REMEDIAL INVESTIGATION/FEASIBILITY STUDY
BEDFORD VILLAGE WELLS
SHOPPING ARCADE SITE
WESTCHESTER COUNTY, NEW YORK

FEASIBILITY STUDY REPORT
VOLUME NO. 4

Prepared For

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

By

DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS
SYOSSET, NEW YORK

and

SCS ENGINEERS
RESTON, VIRGINIA

FEBRUARY 1990

1884E

FEASIBILITY STUDY REPORT APPROVAL FORM

BEDFORD VILLAGE WELLS
SHOPPING ARCADE SITE
WESTCHESTER COUNTY, NEW YORK

Approved by:

Project Manager Richard M. Walka for T.F.M. Date: 2-15-90
Dvirka and Bartilucci Consulting Engineers

Assistant Project Manager Richard M. Walka Date: 2-15-90
Dvirka and Bartilucci Consulting Engineers

Project Manager Paul A. Mandeville Date: 2/15/90
SCS Engineers

1884E

Table of Contents

VOLUME NO. 4 – FEASIBILITY STUDY REPORT

Table of Contents (continued)

VOLUME NO. 4 – FEASIBILITY STUDY REPORT

Table of Contents (continued)

VOLUME NO. 4 – FEASIBILITY STUDY REPORT

List of Figures

VOLUME NO. 4 – FEASIBILITY STUDY REPORT

List of Figures (continued)

VOLUME NO. 4 – FEASIBILITY STUDY REPORT

List of Tables

VOLUME NO. 4 – FEASIBILITY STUDY REPORT

Section 1

1.0 INTRODUCTION

1.1 Purpose and Report Organization

The Westchester County Department of Health (WCDH) conducted a County wide survey of dry cleaners in 1978 due to suspected releases of dry cleaning solvents as a result of improper storage and handling practices. Two areas in Bedford Village, New York, were identified as areas potentially contaminated with dry cleaning wastes; the Shopping Arcade and the Hunting Ridge Mall. Remedial investigations for both sites were performed by Dvirka and Bartilucci (D&B) Consulting Engineers on behalf of the New York State Department of Environmental Conservation (NYSDEC). Details of these investigations can be found on file with the NYSDEC in a report prepared by D&B entitled "Remedial Investigation Report, Bedford Village Wells - Shopping Arcade Site," February 1990, and "Health Risk Assessment, Bedford Village Wells - Shopping Arcade Site," February 1990.

This report presents the results of the Feasibility Study (FS) for the Bedford Village Wells, Shopping Arcade Site in Westchester County, New York. It has been prepared by Dvirka and Bartilucci Consulting Engineers for the NYSDEC as part of the State of New York's efforts to remediate inactive hazardous waste sites. This FS report is based upon field data collection and assessment previously performed by D&B during its remedial investigations. These previous works evaluate the environmental and human health problems presented by the site.

The FS is intended to compare various remedial actions which could be implemented at the site, and to identify the recommended remedial action after considering the following criteria:

- o Short and long-term effectiveness;
- o Reduction of toxicity, mobility, and volume;
- o Implementability;
- o Cost;

- o Compliance with New York State Standards; and
- o Protection of human health and the environment.

As a minimum, we will include at least one remedial action for each of the following criteria:

- o Treatment or disposal at an off-site facility approved by NYSDEC (e.g., pump ground water and discharge to a waste water treatment facility);
- o An alternative which attains applicable New York State Standards (e.g., ground water pump-and-treat and injection);
- o An alternative which exceeds applicable New York State Standards (e.g., ground water treatment coupled with source excavation and soil treatment);
- o An alternative which will not attain applicable New York Standards, but which does reduce the likelihood of a threat from the problem (e.g., point-of-use ground water treatment or provision of public water supply);
- o An on-site treatment alternative (e.g., in situ stripping of volatiles from soils); and
- o A no-action alternative.

This FS has been conducted in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). This FS report is organized into this Introduction and four additional sections. Background information on the site follows this subsection. Section 2.0 presents remedial action objectives, general response actions, and the identification and screening of technologies. Section 3.0 presents remedial action alternatives and evaluates their effectiveness and implementability. Section 4.0 presents a detailed analysis of remedial action alternatives by evaluating the criteria identified in the previous paragraph. The remedial action recommended for implementation is presented in Section 5.0.

1.2 Site Background

1.2.1 Site Description

The Shopping Arcade Site, located on Old Post Road (Route 22) in the Town of Bedford, Westchester County, New York (see Figure No. 1-1) is within the Bedford Village business district. A 1979 sampling program conducted by the Westchester County Department of Health revealed that three private potable water supply wells tested were contaminated with volatile organic chemicals (VOCs), including tetrachloroethene, trichloroethene, and cis-1, 2-dichloroethene. An additional sampling program conducted in 1983 by NYSDEC showed only the Shopping Arcade well to be contaminated with VOCs. Due to the nature and the general location of the chemicals found, the source of contamination was thought to be from the dry cleaning establishment operating in the Shopping Arcade Site.

1.2.2 Site History and Previous Investigations

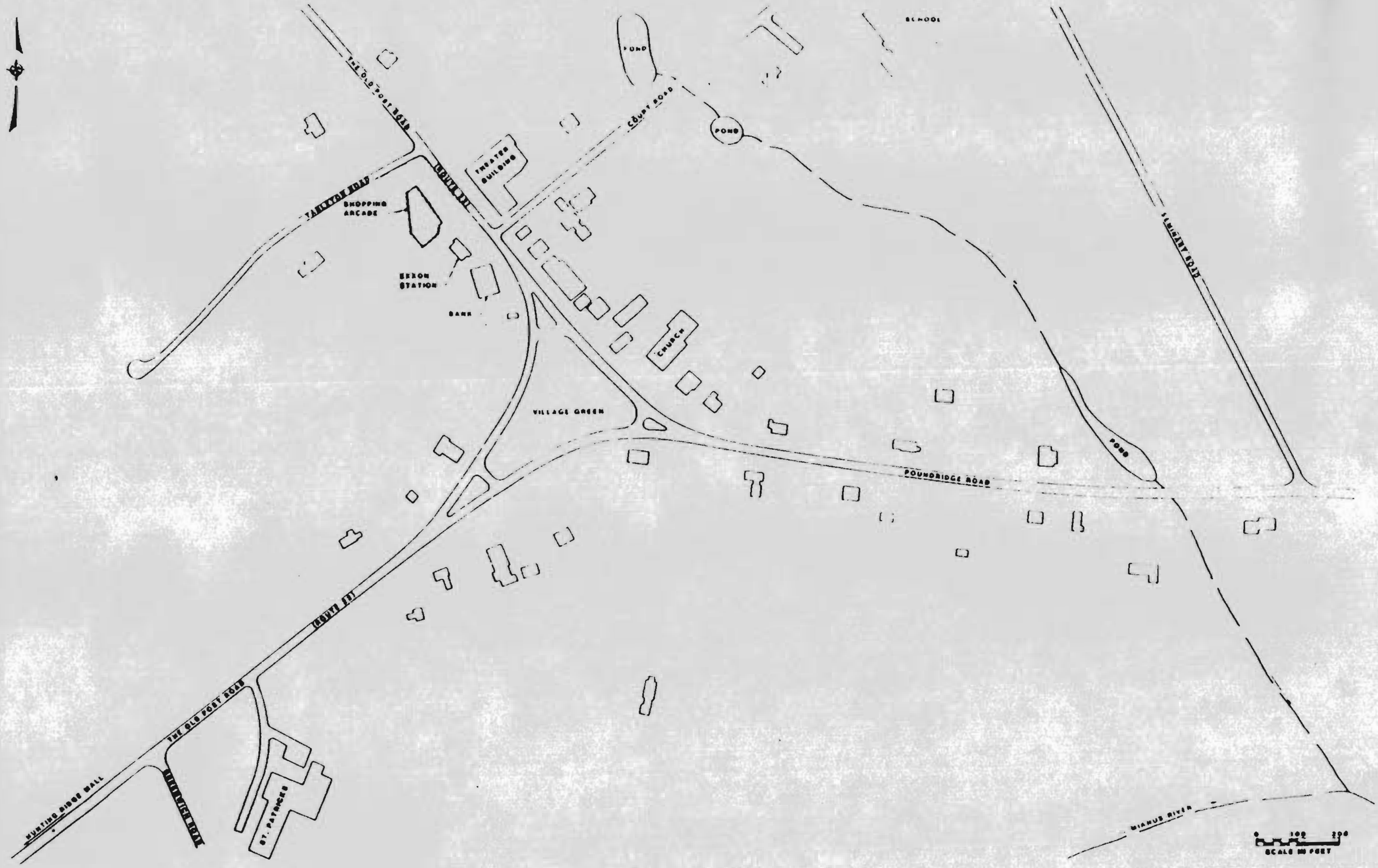
The following presents a chronological summary of historical events regarding the site. Additional, detailed information may be found in the Dvirka and Bartilucci Remedial Investigation Report on file with the NYSDEC.

1979 A Westchester County Department of Health (WCDH) testing program reveals that three wells, located in the Theatre Building, the Shopping Arcade, and an adjacent Exxon gasoline station, are contaminated with varying amounts of tetrachloroethene, trichloroethene, and cis-1,2-dichloroethene. The WCDH places all three wells under "boil water" notices. The Westchester County Commissioner of Health releases an "Information Bulletin" to certain dry cleaning establishments in Westchester County outlining proper storage and disposal methods for cleaning wastes.

1980 The Westchester County Department of Health removes the "boil water" notice from the Exxon gasoline station.

1982 Updated sampling indicates that only the Shopping Arcade well has unacceptable (greater than 50 ug/l) levels of tetrachloroethene. WCDH removes the "boil water" notice from the Theatre Building well, but recommends sampling twice a year.

Figure 1-1 - Shopping Arcade Site and Study Area



Prepared by Dvirka & Bartilucci Consulting Engineers

1983 Wehran Engineering, under contract to NYSDEC, submits the Bedford Village Wells Phase I Investigation Report. This report focuses only on the Shopping Arcade Site. See Figure Nos. 1-2 and 1-3 for the sampling locations for water and/or sediments.

1984 Wehran Engineering completes the Bedford Village Wells Phase II Investigation Report for the New York State Department of Environmental Conservation. The Phase II Report, which focuses primarily on the Shopping Arcade Site, concludes that VOC contamination still persists at this site. The report also contains sampling results for the Hunting Ridge Mall Site. Although the Mall is located just 4,000 feet southwest of the Shopping Arcade, researchers feel that the contamination at the two sites is not related. See Figure Nos. 1-4 and 1-5 for the sampling locations for water and/or sediments.

1985 The Shopping Arcade owner installs granular activated carbon (GAC) filters in May. The theatre building owner installs GAC filters in August.

1986 Tap water sampling programs undertaken by the Westchester County Department of Health and the United States Environmental Protection Agency (USEPA) reaffirm the presence of VOCs in three private wells. Low concentrations of VOCs also appear east and southeast of the Arcade in private wells which were previously uncontaminated.

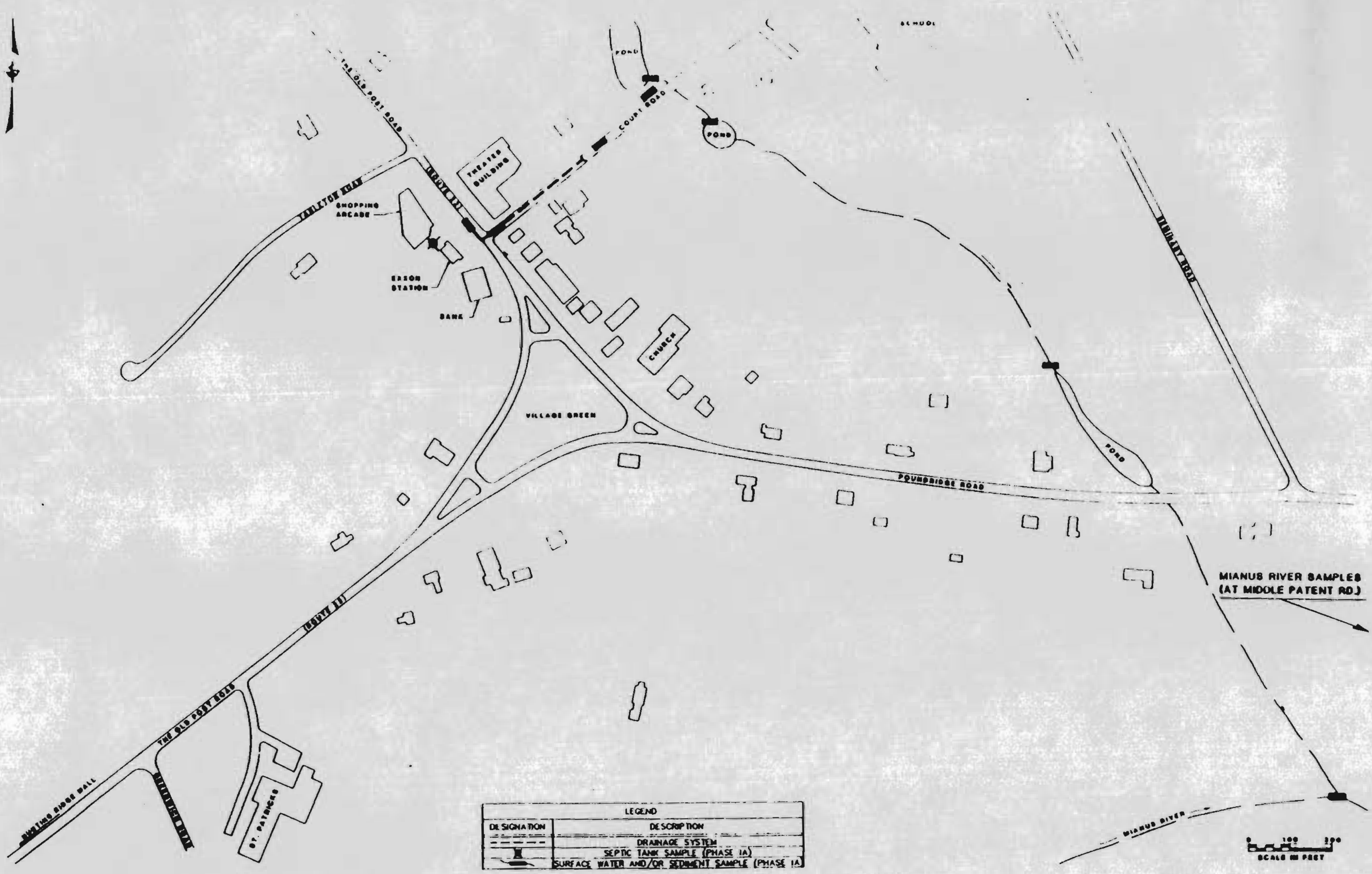
NYSDEC requests five engineering firms to submit proposals for the Bedford Village Wells Remedial Investigation/Feasibility Study project.

1987 NYSDEC, in cooperation with the Town of Bedford and the Westchester County Department of Health, selects Dvirka and Bartilucci (D&B) Consulting Engineers of Syosset, New York to undertake the project.

The State approves the Bedford Village Wells, Shopping Arcade Site and Hunting Ridge Mall Site RI/FS contract between D&B and the Department of Environmental Conservation.

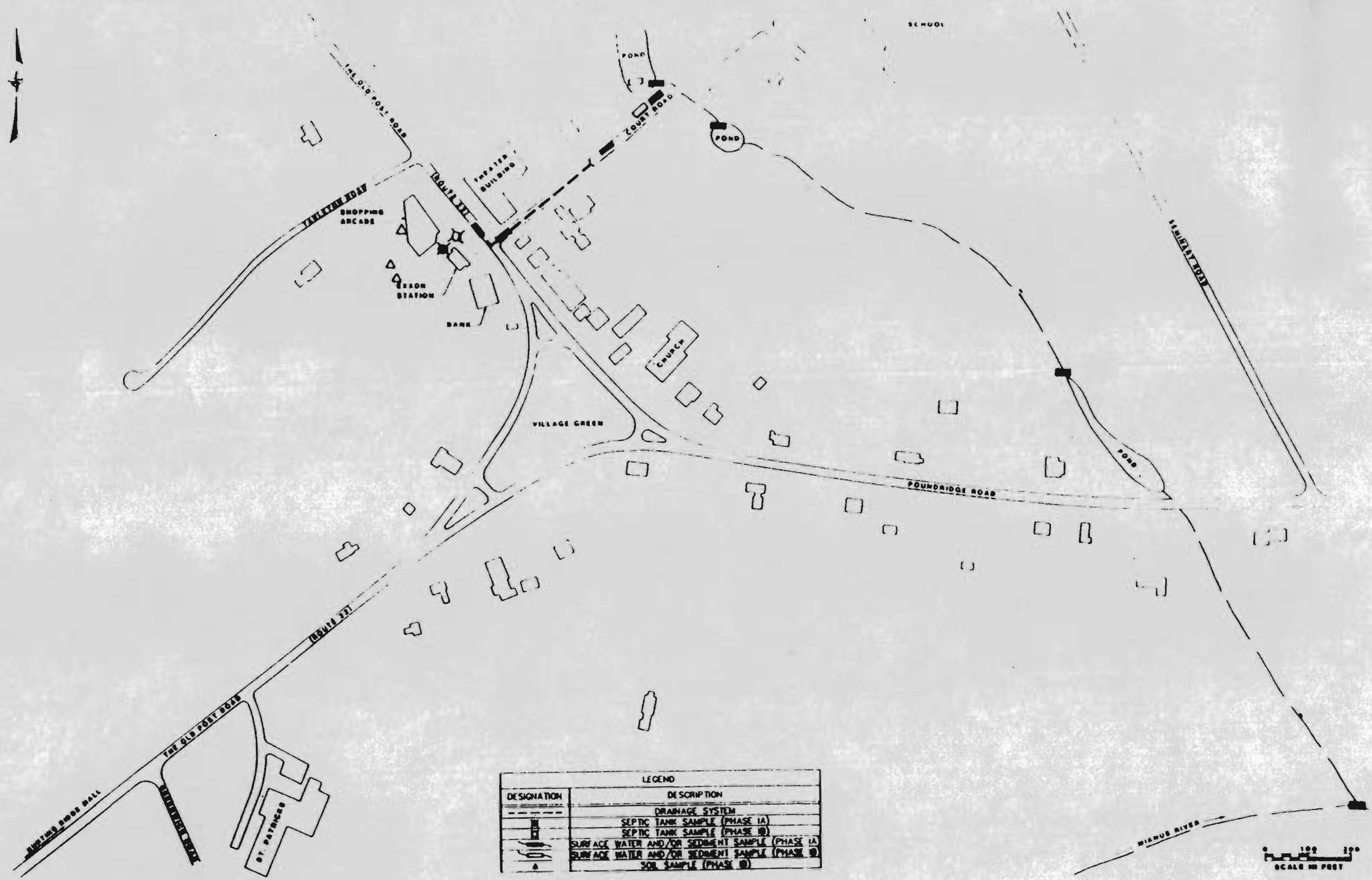
1989 D&B completes a preliminary draft of the RI Report, and a Health Risk Assessment was prepared by Sadat Associates, Inc. for D&B and NYSDEC.

