and Modified Monitoring Program

Direct Capital Cost

	Quantity	Units		Unit Cost	Total Cost
Off-site Fill	15,000	CY	$	12	$180,000
Backfill, Grade	15,000	CY		6	$90,000
Finish Grading, 6-in. Topsoil, and Seeding	5	Acre		10,000	$50,000
Perimeter Hedge	4	per 1000	$	280	$1,100
Labor for installation of hedge	2	Man week		2,000	$4,000
Install 3 additional compliance wells	1	L S		22,000	$22,000
Total Direct Capital Costs					$350,000

Indirect Capital Cost

Engineering, Administrative (7%)	$25,000
Legal (Enact Deed Restrictions)	$5,000
Contingency (10%)	$35,000
Total Indirect Capital Costs	$70,000
Total Estimated Capital Cost	$420,000

TABLE A-4 (Continued)

ALTERNATIVE 3B: Improved Consent Order Cap, Natural Attenuation, and Modified Monitoring Program

Operating and Maintenance Costs

	Quantity	Units	Unit Cost	Total Cost
Monthly Site Inspections	12	Man-day	$ 400	$4,800
Annual Site Inspection	2	Man-day	600	$1,200
Mowing (2 times/year)	2	Lump Sum	4,000	$8,000
Leachate collection and disposal[1]	16,500	Gallons/mo	0.01	$2,000
Control Misc. areas of Erosion	1	Lump Sum	2500	$3,000
Quarterly Monitoring - Labor/Analytical[2]	1	Lump Sum	3,195	$3,195
NA.Monitoring - Analytical (11 wells)[3]	44	Samples	675	$30,000
NA. Monitoring - private wells[4]	3	Samples	375	$1,000
Quarterly Monitoring Summary[4]	4	Lump Sum	1,200	$4,800
Annual Review	1	Lump Sum	3,000	$3,000
Five Year Review (Annual Escrow)	1	Lump Sum	1,000	$1,000

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS	$60,000
Present Worth of Annual Operating Cost (30 Year Project life, i = 5%)	$900,000
Total Estimated Capital Cost	$420,000
REMEDIAL ALTERNATIVE 3B TOTAL ESTIMATED COST	$1,300,000

[1] Assumes leachate disposal cost will remain constant over time (13,000 - 20,000 gal/mo.)

[2] Cost estimate assumes existing Quarterly Monitoring plan will continue for 30 years for wells 17S, 17D, and 13D.

[3] Includes costs for quarterly monitoring (Part 360 baseline parameters and dissolved gases) for 11 wells. (monitoring wells 14S, 14I, 15S, 15I, 16S, 16D, 19S, 20D, 21S, 22S, and 23S)

[4] Includes additional costs associated with annual monitoring of private wells for Part 360 baseline parameters.

TABLE A-5
COST ESTIMATE
Remedial Alternative 4 - 1988 Part 360 Cap
Farwell Landfill Feasibility Study
Cattaraugus County, NY

ALTERNATIVE 4: 1988 Part 360 Cap

Direct Capital Cost

	Quantity	Units	Unit Cost	Total Cost
Contractor's Admin (Mob, bonding, etc.)[1]	1	LS	$ 136,500	$136,500
Off-site Fill	10,000	CY	12	$120,000
Backfill, Grade	10,000	CY	6	$60,000
Geomembrane	15	Acre	20,000	$300,000
Barrier Protection Layer	15	Acre	40,000	$600,000
Finish Grading, 6-in. Topsoil, and Seeding	15	Acre	10,000	$150,000
Install 3 additional monitoring wells	1	L S	22,000	$22,000
Total Direct Capital Costs				$1,400,000

Indirect Capital Cost

Engineering (5%)	$70,000
Legal (enact Deed restrictions)	$5,000
Contingency (10%)	$100,000
Total Indirect Capital Costs	$105,000
Total Estimated Capital Cost	$1,500,000

[1] Typically 10 - 15% of total Project cost

TABLE A-5 (Continued)
ALTERNATIVE 4: 1988 Part 360 Cap

Operating and Maintenance Costs

	Quantity	Units	Unit Cost	Total Cost
Monthly Site Inspections	12	Man-day	$ 400	$4,800
Annual Site Inspection	2	Man-day	600	$1,200
Mowing (2 times/year)	2	Lump Sum	4,000	$8,000
Leachate collection and disposal[1]	16,500	Gallons/mo	0.01	$2,000
Control Misc. areas of Erosion	1	Lump Sum	2500	$3,000
Quarterly Monitoring - Labor/Analytical[2]	1	Lump Sum	3,195	$3,195
NA.Monitoring - Analytical (11 wells)[3]	44	Samples	675	$30,000
NA. Monitoring - private wells[4]	3	Samples	375	$1,000
Quarterly Monitoring Summary[4]	4	Lump Sum	1,200	$4,800
Annual Review	1	Lump Sum	3,000	$3,000
Five Year Review (Annual Escrow)	1	Lump Sum	1,000	$1,000

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS $60,000

Present Worth of Annual Operating Cost (30 Year Project life, i = 5%) $1,000,000

Total Estimated Capital Cost $1,500,000

REMEDIAL ALTERNATIVE 4 TOTAL ESTIMATED COST $3,000,000

[1] Assumes leachate disposal cost will remain constant over time (13,000 - 20,000 gal/mo.)