Figure 1-2 - Phase IA Sampling Locations



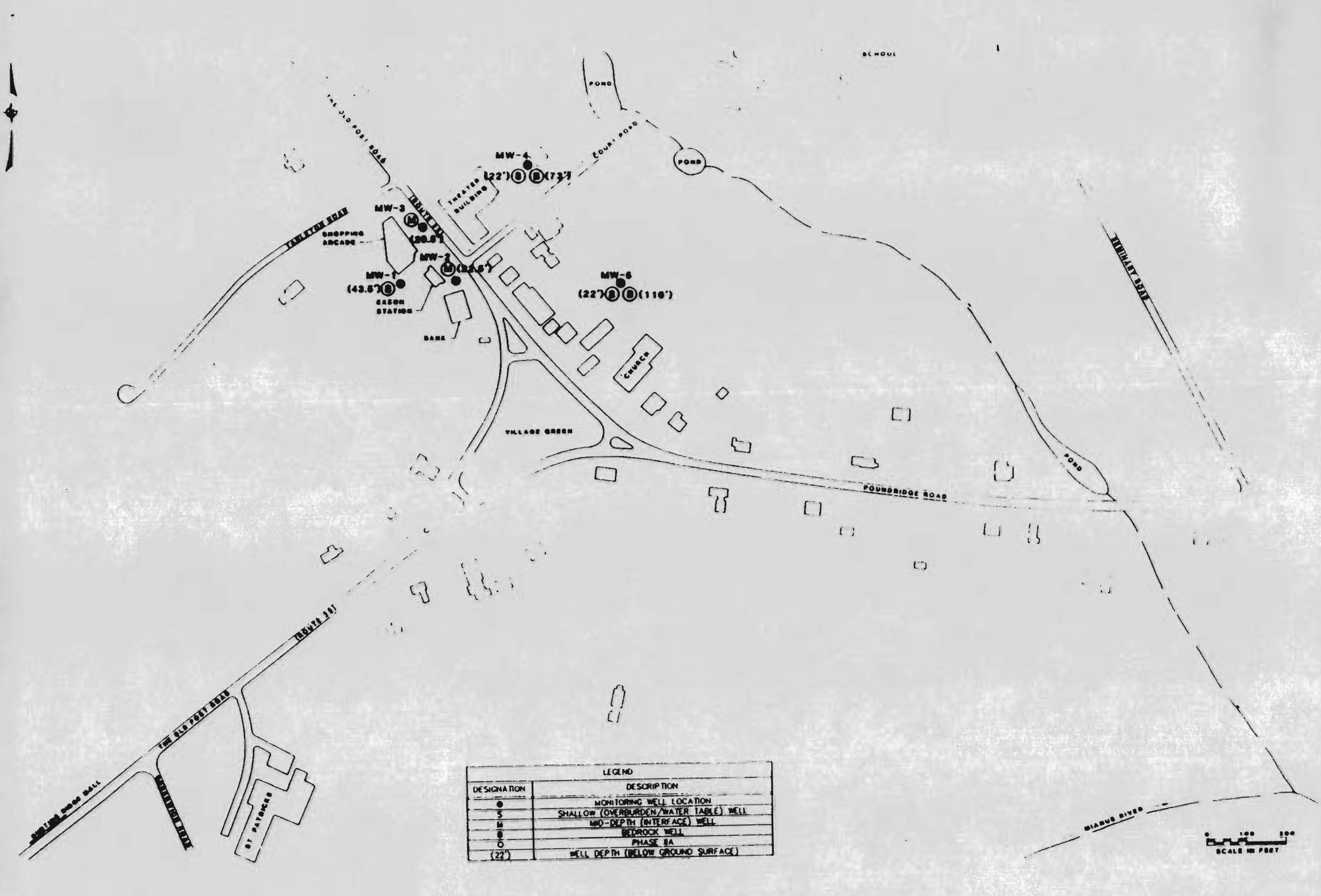
Prepared by Dvirka & Bartilucci Consulting Engineers

Figure 1-3. Phase IA and IB Sampling Locations



Prepared by Dvirka & Bartilucci Consulting Engineers

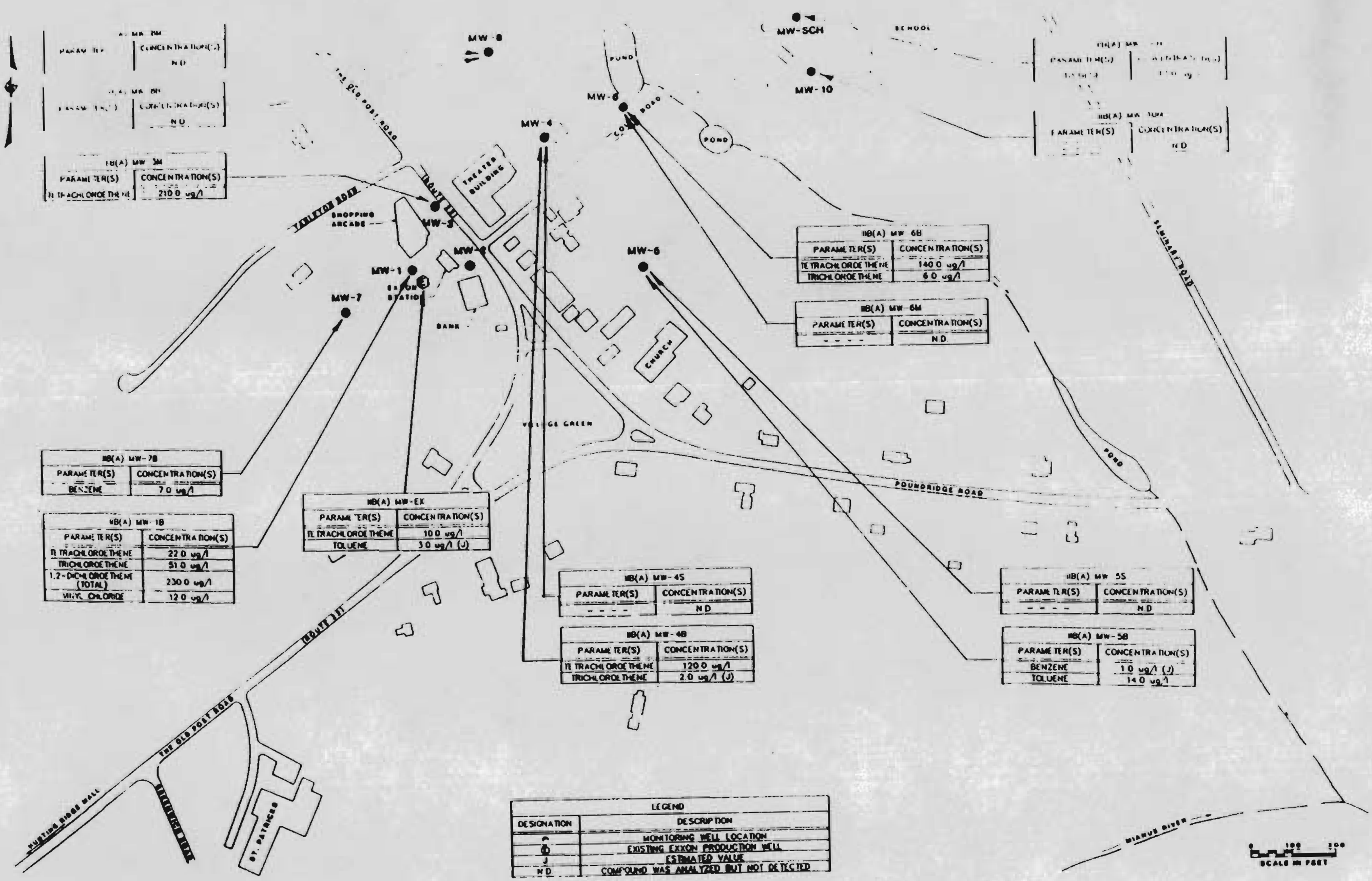
Figure 1-4 - Phase IIA Monitoring Well Locations



LEGEND	
DESIGNATION	DESCRIPTION
●	MONITORING WELL LOCATION
S	SHALLOW (OVERBURDEN/WATER TABLE) WELL
M	MID-DEPTH (INTERFACE) WELL
B	BEDROCK WELL
O	PHASE IIA
(22')	WELL DEPTH (BELOW GROUND SURFACE)

Prepared by Dvirka & Bartilucci Consulting Engineers

Figure 1-5 - Phase IIB Monitoring Well Locations



Prepared by Dvirka & Bartilucci Consulting Engineers

1990 D&B completes the final RI Report and Health Risk Assessment.

1.2.3 Nature and Extent of Contamination

The detailed findings of the Remedial Investigation sampling program and the public health and environmental risk assessment can be found in the following reports:

- o Remedial Investigation Report; "Remedial Investigation/Feasibility Study, Bedford Village Wells, Shopping Arcade Site, Westchester County, New York", Dvirka and Bartilucci Consulting Engineers, February 1990.

- o Remedial Investigation Report; "Health Risk Assessment; Remedial Investigation/Feasibility Study, Bedford Village Wells, Shopping Arcade Site, Westchester County, New York", Sadat Associates, Inc., February 1990.

A brief summary of the findings from the above mentioned reports is included in this section for the following sources and/or locations:

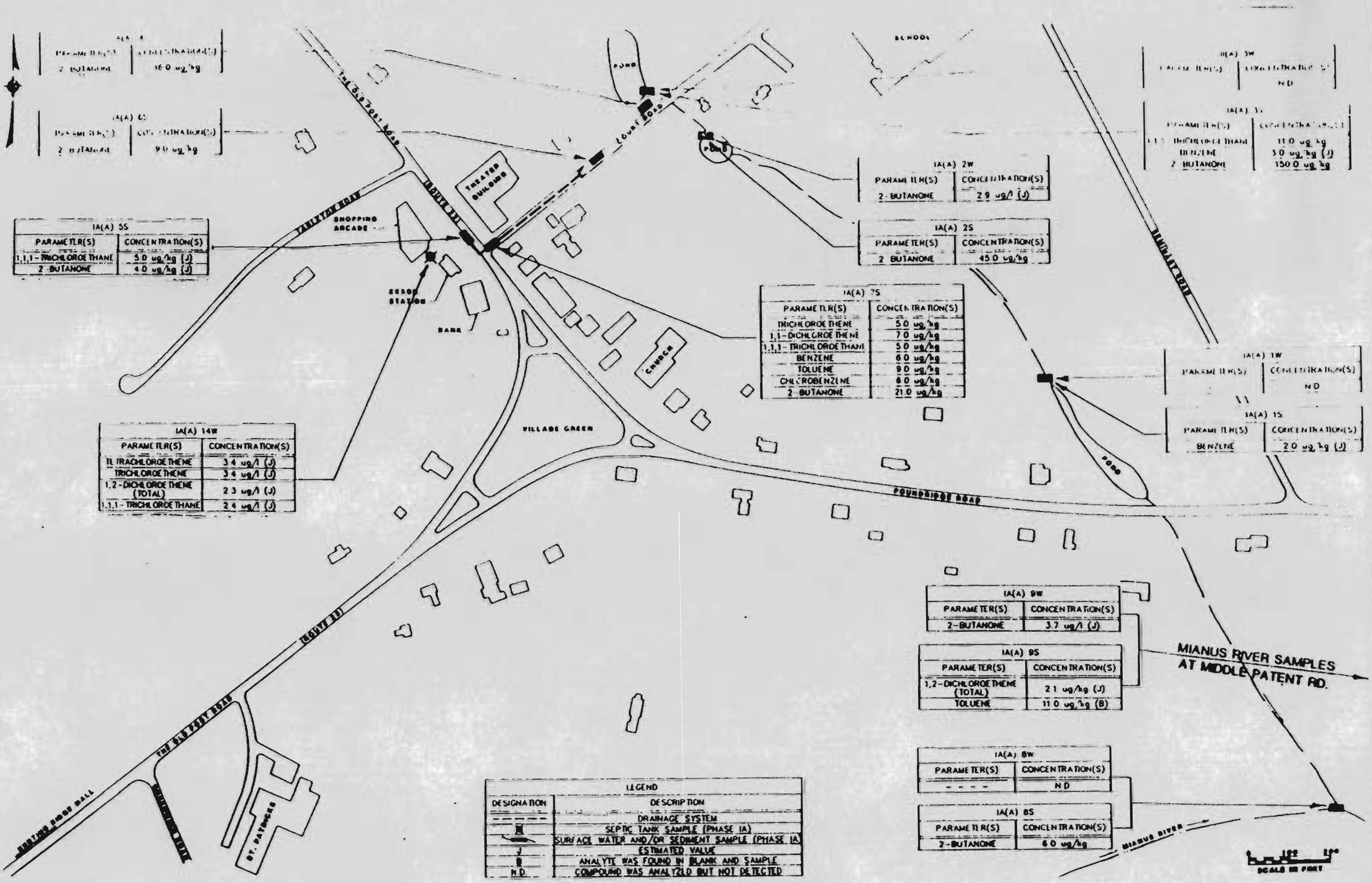
- o Sanitary System;
- o Storm Water Drainage System;
- o Wetlands and Ponds;
- o Mianus River;
- o Subsurface Soils;
- o Ground Water; and
- o Water Supply.

Sanitary System: The analysis of wastewater supernatant in the septic tank of the sanitary system that serves the Shopping Arcade (no sludge was found in the septic tank) indicated low concentrations of solvents typically used in dry cleaning and their breakdown products. This, together with the results obtained from analysis of soils behind the former location of the dry cleaning establishment and at the Arcade's sanitary disposal system leaching field, indicate that there is little continuing contamination resulting from the past dry cleaning operation, and little residual contamination in the soil resulting from prior discharges. However, concentrations of copper (1,750 ug/l), silver (332 ug/l) and phenol (46.8 ug/l) were detected in the Shopping Arcade's septic tank supernatant that exceeded effluent discharge standards. Although copper, silver, and phenol have not been found in ground water downgradient of the site at levels that exceed their respective ground water standards, the elevated concentrations of these parameters in the septic tank supernatant are still in contravention of effluent discharge standards.

Sampling of the Exxon gasoline station sanitary system septic tank sludge detected high levels of benzene (1,700 ug/kg) toluene (300,000 ug/kg), xylene (37,000 ug/kg) and other volatile aromatic hydrocarbons such as ethyl benzene (37,000 ug/kg) and 1,4-dichlorobenzene (2,500,000 ug/kg). Since benzene, toluene, and xylene have been found in the ground water downgradient of the site at concentrations that exceed ground water standards, it is possible that the sanitary system and underlying soil could be a continual source of this contamination and we believe prudent to require the Exxon gasoline station to pump-out and clean its sanitary system. Figure Nos. 1-6 and 1-7 present the results of sampling and analysis for Phase I investigations.

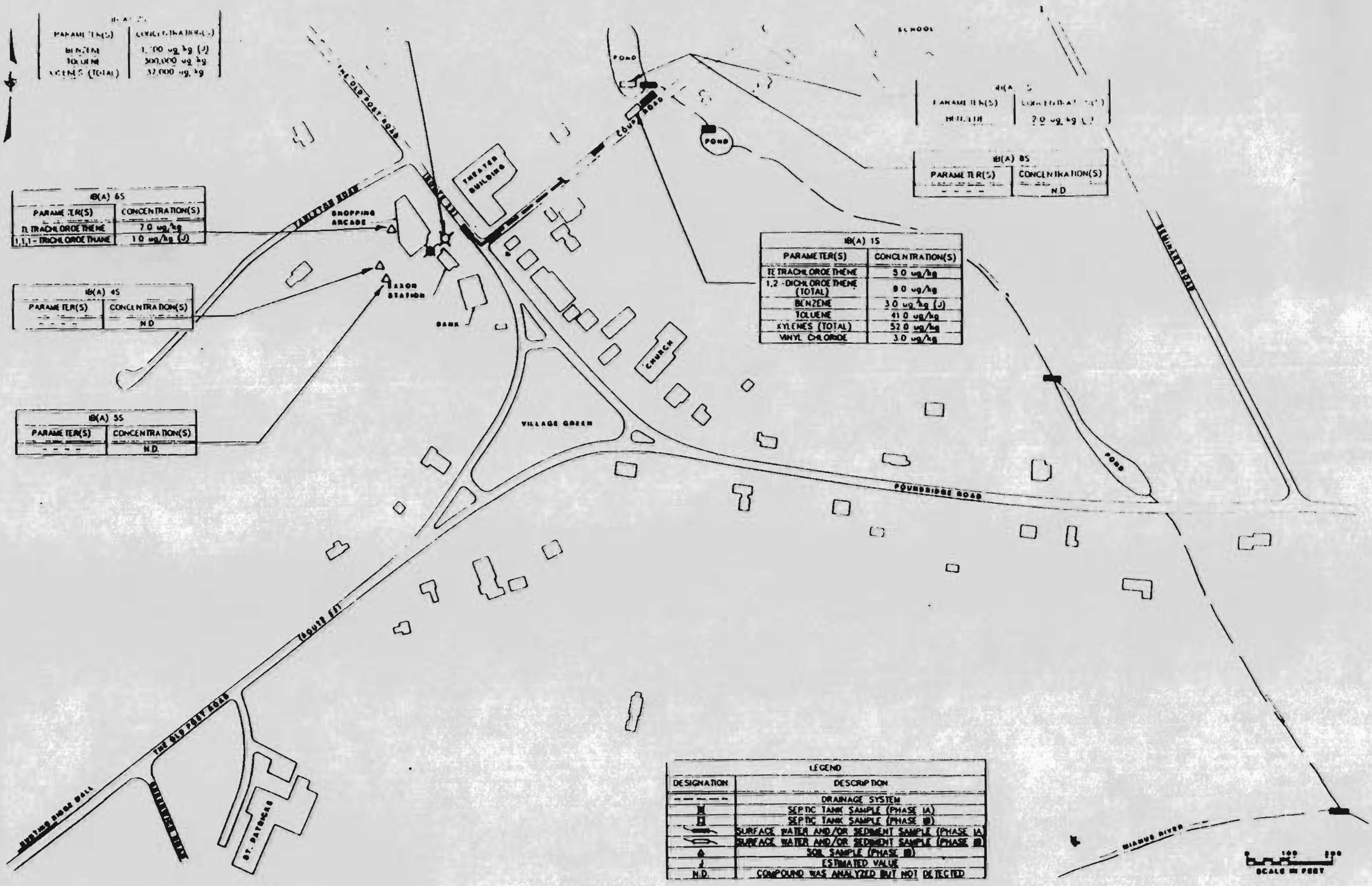
Storm Water Drainage System: Sampling of the sediment in the catch basins as part of the storm water drainage system serving the vicinity of the Shopping Arcade along Route 22 and Court Road and samples from the storm water drainage ditch along Court Road, showed little contamination (see Figure Nos. 1-6 and 1-7). The only sample locations that showed slightly elevated concentrations of volatile organic chemicals/analytes of concern was in the catch basin at the intersection of Court Road and Route 22 and where the storm water drainage ditch merges with the outlet of the pond north of Court Road. The following analytes of concern were detected in the catch basin sediment sample: trichloroethene (5.0 ug/kg); 1,1-dichloroethene (7.0 ug/kg); 1,1,1-trichloroethene (5.0 ug/kg); benzene (6.0 ug/kg); toluene (9.0 ug/kg); 2-butanone (21.0 ug/kg); chlorobenzene (6.0 ug/kg); and 4-methyl-2-pentanone (7.0 ug/kg). The ditch/pond confluence sample contained tetrachloroethene (5.0 ug/kg); 1,2-dichloroethene (9.0 ug/kg); benzene (3.0 ug/kg); toluene (41.0 ug/kg); total xylenes (52.0 ug/kg); and vinyl chloride (3.0 ug/kg). The pond sediment sample also contained several polycyclic aromatic hydrocarbons (PAHs), including pyrene (1,300.0 ug/kg), benzo (k) fluoranthene (930.0 ug/kg), benzo (a) anthracene (530.0 ug/kg), fluoranthene (922.0 ug/kg), benzo (b) fluoranthene (690.0 ug/kg), and phenanthrene (280.0 ug/kg). Recent evidence published in the Handbook of Toxic and Hazardous Chemicals and Carcinogens (M. Sittig, 1985) indicates that PAHs are somewhat ubiquitous and quite persistent in the environment, deriving primarily from petroleum and coal tar, as well as any hydrocarbon combustion processes. In the case of the Shopping Arcade Site, likely sources of these contaminants include stormwater runoff from gas stations and blacktop areas, and automobile exhaust depositions, among other sources. As such, control of the likely sources of PAH contamination would be extremely difficult, if not impossible. Given this, as well as the

Figure 1-6 - Phase IA Organic Chemical Sampling Results



Prepared by Dvirka & Bartilucci Consulting Engineers

Figure 1-7 - Phase IB Organic Chemical Sampling Results



Prepared by Dvirka & Bartilucci Consulting Engineers

fact that these contaminant levels are not considered significant in relation to guidance values established by the New Jersey Department of Environmental Protection (NJDEP) used in determining the need for evaluation of remediation (the guidance value for total PAHs/base neutral compounds is 10,000 ug/kg), remediation of these contaminants is not warranted.

Wetlands/Ponds: Results of sediment samples obtained from the wetlands and ponds north and south of Court Road, to which the storm water drainage system discharges, show little contamination (see Figure Nos. 1-6 and 1-7). Overall it appears that the sediment in the three ponds sampled within the study area contain only low concentrations of the organic compounds of concern and there does not appear to be a concern for future significant releases to the study area and Mianus River from these sediments. Low levels of only two analytes of concern (1,1,1-trichloroethene [11 ug/kg] and benzene [3 ug/kg]) were found only in the pond sediment north of Court Road. However, elevated levels of phenols (740 ug/kg) were found in the last pond in series (Long Pond) located north of Pound Ridge Road, as well as the first pond located north of Court Road (4,590 ug/kg). These concentrations of phenols/acid extractable compounds are less than the level established for evaluation of cleanup, which is 10,000 ug/kg.

Mianus River: Except for 2-butanone (methyl ethyl ketone), which was found in both upstream and downstream samples of water and sediment, the Mianus river showed little contamination (see Figure Nos. 1-6 and 1-7). However, the sediment sample obtained at the confluence of the wetland/pond system discharge to the river contained elevated concentrations of several PAHs, including fluoranthene (780.0 ug/kg), phenanthrene (520.0 ug/kg), benzo(a)pyrene (560.0 ug/kg), and pyrene (580.0 ug/kg), the total of which is substantially less than the NJDEP guidance levels for cleanup. In addition, a slightly elevated concentration of silver (28.0 ug/l) was found in the surface water sample taken at this location; but is less than the standard established for this metal.

A review of the analytical results generated from the Mianus River sampling illustrates relatively unrelated low level occurrence of organic chemical contamination from analytes of concern in the Mianus River, as well as those in the other surface waters in the study area. It does not appear that the Shopping Arcade study area is significantly contributing to contamination found in the Mianus River; however, it does appear that an unidentified source(s) of 2-butanone exists upgradient and possibly in the vicinity of the study area. The PAH compounds most likely result from coal tar and asphaltic compounds in roadway/surface runoff, as discussed above.

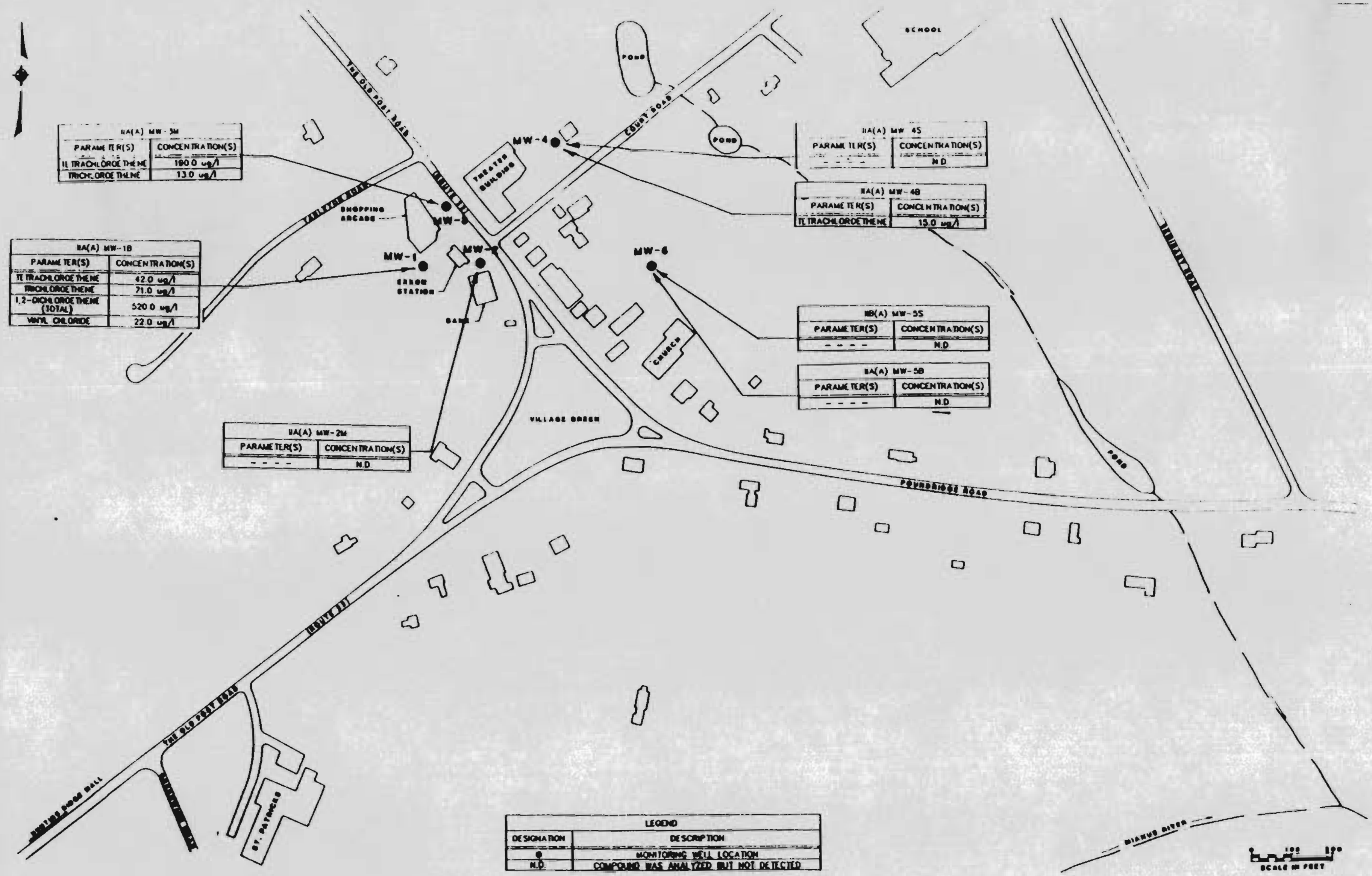
Subsurface Soils: Low levels of contaminants were found in the soils of five (MW-1B, MW-3M, MW-5S, MW-5B, and MW-11) of the seven monitoring well boreholes that were sampled. All of the wells were located downgradient of the Shopping Arcade and one exploratory borehole (MW-11) was located behind the former location of the dry cleaner. The highest concentrations of contaminants were found at MW-3M directly in front of the Arcade building. Three of the four samples collected contained detectable levels of contaminants. In the 5-7 foot sample, 6 ug/kg of toluene was detected. The 15-17 foot sample contained 22 ug/kg of trichloroethene and 32 ug/kg of toluene, and the 20-22 foot sample (bedrock was encountered at 23 feet) contained 34 ug/kg of trichloroethene and 50 ug/kg of toluene.

In addition, an exploratory source boring (MW-11) drilled directly behind where the former dry cleaning establishment was located contained low levels of the indicated contaminants at the indicated depths: tetrachloroethene (10.4 ug/kg) at 0-2 feet; trichloroethene (7.4 ug/kg) at 4-6 feet; trichloroethene (6.1 ug/kg) at 22-24 feet; and trichloroethene (5.7 ug/kg) at 30-32 feet.

All of the aforementioned levels are not considered significant in relation to guidance values established by the New Jersey Department of Environmental Protection (NJDEP) used in determining the need for remediation. That is, it is not believed that such levels in and of themselves would adversely impact the area ground water. Leaching of these contaminants into the ground water would be limited by percolation of water from the surface through the vadose zone and would be only minimally impacted areas that are paved. Additionally, natural attenuation factors including natural biodegradation would minimize these contaminant concentrations in the subsurface soil over time. Figure Nos. 1-8 and 1-9 present the results of sampling and analyses for Phase II investigations.

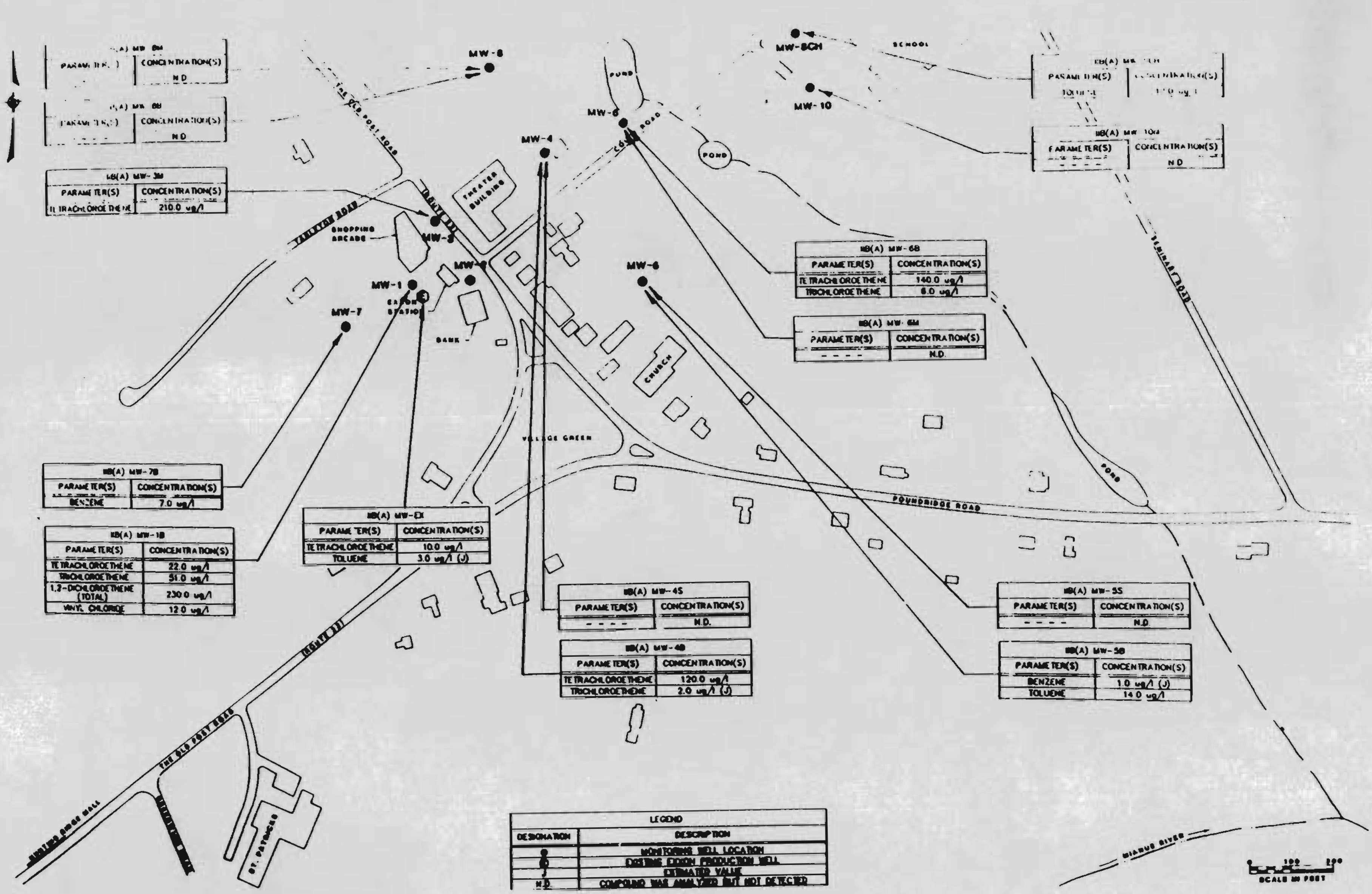
Ground Water: Based on the results of sampling monitoring wells and water supply wells in the study area, three areas of ground water contaminated primarily by the dry cleaning chemical, tetrachloroethene and its breakdown compounds (as well as benzene, toluene and xylene compounds) have been identified. The first area consisting of elevated levels of contamination comprising tetrachloroethene and its breakdown compounds exists in the unconsolidated/overburden deposits in front of the Shopping Arcade. This fairly high contaminated "pocket" of contamination is centered around MW-3M where a total average (average of Phase IIA and IIB sampling results) concentration of tetrachloroethene and its breakdown products was found to be 213 ug/l.