[2] Cost estimate assumes existing Quarterly Monitoring plan will continue for 30 years for wells 17S, 17D, and 13D.

[3] Includes costs for quarterly monitoring (Part 360 baseline parameters and dissolved gases) for 11 wells. (monitoring wells 14S, 14I, 15S, 15I, 16S, 16D, 19S, 20D, 21S, 22S, and 23S)

[4] Includes additional costs associated with annual monitoring of private wells for Part 360 baseline parameters.

TABLE A-6
COST ESTIMATE
Remedial Alternative 5 - 1988 Part 360 Cap and Groundwater Collection and Disposal
Farwell Landfill Feasibility Study
Cattaraugus County, NY

ALTERNATIVE 5: 1988 Part 360 Cap and Groundwater Collection/Disposal

Direct Capital Cost

	Quantity	Units	Unit Cost	Total Cost
Contractor's Admin (Mob, bonding, etc.)[1]	1	LS	$ 136,500	$136,500
Off-site Fill	10,000	CY	12	$120,000
Backfill, Grade	10,000	CY	6	$60,000
Geomembrane	15	Acre	20,000	$300,000
Barrier Protection Layer	15	Acre	40,000	$600,000
Finish Grading, 6-in. Topsoil, and Seeding	15	Acre	10,000	$150,000
Install 3 additional compliance wells	1	L S	22,000	$22,000
Groundwater collection piping	1	Lump Sum	25,000	$25,000
Groundwater collection wells	1	Lump Sum	25,000	$25,000
Pumps	2	Each	10,000	$20,000
Additional Storage Tanks	2	Each	20,000	$40,000
Total Direct Capital Costs				$1,500,000

Indirect Capital Cost

Engineering, Administrative (10%)	$200,000
Legal (enact Deed restrictions)	$5,000
Contingency **(10%)**	$200,000
Total Indirect Capital Costs	$410,000
Total Estimated Capital Cost	$1,900,000

[1] Typically 10 - 15% of total Project cost

TABLE A-6 (Continued)
ALTERNATIVE 5: 1988 Part 360 Cap and Groundwater Collection/Disposal

Operating and Maintenance Costs

	Quantity	Units	Unit Cost	Total Cost
Monthly Site Inspections	12	Man-day	$ 400	$4,800
Annual Site Inspection	2	Man-day	600	$1,200
Mowing (2 times/year)	2	Lump Sum	4,000	$8,000
Groundwater Collection/Disposal	864,000	Gallons/mo	0.01	$104,000
Leachate collection and disposal[1]	16,500	Gallons/mo	0.01	$2,000
Control Misc. areas of Erosion	1	Lump Sum	2500	$3,000
Quarterly Monitoring - Labor/Analytical[2]	1	Lump Sum	3,195	$3,195
NA.Monitoring - Analytical (11 wells)[3]	44	Samples	675	$30,000
NA. Monitoring - private wells[4]	3	Samples	375	$1,000
Quarterly Monitoring Summary[4]	4	Lump Sum	1,200	$4,800
Annual Review	1	Lump Sum	3,000	$3,000
Five Year Review (Annual Escrow)	1	Lump Sum	1,000	$1,000

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS $170,000

Present Worth of Annual Operating Cost (30 Year Project life, i = 5%) $2,600,000

Total Estimated Capital Cost $1,900,000

REMEDIAL ALTERNATIVE 5 TOTAL ESTIMATED COST $5,000,000

[1] Assumes leachate disposal cost will remain constant over time (13,000 - 20,000 gal/mo.)

[2] Cost estimate assumes existing Quarterly Monitoring plan will continue for 30 years for wells 17S, 17D, and 13D.

[3] Includes costs for quarterly monitoring (Part 360 baseline parameters and dissolved gases) for 11 wells. (monitoring wells 14S, 14I, 15S, 15I, 16S, 16D, 19S, 20D, 21S, 22S, and 23S)

[4] Includes additional costs associated with annual monitoring of private wells for Part 360 baseline parameters.