Figure 1-8 - Phase IIA Organic Chemical Sampling Results



Prepared by Dvirka & Bartilucci Consulting Engineers

Figure 1-9 - Phase IIB Organic Chemical Sampling Results



Prepared by Dvirka & Bartilucci Consulting Engineers

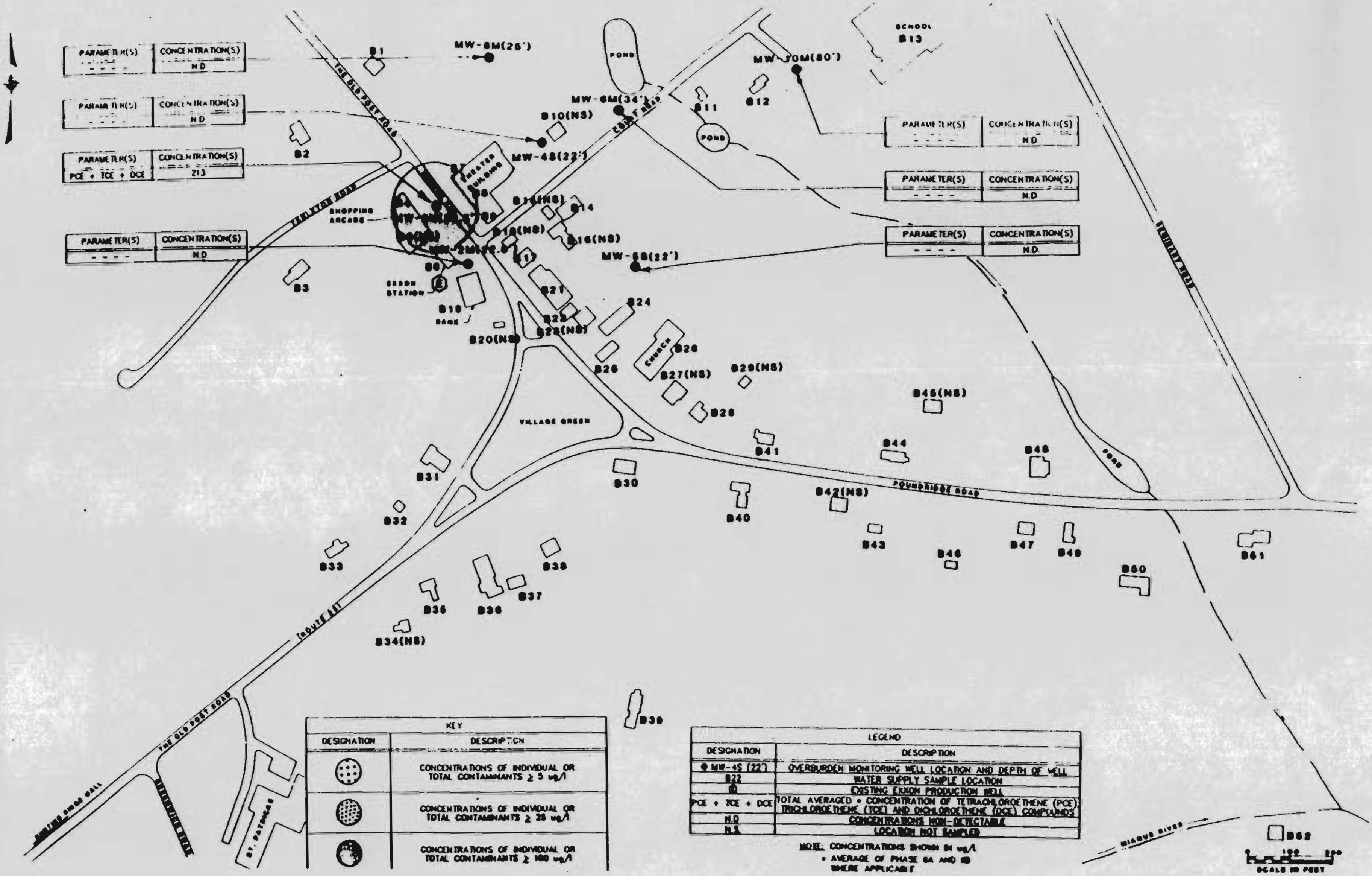
The second area of ground water contamination consisting of mainly tetrachloroethene and its degradation compounds is the large primary plume of significantly contaminated ground water in bedrock migrating/extending northeastward from the vicinity of the Shopping Arcade's private water supply well downgradient to approximately monitoring well MW-6B. The dimensions of this plume are approximately 800 feet in length and 200 feet in width at its widest point. The total average (average of Phase IIA and IIB sampling results) concentrations of tetrachloroethene and its breakdown compounds in this plume range between a low of 146 ug/l at MW-6B to a high of 746 ug/l at the Shopping Arcade water supply well. Other high values recorded were 468 ug/l at MW-1B, 285 ug/l at the Exxon gasoline station water supply well and 216 ug/l (as well as 514 ug/l of BTX contamination) in an abandoned water supply well that once served the Banks building located directly opposite/downgradient of the Exxon Station as well as the Arcade.

The third area of ground water contamination, or secondary plume, is a portion of the primary plume of contaminated ground water in the bedrock that has migrated perpendicular to Court Road in a southeasterly direction along the east side of Route 22 near the center of the village. Concentrations of tetrachloroethene and its breakdown products ranged from a total averaged level of 26 ug/l in the private water supply well at a residence at 11 Court Road to 85 ug/l in the private water supply well serving the Fire Department building on the Village Green.

All three areas of ground water contamination have resulted from prior discharges of tetrachloroethene to the Shopping Arcade's sanitary system, direct disposal to surface soils and contamination of the area's storm water drainage system. The benzene, toluene, and xylene compounds found in the ground water are due to prior discharges of these contaminants to the Exxon gasoline station's sanitary system, underground fuel tank leakage and spills at the Exxon station and possibly the Bedford School, as well as roadway runoff. Figure Nos. 1-10 and 1-11 show the location of the contaminant plume mentioned above.

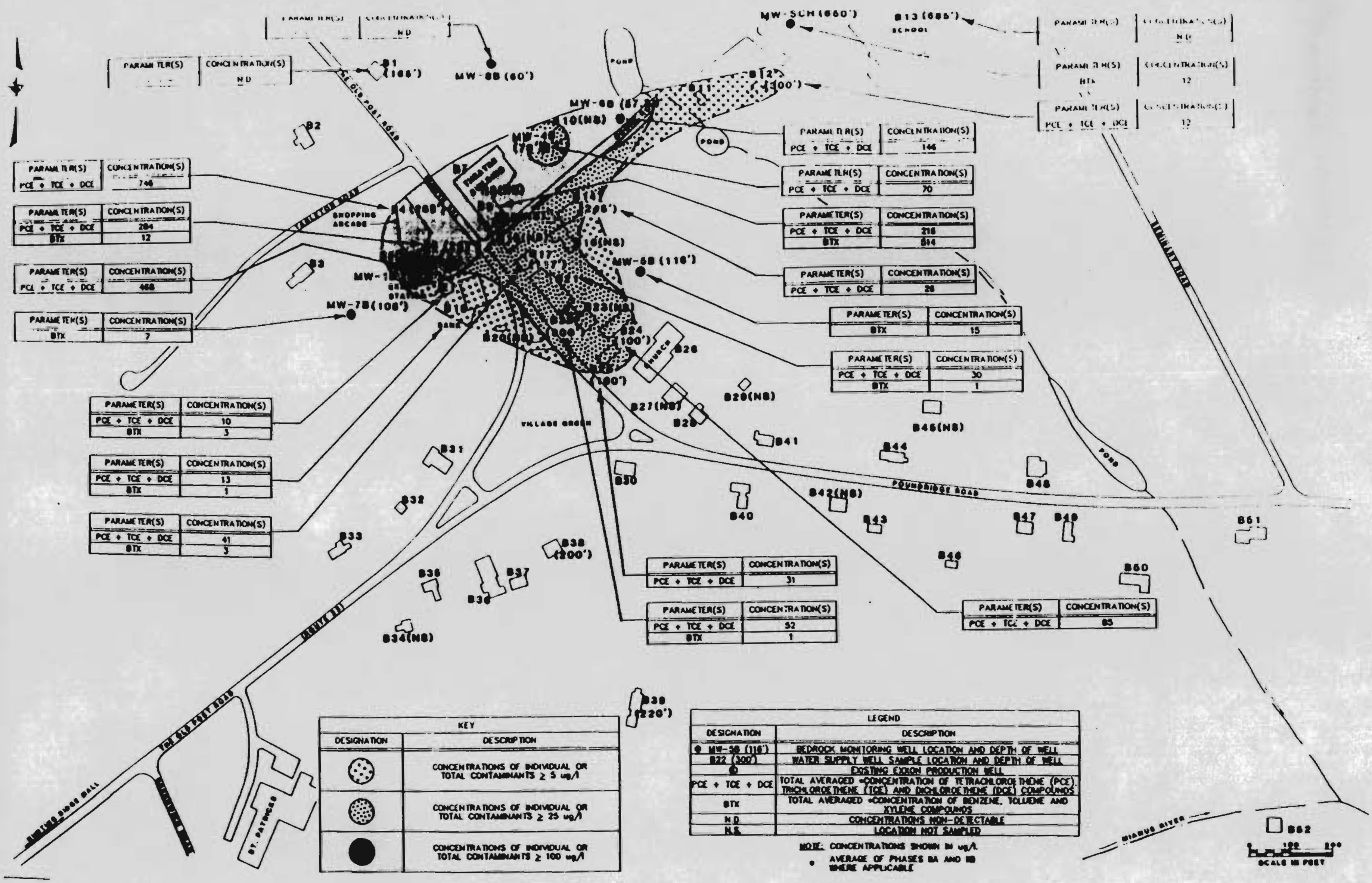
<u>Water Supply</u>: As described above, sampling of community and private wells in the study area revealed significant contamination of water supply based upon exceedance of ambient ground water standards and guidelines and drinking water standards, both within the boundary of the Shopping Arcade property and along Route 22 and in the Village Green, and Court Road. Although there is some contamination of benzene, toluene, and xylene, caused by reported gasoline and fuel leaks/spills at the Exxon gasoline station and

Figure 1-10 - Total Organic Contamination in Overburden Wells



Prepared by Dvirka & Bartilucci Consulting Engineers

Figure 1-11 - Total Organic Contamination in Bedrock Wells



Prepared by Dvirka & Bartilucci Consulting Engineers

Bedford School in the study area, most of the contamination found in this investigation appears to be related to dry cleaning solvents and its degradation products. Based on trends in the levels of contamination, it appears that, in general, the contaminant concentrations in the Shopping Arcade Study Area have slightly declined, due to the cessation of waste discharges and periodic cleanout/pumpout of the Arcade's sanitary system. However, the most recent analytical results indicate that some private water supply wells (especially at the Arcade and Exxon station) showed increases in some contaminants. Overall, a large portion of the study area still contains contaminated ground water that is above standards established by New York State for both ambient ground water and drinking water.

Section 2

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents a discussion of potentially feasible technologies for initial consideration for remediation efforts at the Shopping Arcade Site. This section is based on the information contained in the earlier remedial investigations as well as risk assessment reports. In order to identify appropriate technologies for the Shopping Arcade Site, it is essential to determine remedial action objectives and general response actions. During the screening process, the appropriate technologies will be reviewed in order to select technologies most appropriate for the Shopping Arcade Site contaminant remediation efforts. This section is divided into the following subsections:

- o Remedial Action Objectives;
- o General Response Actions;
- o Identification of Technologies; and
- o Screening of Technologies.

2.1 Remedial Action Objectives

Effectiveness of remedial efforts depends on focusing on the media and the contaminants of concern. Remedial action objectives are based on the site specific conditions such as contaminant types and media of concern, exposure pathways and applicable or relevant and appropriate federal, state, and local requirements. Remedial action objectives will be outlined with a brief discussion of the following:

- o Media and Contaminants of Concern;
- o Exposure Pathways; and
- o New York State standards.

2.1.1 Media and Contaminants of Concern

Based on the previous detailed remedial investigation and health and risk assessment reports, ground water is the only media identified as requiring potential remedial action at Shopping Arcade Site due to elevated concentrations of contaminants. The contaminant of primary concern is tetrachloroethene (commonly known as Perchlorethylene or Perc) and its breakdown products. Table No. 2-1 presents the contaminants of concern and their maximum detected concentrations in the ground water at the site.

Table No. 2-1

MEDIA, CONTAMINANTS OF CONCERN, AND MAXIMUM DETECTED CONCENTRATIONS

Media	Contaminant	Concentration (ug/l)
Ground Water	Tetrachloroethene (PCE)	710
	Trichloroethene (TCE)	47
	1,2-Dichloroethene (DCE)	64
	Benzene	440
	Toluene	35
	Xylene	39

ug/l = migrogram per liter or part per billion

During previous studies of the Shopping Arcade Site, the source of the ground water and surface water contamination was identified as sediments in the sanitary and storm water drainage systems serving the Shopping Arcade Site. The most recent data indicates that the soil/sediment samples are no longer serving as a source of contamination. Since there is no longer a source of contamination with respect to the primary contaminants previously noted, source control will not be considered in this feasibility study.

2.1.2 Exposure Pathways

The contaminants present in the ground water may find their way to the Mianus River based on the hydrogeological investigations performed as part of the remedial investigation study. Based on this assumption, the two most likely exposure pathways for the contaminants of concern are ground water and surface water. Each pathway will be described in detail in this subsection.

Ground Water: Ground water is the route likely to present the most significant exposure of volatile organic chemicals to the human population within the study area. Ground water in the area is classified as Class GA by the State of New York. Class GA waters are best used as a source of potable water supply; ground water in the area is used for this purpose.

The two major water-bearing zones in the area are the surficial unconsolidated glacial deposits and the underlying fractured bedrock (Leggett, Brashears and Graham, 1985). The unconsolidated deposits are generally characterized by a higher percentage of silt and clayey silt in the upper 5 to 10 feet, with sands at greater depths. No wells in the area are known to currently draw water from these deposits, but the deposits are capable of providing a reliable water supply. These deposits range in thickness from approximately eight feet on the southwest corner of the Arcade to approximately 70 feet to the southeast. Locally, the direction of ground water flow within these deposits is generally to the northeast.

The porosity of the bedrock is estimated at 20 percent (Freeze & Cherry 1979). This estimate takes into account the variability of a fractured media including interconnected and dead-end fractures. Data collected during a pump test as part of design support testing would allow refinement of the estimate for bedrock porosity in the study area.

Fractured bedrock can be divided into the Fordham and Bedford Gneiss and the Manhattan Formation (schist and gneiss), and the Inwood Marble. The gneiss and schist supply water to most of the private wells in the area; a small percentage of the private wells draw water from the Inwood Marble. Locally, the direction of ground water flow within the bedrock appears to be generally to the southeast. This is based upon ground water elevation measurements taken over a one-year period during the remedial investigation program. However, actual ground water flow within the bedrock is difficult to predict with any certainty because of the limited amount of data available and the uncertainty regarding fracture flow, which is affected by fracture density, interconnection of fractures and pressures associated with the fluids within the fractures.

Lower concentrations of contaminants were encountered in the unconsolidated deposits. The general northeastern trend of the primary plume is parallel to the direction of ground water flow. A secondary plume is perpendicular to the primary plume and extends to the southeast. It is thought that this secondary plume has been caused by the influence of pumping water supply wells in this direction in combination with the steep bedrock slope which also occurs in this direction.

Since no evidence of an aquitard was identified in the RI, it is assumed that ground water in the unconsolidated deposits and fractured bedrock are hydraulically connected.

Surface Water: Surface water is an additional potential exposure pathway to humans and biota. The Mianus River is approximately one-half mile southeast of the Mall. The Mianus Reservoir, located further downstream, is used as a primary drinking water source. As a result, the Mianus River is classified as Class AA-Special by the State of New York. Turtle Pond and two other ponds as well as an interconnecting stream which are tributaries to the Mianus River are also classified as Class AA-Special.

Ground water northwest of the Mianus River, including the area where contaminants were detected, probably discharges into the River. Thus, it is likely that contaminants in ground water, if not removed, will ultimately discharge into the Mianus River.

Trout are present in the Mianus River. Therefore, consumption of fish, in addition to drinking water, is a possible route of human exposure.

2.1.3 New York State Standards

This FS has been conducted in accordance with the New York State "Superfund" regulations, as well as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

Applicable requirements are federal and state public health and environmental requirements which would be legally applicable to the response or remedial action if that action was not undertaken pursuant to CERCLA.

Relevant and appropriate requirements are federal and state public health and environmental requirements that apply to circumstances sufficiently similar to those encountered at CERCLA sites where their application would be appropriate although not legally required.

Other considerations include federal and state advisories, guidance documents, policy statements, etc., which may not be enforceable but pertain to conditions encountered in the remediation of CERCLA sites.

A review of federal and state requirements was conducted, and the results are listed in Table Nos. 2-2 and 2-3 by category, i.e., chemical-specific and action-specific. Note that since the site is not in a 100-year floodplain or protected wetland area, no location-specific standards are presented. The list for action-specific standards was developed assuming a pump and treat or in situ ground water treatment, and may be revised later if other types of alternatives are considered. The contaminants of concern and chemical-specific standards are listed in Table No. 2-4. These levels will constitute the acceptable levels by which each alternative will be assessed.

2.1.4 Remediation Goals

The risk assessment concludes that the average non-carcinogenic risk for the entire study area, as measured by the hazard index value, is well below 1 (thus indicating no known adverse effects) for the contaminants of concern. However, calculated carcinogenic risks posed to humans ingesting contaminated ground water indicate that values of computed risks are significant. The contaminants that cause the high

Table No. 2-2

CHEMICAL - SPECIFIC FEDERAL AND NEW YORK STATE STANDARDS AND GUIDANCE VALUES

Applicable Requirements	Comments
Federal - none	
State	
New York State Department of Environmental Conservation	
(a) Ambient Water Quality Standards (Part 701)	All ground water in New York is classified as drinking water (GA) and the Mianus River and its tributaries in the study area are classified as AA-Special because the river is a public water supply source downstream.
(b) Ground Water Quality Standards (Part 703)	Same as above.
(c) Discharge Criteria for Class GA Waters (Only those values which are enforceable apply here.)	Same as above.

Table No. 2-2 (continued)

CHEMICAL - SPECIFIC FEDERAL AND NEW YORK STATE STANDARDS AND GUIDANCE VALUES

Relevant and Appropriate Requirements	Comments
Federal	
Safe Drinking Water Act (40 CFR Part 141) (enforceable for public water supplies only)	
(a) Maximum Contaminant Levels (MCLs)	
State	
New York State Department of Health Requirements for General Organic Chemicals in Drinking Water (Public Health Law, Sections 201 and 205) (enforceable for public water supplies only)	All ground water in New York is classified as drinking water (GA) and the Mianus River and its tributaries in the study area are classified as AA-Special because the river is a public water supply source downstream.

Table No. 2-2 (continued)

CHEMICAL - SPECIFIC FEDERAL AND NEW YORK STATE STANDARDS AND GUIDANCE VALUES

Criteria to be Considered	Comments
Federal	
Safe Drinking Water Act (40 CFR Part 141) (enforceable for public water supplies only)	
(a) Maximum Contaminant Level Goals (MCLGs)	Ground water on-site and off-site constitutes a sole source aquifer which is currently used as a water supply.
Clean Water Act (40 CFR Part 122)	
(a) Ambient Water Quality Criteria for Protection of Human Health (drinking water only) (not enforceable)	Mianus River is a drinking water supply for a community downstream.
(b) Ambient Water Quality Criteria for Protection of Aquatic Life (not enforceable)	Mianus River and upstream ponds support aquatic life.
State	
New York State Department of Environmental Conservation	
(a) Ambient Water Quality Standards (Part 701)	All ground water in New York is classified as drinking water (GA) and the Mianus River and its tributaries within the study area are classified as AA-Special as the river is a water supply source downstream.
(b) Ground water Quality Standards (Part 703)	Same as above.
(c) Discharge Criteria for Class GA Waters (Part 703.6) (Only those values which are not enforceable are shown here)	Same as above.

Table No. 2-3

POTENTIAL ACTION - SPECIFIC FEDERAL AND NEW YORK STATE STANDARDS AND GUIDANCE VALUES

Applicable Requirements	Comments
Federal	
Clean Water Act (FL92-500)	
(a) NPDES Permit (enforceable for all discharges to surface water)	Ground water treatment may entail discharge to surface waters.
Clean Air Act (40 CFR Part 50)	
(a) National Ambient Air Quality Standards for Six Criteria Pollutants	Ground water remediation may entail air stripping.
State	
New York State Water Classification and Quality Standards	
(a) Discharge Criteria for Class GA Waters (Chapter X, Section 703.6) (enforceable for all discharges to surface water)	Ground water treatment may entail discharge to surface waters.
New York Code of Rules and Regulations	
(a) Process Emission Sources (6 NYCRR Part 212)	Criteria for permitting an air emission source.

Table No. 2-3 (continued)

POTENTIAL ACTION - SPECIFIC FEDERAL AND NEW YORK STATE STANDARDS AND GUIDANCE VALUES

Relevant and Appropriate Requirements	Comments
Federal	
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA) and including the National Contingency Plan developed under this Act (enforceable for NPL sites only)	Outlines the goals and procedures for remediation of hazardous waste sites and emphasizes the use of permanent remedies which significantly reduce the mobility, toxicity, or volume of wastes.
Resource Conservation and Recovery Act (RCRA, Subtitle C, 40 CFR Part 264)	
(a) Ground Water Monitoring (Subpart F, 264.92)	Requirements for ground water monitoring program and cleanup levels (i.e., TCLP and background MCLs).
(b) Closure and Post-Closure (Subpart G, 264.110)	Requirements for long-term monitoring and maintenance of the site.
(enforceable for RCRA-permitted facilities only)	
Occupational Safety and Health Administration (OSHA) Requirements	
(a) General Industrial Standards (29 CFR, Part 1910)	Specifies 8-hour time weighted average concentration for various organics applicable to on-site remediation.
(b) Safety and Health Standards (29 CFR, Part 1926)	Specifies safety equipment and procedures to be followed during site remediation.
(c) Recordkeeping, Reporting and Related Regulations	Outlines recordkeeping and reporting requirements applicable to all site contractors and subcontractors during site work.
(enforceable for NPL sites, RCRA facilities and some emergency responses to incidences involving the handling, processing, and transportation of hazardous substances only)	

Table No. 2-3 (continued)

POTENTIAL ACTION - SPECIFIC FEDERAL AND NEW YORK STATE STANDARDS AND GUIDANCE VALUES

Relevant and Appropriate Requirements	Comments
State	
New York Code of Rules and Regulations Final Status Standards for Owners and Operators of Hazardous Waste TSDFs (6 NYCRR Subpart 373-2) (enforceable for permitted state facilities only)	Provides criteria for ground water monitoring and closure/post-closure of permitted TSDFs (corresponds to RCRA Part 264)

Table No. 2-3 (continued)

POTENTIAL ACTION - SPECIFIC FEDERAL AND NEW YORK STATE STANDARDS AND GUIDANCE VALUES

Criteria and Advisories	Comments
Federal - none	
State	
New York State Air Guide - 1	Provides methods for analyzing potential emissions and their acceptability which is used to obtain air permits under 6 NYCRR Part 212.
New York State Ground water Use Guidance Policy	Specifies a nondegradation policy for aquifers in the state

Table 2-4
List of Clean-Up Targets

	Effluent Discharge (ug/l) (NYSDEC Part 703.6)	Groundwater (ug/l) NYSDEC TOGs	Groundwater (ug/l) NYSDOH MCL	Surface Water (ug/l) NYSDEC TOGs	Surface Water (ug/l) CWA Criteria	Soil/Sediment NJDEP (mg/kg)
Tetrachloroethene	---	0.7(G)	5	0.7(G)	5200/840	***
Trichloroethene	---	10(G)	5	3(G)	---	***
1,2-Dichloroethene	---	50(G)	5	50(G)	11,000/-	***
Benzene	ND	ND(S)	5	1(G)	5,300/-	***
Toluene	---	50(G)	5	50(G)	17,000/-	***
Xylene	---	50(G)	5	50(G)	---	***
Ethylbenzene	---	50(G)	5	50(G)	32,000/-	***
1,4-Dichlorobenzene	---	4.7(G)	5	30(S)	---	***
Phenol	---	1.0(S)	---	1.0(S)	10,000/2,500	
Lead	50	25(S)	50	50(S)	8.2/3.2	100
Nickel	2,000	---	---	---	1,800/96	100
Silver	100	50(S)	50	50(S)	4.1/0.12	5
Barium	2,000	1,000(S)	1,000	1,000(S)	---	
Chromium	100**	50(S)	500	500(S)	16/11	100
Copper	1,000	1,000(S)	1,000	200(S)	18/12	170

* Acute/Chronic
** Hexavalent
*** Total Volatile Organics = 1

(S) = Standard
(G) = Guideline
ND = Non-Detectable

carcinogenic risk values are tetrachloroethene, trichloroethene, and 1,2-dichloroethene. Therefore, the goals for this site are as follows:

- o Reduction of contaminants in the ground water to acceptable levels;
- o Prevention of the further migration of harmful levels of contaminants; and
- o Elimination of exposure of contaminants in the drinking water and consumptive use exposure pathways by providing an alternate source of drinking water or providing point-of-use treatment for affected residences.

2.2 General Response Actions

The screening process is initiated by identifying General Response Actions (GRAs). GRAs are broad responses that can be implemented for remediation. Associated with GRAs are specific remedial technologies or methodologies describing how to implement GRAs. A screening process is used to identify technologies applicable under each of the GRAs. GRAs identified as applicable to the Shopping Arcade Site are as follows:

- o Extraction;
- o Containment;
- o In Situ Treatment;
- o On-site Treatment;
- o On-site Disposal;
- o Off-site Treatment/Disposal; and
- o No Action.

2.3 Identification of Technologies/Methodologies

Based on the general response actions, the following technologies/methodologies have been identified:

- o Extraction
  - Wells
  - Ground Water Interceptor Trenches

- On-site Treatment – Biological
  - Biological Treatment Units
  - In Situ Treatment
- On-site Treatment – Chemical
  - Oxidation/Reduction
- On-site Treatment – Physical
  - Carbon Adsorption
  - Air Stripping
  - UV Oxidation
- On-site Disposal
  - Reinjection/Infiltration
  - Surface Discharge
  - Reuse
- Off-site Disposal
  - Off-site Treatment at POTW
- Alternate Water Supply
  - Point of Use Water Treatment
  - Development of Public Water Supply
- Contaminant Containment
  - Cut off Slurry Wall

- No Action

  - Extraction/Reinjection with No Water Treatment
  - Ground water Monitoring
  - Deed Restriction/Institutional Controls

Table No. 2-5 presents the general response actions and the applicable technologies/ methodologies considered with these actions. Each of the above mentioned technologies/ methodologies will be evaluated in the following section (Section 3) based on implementability, effectiveness and costs associated with its implementation.

2.4 Screening of Technologies/Methodologies

GRAs and applicable remedial technologies listed in Table No. 2-5 have been screened to eliminate those technologies that cannot be implemented technically at the site. A summary of the screening of each response action and associated technologies is provided below. Technologies accepted in this screening will be incorporated in the development of remedial action alternatives and will be evaluated and described in greater detail in Section 3.

2.4.1 Extraction

Extraction is a remedial technology usually used in combination with treatment technologies to control/remove contaminants in ground water. Two extraction technologies were considered, pumping wells and ground water interceptor trenches.

Wells: The use of wells to pump contaminated ground water was considered. With this technology, contaminated ground water can be extracted for on-site or off-site treatment and disposal. Wells can be installed in both unconsolidated deposits and fractured bedrock. Pumping from both units would be technically feasible and effective if a system to fully intercept contaminated ground water could be designed and constructed. Ground water modeling could assist in this effort to identify optimal well locations. Because of its demonstrated effectiveness and wide acceptability, this technology will be evaluated in Section 3 of this report.

Table No. 2-5

GENERAL RESPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES FOR GROUND WATER REMEDIATION

General Response Action	Applicable Remedial Technologies
Extraction	Wells Ground Water Interceptor Trenches
On-Site Treatment - Biological	Biological Treatment Units In Situ Treatment
On-Site Treatment - Chemical	Oxidation/Reduction
On-Site Treatment - Physical	Carbon Adsorption Air Stripping UV Oxidation
On-Site Disposal	Reinjection/Infiltration Surface Discharge Reuse
Off-Site Treatment/Disposal	Transport via Tank Truck to POTW
Alternate Water Supply	Point of Use Water Treatment Development of Public Water Supply
Contaminant Containment	Cut-off Slurry Wall
No Action	Extraction/Reinjection with No Water Treatment Ground Water Monitoring Deed Restriction/Institutional Controls

Ground Water Interceptor Trenches: As opposed to wells, ground water interceptor trenches have been used successfully to extract ground water in situations where the depth to ground water is shallow, contamination is limited to the upper portion of the aquifer, and soils can be excavated without excess caving. At the Shopping Arcade Site, depth to ground water ranges from approximately 3 to 35 feet below grade. Contaminants have been detected in both the surficial unconsolidated deposits and underlying fractured bedrock, which occurs at a depth of 60 to 70 feet over much of the area. Due to the vertical distribution of contaminants, extraction through the use of ground water interceptor trenches is not considered technically implementable and will not be considered further for this feasibility study.

2.4.2 On-Site Treatment

Once extracted, ground water contaminated with organic compounds must be treated to meet standards. Applicable treatment technologies include biological, chemical, and physical processes.

Biological Treatment: Typically, this technology involves the introduction of pumped ground water into biological treatment units where enzymes and micro-organisms decompose organic contaminants into carbon dioxide, water, and small amounts of nonhazardous components. Supplemental nutrients are often added to assist the biotreatment process. Biological treatment occurs slowly, as the rate of decomposition is low. Biodegradation may also be accomplished in situ through the same processes involved with treatment units. However, the contaminant concentrations on-site are not high enough for biodegradation to work effectively. Because of this, biological treatment is not considered technically implementable and will not be considered further for this feasibility study.

Chemical Treatment: Chemical treatment technology uses chemical addition to detoxify a waste stream by altering the chemistry of the contaminant. Chemical treatment can be achieved by several processes, including oxidation and reduction. However, non-chemical treatment technologies can remove organic contaminants more efficiently. Therefore, chemical treatment is not considered an efficient treatment process for this site and will not be considered further for this feasibility study.

Physical Treatment: This treatment technology uses physical processes to remove contaminants. Activated carbon and air stripping are technically implementable and have been used successfully to treat similar organic contaminants to those found at this site.

Activated carbon selectively absorbs hazardous constituents by surface attractions. An air stripping system is comprised of a packed tower equipped with an air blower which works on the principle of counter-current flow. Activated carbon and air stripping have both been proven in the field, have been widely accepted and therefore, will be discussed in greater detail in Section 3.0.

Another technology identified under physical treatment is UV Oxidation. UV light acts as a catalyst to promote the chemical oxidation of organic chemicals. UV oxidation is a relatively new technology that has not been developed to the extent that it can be implemented at this site without some pilot testing. It has only been available for commercial application for the past two years and has a limited data base. Due to the need for pilot testing and the limited availability of a data base, this technology will not be considered further for this feasibility study.

2.4.3 On-Site Disposal

Once treated, ground water must be disposed of. Disposal can be to the subsurface through reinjection/infiltration, discharge to a surface water body, or treated ground water can be put to a beneficial use (reuse).

Reinjection/Infiltration: Treated ground water can be reinjected or allowed to infiltrate back into the aquifer. Direct injection would be through the use of injection wells. Infiltration could occur through the use of infiltration galleries or percolation ponds. Reinjection/infiltration could be performed in conjunction with ground water pumping to enhance the extraction of contaminated ground water through optimal placement of reinjection/infiltration locations. Ground water modeling could assist in this effort.

Surface Discharge: As an alternative to reinjection/infiltration, treated ground water could be discharged directly or indirectly to a surface water body. Discharge could be to the storm water drainage system or to a natural watercourse. Surface discharge would ultimately flow to the Mianus River.

Reuse: Treated ground water could possibly be put to a beneficial use (reuse). Examples of reuse include spray irrigation and use as an industrial water supply.

2.4.4 Off-Site Treatment/Disposal

After extraction, contaminated ground water could be transported via tank truck to a publicly owned treatment works (POTW). This would require on-site storage, the use of a tank truck(s), and permission of a POTW. While technically implementable, the anticipated volume of ground water to be pumped would most likely eliminate this technology as not cost-effective.

If sanitary sewer were available (e.g., in conjunction with extending public water supply to the affected area) then disposal to POTW might be feasible. This technology will be discussed in further detail in Section 3.

2.4.5 Alternative Water Supply

For private wells affected by contaminated ground water, an alternative supply is essential. Point-of-use treatment could be performed at individual areas of concern. Potable water could be purchased from nearby private water supply systems. Alternatively, a new community water supply system could be developed. This will be discussed in greater detail in Section 3.

2.4.6 Contaminant Containment

A commonly used technology under this category is the cut-off slurry wall. A cut-off-slurry wall is an effective way to keep contaminants from migrating off-site. This is usually achieved by digging deep trenches and filling them with clay/bentonite slurry to act as a barrier. Due to excessive depths ranging between 30 and 70 feet, implementation of this will be difficult and very expensive. Also, New York State standards require a no-degradation policy for its ground water source. Due to the above-mentioned reasons, this technology will not be considered further for this feasibility study.

2.4.7 No Action

The no-action alternative would not address the ground water contamination itself. The further spread of ground water contamination would not be controlled. Wells not currently contaminated could be contaminated in the future. Applicable remedial technologies under this GRA are ground water monitoring, deed restrictions and institutional controls, and development of an alternative water supply.

Extraction/Reinjection: Extraction/reinjection of contaminated water contains the migration of a contaminant plume. This technology will be discussed in greater detail in Section 3.

Ground Water Monitoring: Existing, and possibly new monitoring wells could be used to track the migration of contaminated ground water and provide a long-term data base regarding the extent and nature of ground water contamination.

Deed Restriction and Institutional Controls: Deed restrictions could be applied to property overlying contaminated ground water. The restrictions could be worded to prevent or safely control on-site activities, as required, and prevent increased endangerment of human health or welfare or the environment.

Section 3

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ACTION ALTERNATIVES

The remedial action technologies applicable to the remediation of the Bedford Village Wells, Shopping Arcade Site were identified and preliminarily screened in Section 2.0. These technologies are combined in this section to form potentially effective remedial action alternatives that could be implemented to mitigate site contamination. The technologies selected as acceptable for application at the site include ground water extraction, physical treatment of ground water, disposal of treated ground water, development of an alternative drinking water supply, and a no-action alternative which includes a ground water monitoring program.

In performing this feasibility study, a number of alternatives have been considered, one or more of which meet the following:

- Treatment or disposal at an off-site facility approved by NYSDEC and USEPA.
- An alternative which attains applicable New York State public health or environmental standards.
- An alternative which exceeds applicable New York State public health or environmental standards.
- An alternative which will not attain applicable or New York State public health or environmental standards, but which does reduce the likelihood of a threat from the problem.
- A no-action alternative/natural attenuation. This alternative does not involve engineered treatment but allows for the natural attenuation mechanism to reduce or eliminate the contaminants in the ground water. This alternative would involve periodic monitoring to check progress.

3.1 Ground Water Remedial Alternatives

Given the technologies deemed acceptable for application at the site (Section 2.0), several ground water remedial alternatives were developed using various combinations of applicable technologies. The remedial alternatives developed for the Shopping Arcade Site are as follows:

- Ground Water Extraction
  - Removal of contaminated ground water in 3 years
  - Removal of contaminated ground water in 6 years
- Contaminated Ground Water Treatment
  - Removal of contaminants by air stripping
  - Removal of contaminants by carbon adsorption
  - Removal of contaminants by air stripping and carbon adsorption
  - No physical, chemical, or biological treatment of contaminated water (Natural mechanism will be the principal mechanism relied on to reduce or eliminate the contaminants in the ground water)
- Disposal of Treated Ground Water
  - Aquifer recharge via deep well injection or infiltration gallery
  - Discharge to storm water drainage system
  - Discharge to publicly owned treatment works (P0TW)
  - Use of treated water as non-potable water supply
- Alternative Drinking Water Supply
  - Expansion of Bedford Farms Community Water Supply System
  - Expansion of the planned Ponds Development Water Supply System
  - Development of a new Community Water Supply System
  - Development of a Point-of-Use Treatment District
- No-Action Alternative

Remedial action alternatives were developed by combining various options of each technology presented. The alternatives developed are presented in Table No. 3-1.

In order to simplify the discussion of the remedial action alternatives, each of the technologies will be described separately.

3.1.1 Contaminated Ground Water Extraction

This technology involves the removal of contaminated ground water by pumping through extraction wells placed downgradient from the contaminant plume. The location of wells would be determined based on the ground water flow and contaminant plume direction. The configuration of extraction wells would be designed to contain the contaminant plume within a cone of depression created by the extraction wells and to prevent further migration. Based on findings in the RI, it appears that the majority of the contaminated ground water is in the bedrock with a small area of contaminated ground water in the overburden. Therefore, the extraction wells would be screened in the overburden and the bedrock. The remediation effort would initially be focused on the contaminated ground water in the overburden. The bedrock extraction wells would be activated approximately 6 months after the overburden wells.

To develop the ground water extraction alternative fully, a calculation of the approximate total of contaminated ground water in the overburden was made using the following assumptions:

- o Contaminant plume surface area = 31,400 square feet
- o Saturated thickness of overburden = 30 feet
- o Porosity of overburden (soil) = 30 percent

Using the above simplified assumptions, the total volume of contaminated ground water in the overburden is estimated to be approximately 2,100,000 gallons. These simplified assumptions were made because there was no available information on the amount of contaminants released into the soil and ground water. Generally, anywhere between three and ten pore volumes of contaminated ground water is removed for effective remediation. Due to the nature and extent of contaminant concentrations, removal of six pore volumes of contaminated ground water is considered adequate. Six pore volumes of contaminated ground water amounts to approximately 12,600,000 gallons. Considering these assumptions and existing site conditions, including average

TABLE 3-1 - PRELIMINARY CLASSIFICATION OF REMEDIAL ACTION ALTERNATIVES FOR SHOPPING ARCADE AREA

ALTERNATIVE	EXTRACTION	TREATMENT	DISPOSAL	WATER SUPPLY	OFF-SITE T or D	ATTAINS/ EXCEEDS STANDARDS	DOES NOT ATTAIN STANDARDS	ON-SITE TREATMENT/ CONTAINMENT	NO ACTION
1/25	3 yrs/6 yrs	No treatment	Recharge	Public water			X	C	
2/26	3 yrs/6 yrs	No treatment	Recharge	Point-of-use treatment			X	D	
3/27	3 yrs/6 yrs	Air stripping	Recharge	Public water		E		T/C	
4/28	3 yrs/6 yrs	Air stripping	Recharge	Point-of-use treatment		E		T/C	
5/29	3 yrs/6 yrs	Air stripping	Discharge to sewer	Public water	D	E		T	
6/30	3 yrs/6 yrs	Air stripping	Discharge to sewer	Point-of-use treatment	D	E		T	
7/31	3 yrs/6 yrs	Air stripping	Discharge to POTW	Public water	T	E		T	
8/32	3 yrs/6 yrs	Air stripping	Discharge to POTW	Point-of-use treatment	T	E		T	
9/33	3 yrs/6 yrs	Air stripping	Public use/treated H_2O	----		A		T	
10/34	3 yrs/6 yrs	Carbon adsorption	Recharge	Public water		E		T/C	
11/35	3 yrs/6 yrs	Carbon adsorption	Recharge	Point-of-use treatment		E		T/C	
12/36	3 yrs/6 yrs	Carbon adsorption	Discharge to sewer	Public water	D	E		T	
13/37	3 yrs/6 yrs	Carbon adsorption	Discharge to sewer	Point-of-use treatment	D	E		T	
14/38	3 yrs/6 yrs	Carbon adsorption	Discharge to POTW	Public water	T	E		T	

Off-site T or D: Treatment or disposal at an off-site facility approved by NYSDEC.
Attains Standards (A): An alternative which attains applicable Federal or New York State public health or environmental standards.
Exceeds Standards (E): An alternative which exceeds applicable Federal or New YOrk State public health or environmental standards.
Does Not Attain Standards: An alternative which will not attain applicable Federal or New York State public health or environmental standards, but which does reduce the likelihood of a threat from the problem.

On-site Treatment (T): An on-site treatment alternative.
On-site Containment (C): An on-site containment alternative.
No Action: A no-action alternative.
T: Treatment.
D: Disposal

TABLE 3-1 - PRELIMINARY CLASSIFICATION OF REMEDIAL ACTION ALTERNATIVES FOR SHOPPING ARCADE AREA (cont.)

ALTERNATIVE	EXTRACTION	TREATMENT	DISPOSAL	WATER SUPPLY	OFF-SITE T or D	ATTAINS/ EXCEEDS STANDARDS	DOES NOT ATTAIN STANDARDS	ON-SITE TREATMENT/ CONTAINMENT	NO ACTION
15/39	3 yrs/6 yrs	Carbon adsorption	Discharage to POTW	Point-of-use treatment	T	E		T	
16/40	3 yrs/6 yrs	Carbon adsorption	Public use/treated H_2O	---		A		T	
17/41	3 yrs/6 yrs	Air stripping/ carbon adsorption	Recharge	Public water		E		T/C	
18/42	3 yrs/6 yrs	Air stripping/ carbon adsorption	Recharge	Point-of-use treatment		E		T/C	
19/43	3 yrs/6 yrs	Air stripping/ carbon adsopriotn	Discharge to sewer	Public water	D	E		T	
20/44	3 yrs/6 yrs	Air stripping/ carbon adsorption	Discharge to sewer	Point-of-use treatment	D	E		T	
21/45	3 yrs/6 yrs	Air stripping/ carbon adsorption	Public water		T	E		T	
22/46	3 yrs/6 yrs	Air stripping/	Discharge to POTW	Point-of-use treatment		E		T	
23/47	3 yrs/6 yrs	Air stripping/ carbon adsorption	Public use/treated H_2O	---		A		T	
24	---	No action	---	---					X

Off-site T or D:	Treatment or disposal at an off-site facility approved by NYSDEC.
Attains Standards (A):	An alternative which attains applicable Federal or New York State public health or environmental standards.
Exceeds Standards (E):	An alternative which exceeds applicable Federal or New YOrk State public health or environmental standards.
Does Not Attain Standards:	An alternative which will not attain applicable Federal or New York State public health or environmental standards, but which does reduce the likelihood of a threat from the problem.
On-site Treatment (T):	An on-site treatment alternative.
On-site Containment (C):	An on-site containment alternative.
No Action:	A no-action alternative.
T:	Treatment.
D:	Disposal

yields from wells in the overburden in this area an appropriate estimate and extraction well pumping rate would be 5 gallons per minute. However, these calculations are only estimates. Additional information on aquifer characteristics will be needed prior to design of the extraction system. A pump test of the aquifer will provide the necessary data. Considering these assumptions, an extraction system consisting of three wells, each pumping at 5 gallons per minute would remove six pore volumes in approximately 1.6 years, whereas an extraction system consisting of six wells each pumping at 5 gallons per minute would remove six pore volumes in approximately 0.8 years.

To calculate an approximate total of contaminated ground water in the bedrock, the contaminant plume surface area was estimated at approximately 180,000 square feet. The saturated thickness in the overburden was estimated at approximately 150 feet (porosity 20 percent). These assumptions result in a total volume of contaminated ground water of approximately 40,000,000 gallons. Generally, anywhere between three and ten pore volumes of contaminated ground water is removed for effective remediation. Due to the nature and extent of contaminant concentrations, removal of three pore volumes of contaminated ground water is considered adequate. Three pore volumes of contaminated ground water amounts to approximately 120,000,000 gallons. Considering these assumptions and existing site conditions including average yields from wells in the overburden in this area, an appropriate estimate for an extraction well pumping rate would be 10 gallons per minute. Considering these assumptions, an extraction system consisting of three wells, each pumping at 10 gallons per minute would remove three pore volumes in approximately 4.6 years, whereas an extraction system consisting of 10 wells each pumping at 10 gallons per minute would remove three pore volumes in approximately 2.3 years.

The bedrock extraction wells would operate in conjunction with the overburden wells. Initially the overburden extraction wells would most likely operate alone with the bedrock extraction wells being activated approximately 6 months after the start-up of the overburden extraction wells. Operating the shallow wells for a short period of time before commencing operation of the bedrock extraction wells would remove at least some of the contaminants in the overburden aquifer before they would be drawn deeper into bedrock through operation of the bedrock extraction wells.

The remediation duration for both the bedrock and overburden extraction systems would be approximately 3 years for a system of 8 extraction wells and 6 years for a system of 16 extraction wells.

These ground water extraction alternatives were developed for screening purposes. The simplifying assumptions made were based on information gathered in the RI. A pre-design pump test of the aquifers will be needed to design an effective ground water extraction system.

3.1.2 Contaminated Ground Water Treatment

The treatment is comprised of technologies that physically remove the contaminants from the ground water. Each technology will be discussed in this section.

Air Stripping: Air stripping is a mass transfer process in which volatile contaminants in water are transferred to gas. An air stripping system is comprised of a packed tower equipped with an air blower. The packed tower works on the principle of countercurrent flow. The contaminated water stream flows down through the packing while the air flows upward, and is exhausted through the top of the tower. Volatile, soluble compounds have an affinity for the gas phase over the aqueous phase and thus tend to leave the aqueous phase for the gas phase. Generally organic compounds with Henry's Law constants greater than 0.003 can be effectively removed by air stripping. This includes tetrachloroethene, trichloroethene, and 1,2-dichloroethene, the contaminants of concern which are found in the ground water at the site.

An air stripping system can usually be designed to reduce the concentration of volatile organic compounds to below detectable limits. Air stripping has been found to be an economical and effective solution at numerous ground water remediation sites.

However, the disadvantages of an air stripping system include the inability of the column to handle concentrations of volatile organic compounds (VOCs) over the design conditions. In general, stripping columns can handle excess VOC concentrations only in proportion to the safety factor used in the system design. Occasional slugs of VOC concentrations (over the average concentrations) encountered in the ground water may result in exceeding effluent requirements imposed at some sites. This can be prevented by providing a good factor of safety in the design stages of an air stripping system. An additional disadvantage of air stripping system is that its efficiency varies with temperature. Colder air and water temperatures tend to reduce the volatility of the VOCs, thereby reducing the ease of stripping. Operational efficiency of an air stripping system tends to decrease during winter months. Ground water temperatures do not vary with season as much as the air temperatures do and therefore, to ensure acceptable performance during these periods, the system should be designed to handle air temperatures during winter months.

With more and more states becoming aware of and implementing regulations for toxic air contaminants, the major disadvantages of air stripping systems are the requirements of permitting by the State and local air pollution control agencies and in many cases treatment of off-gases containing VOCs. The permitting process can cause delay in the start-up of remedial efforts and in instances where off-gas treatment is required, other viable options may become more attractive due to these restraints as well as cost restraints.

Carbon Adsorption: The process of carbon adsorption onto activated carbon involves direct contact of a waste stream with activated carbon, usually by flow through a series of activated carbon beds. The activated carbon selectively adsorbs volatile and semi-volatile organic compounds where organic molecules are attracted to the surface and internal pores of the carbon granules. Carbon adsorption is capable of removing high percentages of both volatile and semi-volatile organic compounds including tetrachloroethene, trichloroethene, and 1,2-dichloroethene, which are found in the contaminated ground water at the site.

A primary advantage of carbon adsorption systems is that they can handle slugs of significantly higher contaminant concentrations in the ground water than the average design concentration. For this reason, carbon is particularly attractive if the treated water is to be used as drinking water supply. Also, due to lack of off-gases, permitting from State and local air pollution control agencies may not be required.

One of the drawbacks of activated carbon systems is that carbon has a limited useful life and needs replacement once saturated. In most cases, the spent carbon must be transported and disposed as a RCRA hazardous waste or regenerated. Furthermore, carbon adsorption systems require relatively frequent effluent sampling and analysis to determine when breakthrough occurs. Although carbon capacities are estimated during the design phase, these estimates do not always prove reliable. Variations in feed concentrations and slugs of high concentration in the influent can reduce the expected carbon life. Also, the adsorptive capacity of the carbon depends on the concentrations of volatile and semi-volatile organics in the waste stream. In general, the lower the contaminant concentrations in the waste stream, the lower the adsorptive capacity of the activated carbon, and the shorter the useful life.

Air Stripping Followed by Carbon Adsorption: Another option available is the system configured with the combination of air stripping and carbon adsorption technologies. The air stripping system is relied on to remove a large percentage of the contaminants from the waste stream with the remainder being adsorbed by the activated carbon system acting as a polishing step. Major advantage of combining both of these technologies is that, in case of occasional slugs of VOC concentrations over the average design concentrations, the activated carbon adsorption unit would be able to handle increased effluent concentrations from the air stripping system.

Furthermore, this combination would be able to produce consistent effluent concentration during summer as well as cooler months when the efficiency of the air stripping system is slightly reduced.

Permitting and control requirements by air pollution control agencies may make this a less feasible option due to time and cost restraints. Detailed evaluation in later sections will provide better judgment regarding the off-gas treatment requirements.

No Action: Also included in this analysis is a no-treatment alternative. Contaminated ground water would be removed from the aquifer and reinjected through the deep well injection system upgradient from the site. This option would prevent further migration of the contaminated ground water, and natural attenuation mechanism will be relied on to reduce the contaminant concentrations to the acceptable limits. Due to extensive time required for the natural attenuation to lower the contaminant levels to acceptable limits, this option will not be discussed any further.

3.1.3 Disposal of Treated Ground Water

There are several options available for disposing treated ground water. Each option will be discussed in this section.

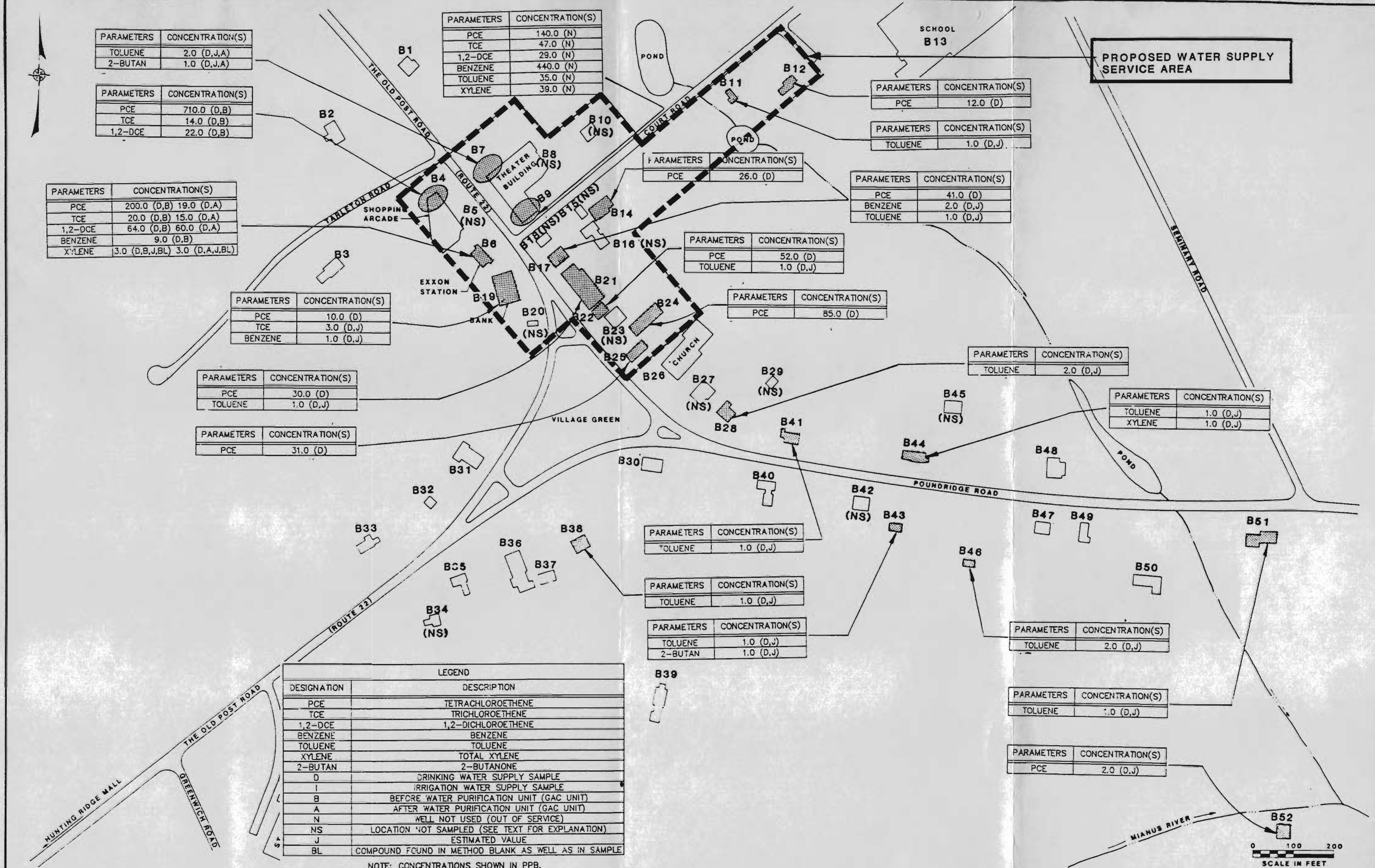
Aquifer Recharge: One option involves aquifer recharge by a deep well injection system which allows large volumes of water to be pumped into the bedrock aquifer upgradient from the extraction wells. A second option involves aquifer recharge by an infiltration gallery. The infiltration gallery consists of a trench filled with crushed stone or gravel which allows for large volumes of water to infiltrate into the overburden. The gallery would be placed upgradient from the extraction wells. These types of systems not only prevent the contaminated ground water from migrating further (via extraction) but also conserve the natural resource by reinjecting the treated ground water back into the aquifer system.

Discharge to Storm Drainage System: Extracted water may be discharged to the local storm water drainage system. Storm water in the area is collected by several streams, drainage ditches, and catch basins and eventually flows into the Mianus River. The advantage of this option is that the system is already in place and capable of handling the quantity of water which will be generated by the extraction system. However, in order to discharge to the storm water drainage system, contaminant concentrations in the treated water must meet standards set by the NYSDEC. In addition, a State Pollution Discharge Elimination System (SPDES) permit may be needed before the treated water can be discharged to the storm water drainage system.

Discharge to Publicly Owned Treatment Works (POTW): Discharge of untreated ground water to a publicly owned treatment works (POTW) for the purpose of treatment is another option available for disposal. However, the nearest point that waste water may be discharged to a POTW is approximately six miles from the site. At this time, there are no plans to extend the POTW system to the site. Waste water could be transported to the POTW via tanker trucks. However, the quantities of water and the distance to the POTW system would make this alternative difficult to implement. Therefore, this option will not be considered further.

3.1.4 Alternative Water Supply Options

One of the general response actions previously referenced in this feasibility study report includes the provision for evaluating alternative water supplies for affected areas within the Shopping Arcade (SA) study area. This response action would provide a direct, long-term solution to the public health concerns arising from utilizing contaminated ground water as a source of potable supply. This response action does not involve the direct remediation of a source of contamination nor does it make provision for the management of contaminant migration, in this case a plume of contaminated ground water. The evaluation of specific engineering alternatives addressing these remedial aspects of the project are addressed in the previous sections of this report and will be carried through the feasibility study report as appropriate. The alternative water supply options discussed below include providing potable water service to those affected commercial and residential users in the area of concern. This area, including the SA proper and adjacent areas, is indicated in Figure No. 3-1.



PARAMETERS	CONCENTRATION(S)
TOLUENE	2.0 (D,J,A)
2-BUTAN	1.0 (D,J,A)

PARAMETERS	CONCENTRATION(S)
PCE	710.0 (D,B)
TCE	14.0 (D,B)
1,2-DCE	22.0 (D,B)

PARAMETERS	CONCENTRATION(S)
PCE	200.0 (D,B) 19.0 (D,A)
TCE	20.0 (D,B) 15.0 (D,A)
1,2-DCE	64.0 (D,B) 60.0 (D,A)
BENZENE	9.0 (D,B)
XYLENE	3.0 (D,B,J,BL) 3.0 (D,A,J,BL)

PARAMETERS	CONCENTRATION(S)
PCE	140.0 (N)
TCE	47.0 (N)
1,2-DCE	29.0 (N)
BENZENE	440.0 (N)
TOLUENE	35.0 (N)
XYLENE	39.0 (N)

PARAMETERS	CONCENTRATION(S)
PCE	10.0 (D)
TCE	3.0 (D,J)
BENZENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
PCE	30.0 (D)
TOLUENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
PCE	31.0 (D)

PARAMETERS	CONCENTRATION(S)
PCE	26.0 (D)

PARAMETERS	CONCENTRATION(S)
PCE	12.0 (D)

PARAMETERS	CONCENTRATION(S)
TOLUENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
PCE	41.0 (D)
BENZENE	2.0 (D,J)
TOLUENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
PCE	52.0 (D)
TOLUENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
PCE	85.0 (D)

PARAMETERS	CONCENTRATION(S)
TOLUENE	2.0 (D,J)

PARAMETERS	CONCENTRATION(S)
TOLUENE	1.0 (D,J)
XYLENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
TOLUENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
TOLUENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
TOLUENE	1.0 (D,J)
2-BUTAN	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
TOLUENE	2.0 (D,J)

PARAMETERS	CONCENTRATION(S)
TOLUENE	1.0 (D,J)

PARAMETERS	CONCENTRATION(S)
PCE	2.0 (D,J)

LEGEND

DESIGNATION	DESCRIPTION
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
1,2-DCE	1,2-DICHLOROETHENE
BENZENE	BENZENE
TOLUENE	TOLUENE
XYLENE	TOTAL XYLENE
2-BUTAN	2-BUTANONE
D	DRINKING WATER SUPPLY SAMPLE
I	IRRIGATION WATER SUPPLY SAMPLE
B	BEFORE WATER PURIFICATION UNIT (GAC UNIT)
A	AFTER WATER PURIFICATION UNIT (GAC UNIT)
N	WELL NOT USED (OUT OF SERVICE)
NS	LOCATION NOT SAMPLED (SEE TEXT FOR EXPLANATION)
J	ESTIMATED VALUE
BL	COMPOUND FOUND IN METHOD BLANK AS WELL AS IN SAMPLE

NOTE: CONCENTRATIONS SHOWN IN PPB.

NO	DATE	REVISION	INT

UNAUTHORIZED ALTERATION OR ADDITION TO THIS DOCUMENT IS A VIOLATION OF SECTION 7209 OF THE NEW YORK STATE EDUCATION LAW

PROJECT ENGINEER | DRAWN BY
DESIGNED BY | CHECKED BY

Dvirka and Bartilucci

BEDFORD VILLAGE
REMEDIAL INVESTIGATION & FEASIBILITY STUDY
WESTCHESTER COUNTY, NEW YORK
SHOPPING ARCADE SITE

SHOPPING ARCADE STUDY AREA
WATER SUPPLY SAMPLING PROGRAM
SAMPLING LOCATIONS AND RESULTS
AND PROPOSED SERVICE AREA

PROJECT NO. 842
DATE
SCALE AS NOTED
FIGURE NO 3-1

It should be noted that any of the alternative water supply options would also have to consider supplying water to the Hunting Ridge Mall (HRM) study area, as remedial alternatives may be identical for both of these sites. The water supply service areas recommended for both the SA study area as well as the HRM study area are within approximately 4,000 feet of each other (see Figure No. 3-2). Any discussions regarding the expansion of an existing or construction of a new water supply system will consider providing service to both sites.

An option to be considered together with any of these alternate water supply response actions, or any other ground water remedial action technology, is to supply bottled water to affected users for an interim period of time during the construction and implementation phase of the chosen remedial action. Federal and/or State regulatory agencies would determine whether supplying bottled water could be warranted during the interim or indefinite period while design and construction of other response actions including alternate water supply, source remediation and/or management of plume migration are implemented.

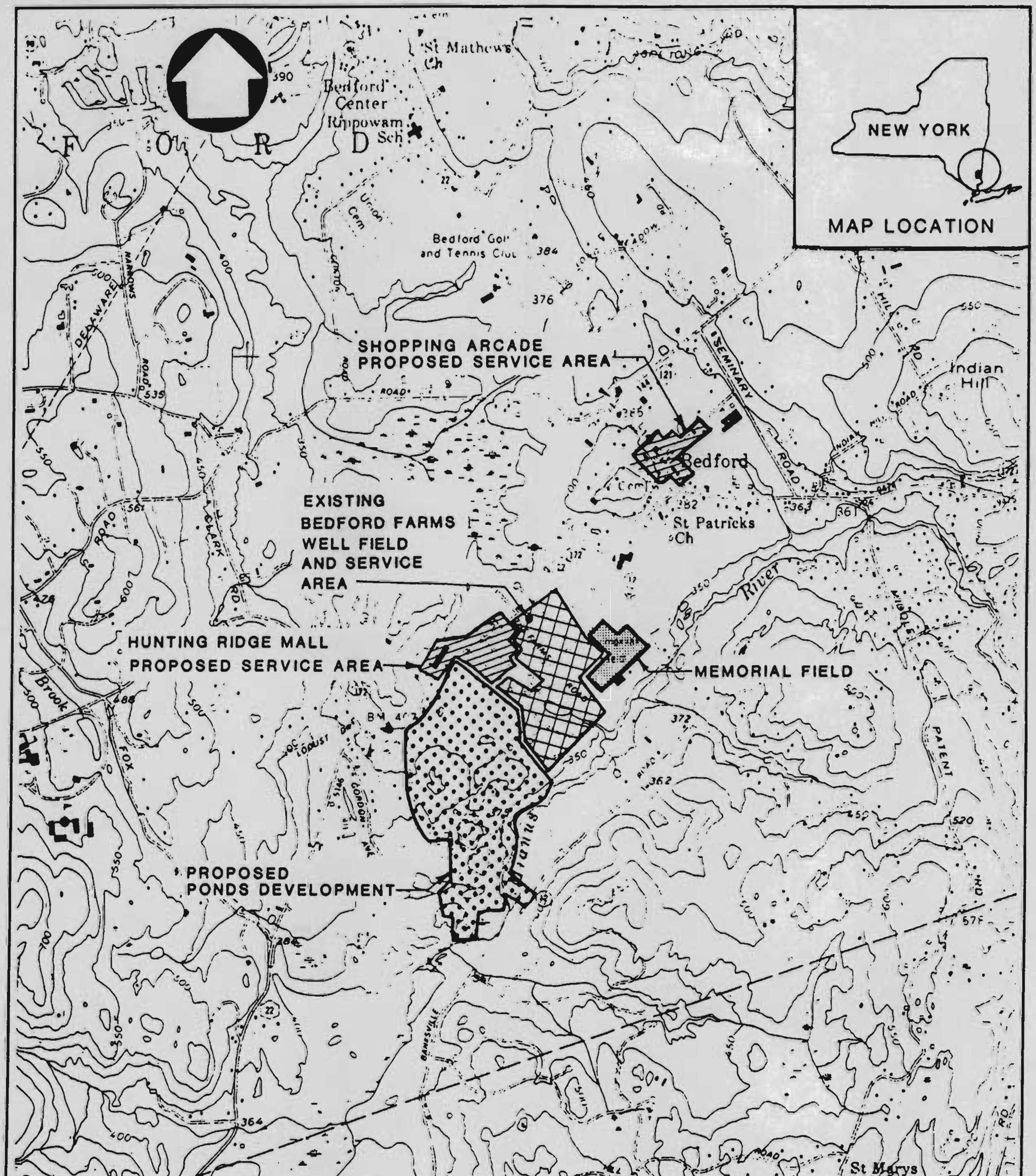
Recently, the New York State Department of Environmental Conservation (NYSDEC) has given consideration to the utilization of New York State Superfund monies in providing assistance to private or public entities whose drinking water supplies have been contaminated. Assistance could be applicable in three cases:

- The temporary supply of bottled water or filters while investigation and study of a Class 2 registry site is on-going. This financial assistance would include all operation and maintenance costs.

- The extension of water lines, and provision for new wells or other permanent solutions when, in the absence of a remedial investigation/feasibility study (RI/FS), data supports a conclusion that a new water supply is required.

- Provision for a permanent solution when an RI/FS produces sufficient data to support a conclusion that a new water supply is required.

As mentioned briefly in Section 2.0 of this report, there are five response options that have been identified and will be discussed in this section under Alternative Water Supply. These five response options are described below.



Map Source: NYS DOT
MOUNT KISCO QUADRANGLE

SCALE: 1"=2000'

Dvirka and Bartilucci CONSULTING ENGINEERS

BEDFORD VILLAGE WELLS
WATER SUPPLY SERVICE AREA
SYSTEMS LOCATION MAP

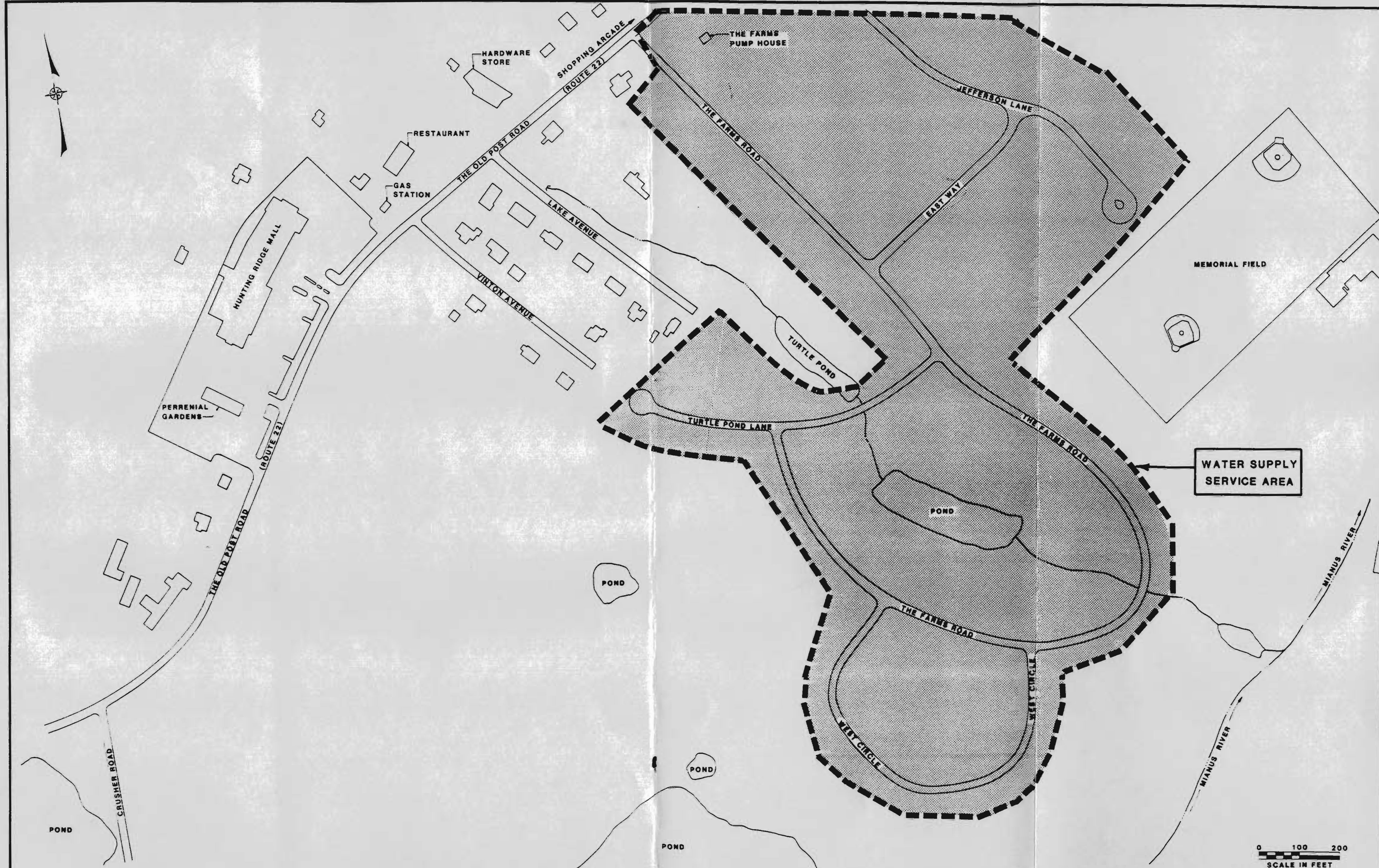
FIGURE NO. 3-2

Expansion of the Existing Bedford Farms Community Water Supply System: The Bedford Farms Community Water Supply System (known as "the Farms") is owned and operated by the Bedford Farms Water Company, a private concern, and serves a residential community located immediately east of Lake and Vinton Avenues within the HRM study area. It supplies potable water to approximately 81 residential units south of Old Post Road. The well field and approximate service area of the Farms system is shown on Figure No. 3-3.

The existing facility consists of three water supply wells located near the intersection of Route 22 and the Farms road; these include: Well No. 1, constructed in 1954, with a capacity of 60 gallons per minute (gpm); Well No. 2, also constructed in 1954, with a capacity of 24 gpm; and Well No. 3, constructed in 1966, with a capacity of 100 gpm. Based on conversations with the well drillers, Well Nos. 1 and 2 are screened from approximately 109 to 129 feet below ground surface within the Glacial Stratified Drift, which consists of sorted deposits of sand, silt, clay and gravel. Well No. 3 is approximately 127 feet below ground surface and is within the Inwood Marble, the top portion of which is weathered and fractured. This system also consists of one 5,000 gallon hydropneumatic tank and two additional 15,000 gallon underground storage tanks. Water is supplied from the facility to its users via underground piping, either 4 inches or 6 inches in diameter. In addition, while fire hydrants are located within the Farms service area they are not in service or recognized for use.

Information recently obtained from the Westchester County Department of Health (WCDH) as well as other private concerns has indicated that currently, Well No. 3 is fully operational while Well No. 1 is providing potable water in the range of 30 to 60 gpm and is used as a stand-by well. Well No. 2 has been permanently decommissioned due to lack of yield.

Information contained in the 1988 Public Service Commission Report on Water Usage indicates that actual water usage during 1988 for the 81 residential units was 6,459,000 gallons, which equates to an average of 17,696 gallons per day. Using standard assumptions for hourly usage, the maximum hourly water usage for these units is calculated to be approximately 49.15 gpm. The New York State Department of Health (NYSDOH) design standards contained in the Ten State Recommended Standards for Water Works, 1987, recommend well and pump capacities to be ten times the average rates or in this case 122.9 gpm. All supporting calculations and analyses are contained in Appendix A.



NO.	DATE	REVISION	NT

UNAUTHORIZED ALTERATION OR ADDITION TO THIS DOCUMENT IS A VIOLATION OF SECTION 7209 OF THE NEW YORK STATE EDUCATION LAW.

PROJECT ENGINEER: DRAWN BY:
DESIGNED BY: CHECKED BY:

Dvirka and Bartilucci

BEDFORD VILLAGE WELLS
REMEDIAL INVESTIGATION & FEASIBILITY STUDY
WESTCHESTER COUNTY, NEW YORK
SHOPPING ARCADE SITE

BEDFORD FARMS WATER COMPANY
COMMUNITY WATER SUPPLY SYSTEM
SERVICE AREA

PROJECT NO. 842
DATE
SCALE AS NOTED
DRAWING NO. 3-3

In order to expand the Farms community water supply system to include affected SA commercial and residential users, it would be necessary to either construct additional supply wells at the existing well field, and/or consider an additional well field location, such as the northern portion of Memorial Field (see Figure No. 3-2). The water use projected for the affected SA study area was calculated using standard assumption and estimates of per capita use for 8 residential units, the 5 commercial units of the Shopping Arcade, a gas station, a bank, a theater, a firehouse, and a county courthouse. These calculations resulted in an estimated average daily flow rate of 15,200 gallons per day. Again using standard assumptions, this figure corresponds to a maximum hourly rate of 42.02 gpm. NYSDOH design standards would recommend an installed well and pump capacity of 105.5 gpm. Any expansion of this system must ensure that the safe yield of the aquifer would not be exceeded. Should this alternative be chosen for implementation, a test well must be installed in order to assess the capacity of water-bearing zones.

It should be emphasized that all calculations and assumptions, presented above and in Appendix A, relate only to providing potable water to the affected commercial and residential users within the SA study area. No provision is being made as part of this study for providing an adequate water supply for fire protection. Although NYSDOH recommended standards suggest that fire protection capabilities be designed into proposed community water supply systems, there are often limitations with respect to available yield that preclude the inclusion of fire protection design flow rates. If fire protection is not part of a community water supply system, homeowners (and commercial business owners) in the service area would have to pay a significantly higher premium for fire insurance than a homeowner in a similar area where fire protection is designed into a water supply system. If fire protection is included in a water supply system, the design, construction and operation of that system must be performed in accordance with the requirements of the Insurance Services Office, Inc., contained in its Fire Suppression Rating Schedule, 1980.

The reason for not including fire protection in the discussion of these alternative water supply options is based upon a review of existing information (well logs, ground water assessment reports, etc.) as well as discussions with local Town of Bedford and Westchester County representatives regarding the available yields of underlying aquifers. The prevailing judgment appears to be that the additional capacity needed to include fire protection would not be available in the subject areas. The Insurance Services Office guidelines state that for fire protection at residential areas, a design flow rate of 1,000 gpm is recommended while for commercial areas 2,000 to 2,500 gpm is recommended.

These figures are substantially greater than the maximum flow rates required for potable water service alone. In addition, to implement fire protection capabilities, costs would increase significantly. Again, the installation of a test well and a pump test would be the only manner in which a definitive statement could be made regarding the ability of the water bearing strata in the study area to support the design flow required for a fire protection system.

Therefore, this option would provide for the expansion of the Farms system to supply potable water to affected commercial and residential users within the SA study area. This expansion would entail the design and construction of supply wells, pumps and hydropneumatic storage tanks, along with the installation of an underground distribution system to convey water from the well field throughout the service area. Attendant activities would include providing administrative support, standby emergency generator services, chemical treatment, and sampling for laboratory analysis.

It must also be noted that New York State policy does not allow for providing State monies for private concerns, which would include the expansion of the Bedford Farms Water Supply System. However, the Town of Bedford has held discussions with the owner of the system regarding possible purchase by the Town. Selection of this alternative would be contingent upon the Town's purchase.

Expansion of the Planned Ponds Development Water Supply System: A townhouse/ condominium development project, commonly referred to as "the Ponds", is proposed for construction on a large tract of presently undeveloped land immediately west of the affected residences of Lake and Vinton Avenues. This housing development proposal is expected to consist of approximately 50 townhouses and 9 estate houses. The location of the proposed Ponds Development is shown on Figure No. 3-2.

In order for this water supply alternative to be implemented, the Town of Bedford would have to purchase the community water supply system from the Ponds developer and expand the system to include supplying potable water to the affected SA commercial and residential users and, in all likelihood, the affected HRM users. Such an expansion would necessarily include additional supply wells and storage facilities, as well as attendant pumping facilities and underground piping. Such an expansion must ensure that the safe yield of the aquifer would not be exceeded.

Development of a New Community Water Supply System: This alternative would consist of establishing a new community water supply system to provide an adequate supply of potable water to a wider geographic area within the Town. Although the immediate concern of this alternative would be to provide potable water to affected SA (and HRH) commercial and residential users, the Town of Bedford and other regulatory agencies have expressed interest in the feasibility of providing service to a larger area.

The projected location for a new community water supply facility would be within the northern portion of Memorial Field, located approximately 1,400 feet due east of the HRM study area. This area is indicated on Figure No. 3-2.

It should be noted that locations in closer proximity to the Shopping Arcade study area were investigated, specifically including one parcel of land being considered for aquisition by the Town of Bedford located behind the Bank and Exxon Station, northwest of the Village Green. Based upon the very limited area of this parcel (1.5 acres), the steep slope of the terrain, the type of land use abutting this property (including residential units and a cemetery), and the ability of the subsurface geology to yield adequate water supply, this location was not considered viable with respect to construction of a water supply system.

Development of a Point-of-Use Treatment District (Filter District): As discussed above, similar to those remedial options that provide for the expansion of an existing community water supply system or the installation of a new well field and distribution system, point-of-use treatment is also a technology that should be addressed under Alternative Water Supply Options. The implementation of such an alternative is independent of site characteristics because remediation would occur at "point-of-use". Point-of-use units for residential applications are generally installed either as a line-bypass, where separate faucets are provided for treated (drinking, cooking, etc.) or non-treated water; faucet-mounted, where all water passing through the faucet is treated; or whole-house, where all water entering the house is treated. This latter option is also known as "point-of-entry."

This alternative would require the implementation of a water supply management and treatment district within the SA study area. Specifically, a municipal maintenance district would utilize in-house municipal employees or outside contractors specializing in this field to install, maintain and monitor treatment units at each commercial and residential unit with levels of contaminants in drinking water in excess of the New York State Department of Health Standards. New York State currently has the required legislation to implement such a district within the Town.

Such an alternative could be implemented at affected residential and commercial properties until such time as either the water supply is remediated by a "pump and treat" program, or the residential/commercial unit is connected to a community water supply system. If this alternative is linked with the "pump and treat" option, the filter district would be established for a period of either 3 or 6 years, depending on the treatment option selected.

3.1.5 No-Action Alternative

Guidance Issued by the United States Environmental Protection Agency (EPA) entitled, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" dated October 1988 indicates that "no-action" may include some type of environmental monitoring, but should not include minimal actions taken to reduce the potential for exposure (e.g., providing bottled water, distributing notices to boil water, etc.). As such, in the case of this Bedford Village Wells project, the no-action alternative would continue the status quo with respect to the affected commercial and residential users within the SA study area. This alternative would allow the continued use of a water supply with concentrations of certain chemicals in excess of New York State Department of Health Standards. Table No. 5-6 of the previously referenced Remedial Investigation Report of February 1990 indicates those commercial and residential users whose drinking water exceeds New York State Standards. It should be noted that a number of the affected commercial and residential users within the SA study area have already taken steps to improve the quality of the water being utilized. These steps include treating the contaminated water supply by using a point-of-use or point-of-entry carbon filter system, by boiling the water to be consumed for an appropriate length of time as instructed by the Westchester County Department of Health, or purchasing bottled water for consumption.

While the No-Action Alternative is not acceptable from a public health standpoint, it will be carried through all steps of the screening of alternatives process for comparison to other action alternatives.

3.2 Screening of Ground Water Remedial Action Alternatives

The screening of remedial technologies and response actions is performed in accordance with the requirements of CERCLA/SARA to ensure that an adequate number of technologies/response actions are identified that are appropriate for remediation of each contaminated environmental medium (i.e., soil, surface water, ground water, etc.). Such a screening involves the use of effectiveness and implementability criteria.

- Effectiveness - Remedial technologies and/or response actions must have the potential to meet established New York State Standards, be protective of human health and the environment, and reduce mobility, toxicity or volume of hazardous substances to be considered effective. In addition, each response action must be evaluated as to its effectiveness in handling the estimated areas or volumes of contamination and meeting the goals of the remedial action objectives. Also, previous case histories must be reviewed to determine the reliability of each response action. With the exception of the No-Action Alternative, which will be covered through all phases of the evaluation process, remedial actions not meeting the minimum requirements of this effectiveness criterion will be eliminated from further consideration.

- Implementability - Remedial technologies and/or response actions will be evaluated for technical and administrative feasibility. Technical implementability evaluates a response action against site-specific characteristics (such as existing land use, site geology and hydrogeology), system reliability and constructability. Administrative implementability includes the ability to obtain necessary permits, the availability of treatment, storage, and disposal services and the availability of necessary equipment and personnel to implement the response action. Other administrative criteria will be addressed in Section 4.0, Detailed Evaluation of Remedial Action Alternatives. These criteria include an evaluation of issues and concerns of the State, local entities and the public regarding each alternative. Remedial actions not readily implementable based upon minimum evaluation criteria will be eliminated from further consideration.

The following portion of this report will present a discussion of the ground water remediation alternatives and the alternative water supply options against the two screening criteria discussed above. The only alternative not being screened, as previously discussed, is the No-Action Alternative, which will be carried through each step of the feasibility study evaluation process.

3.2.1 Ground Water Remedial Action Alternatives

Since ground water extraction is common to each ground water alternative, it will be discussed separately.

Ground water extraction systems were developed for remediation of contaminated ground water over a 3 year period and a 6 year period. For either time period, ground water extraction is effective in reducing the contaminant concentration and the migration of the contaminant plume. As compared to the 6 year cleanup period, the 3 year cleanup period reduces exposure to the contaminants and restores the aquifer in a shorter period of time. However, the 3 year ground water extraction alternative requires a greater number of wells pumping at high flow rates. Because of the high pumping rates, this system may impact local water supply wells in the area. The 6 year ground water extraction alternative requires a smaller number of wells pumping at a lower flow rate and may not impact local water supply wells in the area. The disadvantage of the 6 year system is that the cleanup will take twice as long.

The purpose of the two aquifer restoration time periods is to evaluate the two alternatives on the basis of cost in Section 4. Therefore, in this section, each alternative will be screened without considering the 3 or 6 year remediation alternatives.

Because discharge of treated water is included in each ground water alternative, regulatory approval will be discussed separately. Since all alternatives include discharge of treated ground water to the environment, various approvals must be obtained. Approvals include those of the New York State Department of Environmental Conservation, the Westchester County Department of Health and the Bedford Town Board.

The following alternatives presented involve the extraction, treatment, and disposal of contaminated ground water.

- <u>Ground Water Alternative No. 1</u> – **Extraction, Treatment by Carbon Adsorption, and Aquifer Recharge.**

  In this alternative, contaminated ground water is extracted from bedrock wells at the downgradient edge of the contaminant plume, treated by carbon adsorption and recharged at the upgradient edge of the contaminant plume. This alternative would be selective in controlling the migration of the contaminant plume thereby reducing the risk of exposure to off-site receptors. In addition, recharging the aquifer with the treated ground water would reduce the impact the system may have on local water supply wells.

Given the relatively low contaminant concentrations, carbon adsorption would be effective in removal of contaminants from the ground water to the acceptable levels and meet New York State Standards. This alternative will be capable of handling the total volume of contamination and meeting the remedial action objectives. It will also be effective in reducing the mobility, toxicity, and volume of contaminants and thus reduce the exposure levels to the general public.

The implementation of this alternative is certainly feasible. The technologies are commonly used and have been proven in the field. Using standard engineering practices, installation of this system would be feasible.

This alternative, therefore, will be retained for further consideration.

- **<u>Ground Water Alternative No. 2</u> – Extraction, Treatment by Air Stripping and Aquifer Recharge.**

In this alternative, the extraction and recharge technologies remain the same as Alternative No. 1. Here the extracted ground water would be treated using air stripping. Air stripping is effective in removing volatile compounds which are present in the ground water on-site. However, air stripping is not effective in handling occasional slugs of high contaminant concentrations in ground water exceeding the design concentrations. Therefore, care must be taken during design stages to provide an adequate factor of safety for such an incidence. As with carbon adsorption, this alternative will be effective in reducing the mobility, toxicity, and volume of contaminants and thus reduce the exposure levels to the general public.

This alternative can be implemented at the site using standard engineering practices. The technologies presented are commonly used and proven in the field. One of the requirements necessary for implementing this alternative would be acquiring all the necessary State and local permits. Required permits include those of the New York State Division of Air Resources. Treatment of off-gases may be needed and will be evaluated in later sections. This alternative, therefore, will be retained for further consideration.

- Ground Water Alternative No. 3 – **Extraction, Treatment by Air Stripping and Carbon Adsorption, and Aquifer Recharge.**

  Again, in this alternative, the extraction and recharge technologies remain the same as Alternative No. 1. This alternative uses the combination of air stripping and carbon adsorption to treat contaminated ground water. The contaminated ground water would first be passed through the air stripping tower to remove most of the volatile organic compounds. Carbon adsorption would then be used to remove any remaining contaminants. This combination would be effective in removing the contaminants and insuring that contaminant levels in ground water recharging the aquifer do not exceed New York State Standards.

  As discussed earlier, this alternative could be implemented at the site using standard engineering practices commonly used and proven in the field.

  Therefore, this alternative will be retained for further consideration.

- Ground Water Alternative No. 4 – **Extraction, Treatment by Carbon Adsorption, and Discharge of Treated Water to Storm Water Drainage System.**

  This alternative is similar to Alternative No. 1 except that the treated ground water would be discharged to the storm water drainage system in the area. By discharging contaminated ground water to the storm water drainage system, ground water recharge amounts would not be substantial. Without ground water recharge, local water supply wells may be impacted. Design support testing that includes an aquifer pump test and ground water modeling would be needed to determine the impact that discharge to the storm water system would have on the aquifer system. However, discharging to the storm water drainage system would be effective in disposing treated water.

  This alternative would be relatively simple to implement because the extraction and treatment systems could be designed to effectively utilize the drainage system. The effectiveness and implementability review of the extraction and treatment systems is described in Alternative No. 1.

This alternative, therefore, will be retained for further consideration.

- <u>Ground Water Alternative No. 5</u> – **Extraction, Treatment by Air Stripping, and Discharge of Treated Ground Water to Storm Water Drainage System.**

  This alternative is similar to Alternative No. 2 except that the treated ground water would be discharged to the storm water drainage system in the area. Because this alternative involves only air stripping to treat contaminated ground water, the review of the effectiveness and implementability of this alternative is similar to that described for Alternative No. 2.

  Therefore, this alternative will be retained for further consideration.

- <u>Ground Water Alternative No. 6</u> – **Extraction, Treatment by Air Stripping and Carbon Adsorption and Discharge of Treated Ground Water to Storm Water Drainage System.**

  This alternative is similar to Alternative No. 3 except that the treated ground water would be discharged to the storm water drainage system in the area. As discussed in the screening of Alternative No. 3, the combination of air stripping and carbon adsorption would effectively remove contaminants from ground water to the extent that the treated water could be discharged to the storm water drainage system. This technology is commonly used and proven in the field. The review of the effectiveness and implementability of this alternative is similar to that described in Alternative No. 3.

  Therefore, this alternative will be retained for further consideration.

<u>Summary</u>: All six of the ground water alternatives have passed the initial screening with respect to effectiveness and implementability. Therefore, these alternatives will be retained for further detailed evaluation. Table No. 3-2 provides a synopsis of the ground water remediation alternatives with their appropriate effectiveness and implementability. The No-Action Alternative is required to be carried throughout the entire feasibility study process.

TABLE 3-2 - SCREENING FACTORS FOR REMEDIAL ACTION ALTERNATIVES FOR THE SHOPPING ARCADE AREA

ALTERNATIVE	EXTRACTION	TREATMENT	DISPOSAL	WATER SUPPLY	EFFECTIVENESS	IMPLEMENTABILITY	COMMENTS
1/25	3 yrs/6 yrs	No treatment	Recharge	Public water	U	A	Not Retained
2/26	3 yrs/6 yrs	No treatment	Recharge	Point-of-use treatment	U	A	Not Retained
3/27	3 yrs/6 yrs	Air stripping	Recharge	Public water	A/T	A	Retained
4/28	3 yrs/6 yrs	Air stripping	Recharge	Point-of-use treatment	A/T	A	Retained
5/29	3 yrs/6 yrs	Air stripping	Discharge to sewer	Public water	A/T	A	Retained
6/30	3 yrs/6 yrs	Air stripping	Discharge to sewer	Point-of-use treatment	A/T	A	Retained
7/31	3 yrs/6 yrs	Air stripping	Discharge to POTW	Public water	A/T	U	Not Retained
8/32	3 yrs/6 yrs	Air stripping	Discharge to POTW	Point-of-use treatment	A/T	U	Not Retained
9/33	3 yrs/6 yrs	Air stripping	Public use/treated H_2O	----	A/T	U	Not Retained
10/34	3 yrs/6 yrs	Carbon adsorption	Recharge	Public water	A	A	Retained
11/35	3 yrs/6 yrs	Carbon adsorption	Recharge	Point-of-use treatment	A	A	Retained
12/36	3 yrs/6 yrs	Carbon adsorption	Discharge to sewer	Public water	A	A	Retained
13/37	3 yrs/6 yrs	Carbon adsorption	Discharge to sewer	Point-of-use treatment	A	A	Retained
14/38	3 yrs/6 yrs	Carbon adsorption	Discharge to POTW	Public water	A	U	Not Retained

A = Acceptable.
A/T = Assumed Acceptable, verification testing required.
U = Unacceptable.

TABLE 3-2 - SCREENING FACTORS FOR REMEDIAL ACTION ALTERNATIVES FOR THE SHOPPING ARCADE AREA (cont.)

ALTERNATIVE	EXTRACTION	TREATMENT	DISPOSAL	WATER SUPPLY	EFFECTIVENESS	IMPLEMENTABILITY	COMMENTS
15/39	3 yrs/6 yrs	Carbon adsorption	Discharage to POTW	Point-of-use treatment	A	U	Not Retained
16/40	3 yrs/6 yrs	Carbon adsorption	Public use/treated H_2O	---	A	U	Not Retained
17/41	3 yrs/6 yrs	Air stripping/ carbon adsorption	Recharge	Public water	A	A	Retained
18/42	3 yrs/6 yrs	Air stripping/ carbon adsorption	Recharge	Point-of-use treatment	A	A	Retained
19/43	3 yrs/6 yrs	Air stripping/ carbon adsopriotn	Discharge to sewer	Public water	A	A	Retained
20/44	3 yrs/6 yrs	Air stripping/ carbon adsorption	Discharge to sewer	Point-of-use treatment	A	A	Retained
21/45	3 yrs/6 yrs	Air stripping/ carbon adsorption	Public water		A	U	Not Retained
22/46	3 yrs/6 yrs	Air stripping/	Discharge to POTW	Point-of-use treatment	A	U	Not Retained
23/47	3 yrs/6 yrs	Air stripping/ carbon adsorption	Public use/treated H_2O	---	A	U	Not Retained
24	---	No action	---	---	U	A	Retained

A = Acceptable.
A/T = Assumed Acceptable, verification testing required.
U = Unacceptable.

3.2.2 Water Supply Alternatives

The following portion of this report will present a discussion of each of the four alternate water supply options against the two screening criteria previously discussed in this section. The only alternative not being screened, as previously discussed, is the No-Action Alternative, which will be carried through each step of the feasibility study evaluation process.

- **Water Supply Alternative No. 1 – Expansion of the Existing Bedford Farms Community Water Supply System.**

  This alternative is considered to be an effective alternative relative to the protection of human health in that it would replace the potable water now being utilized by the affected residential and commercial users in the SA study area with potable water that meets all applicable New York State Standards for drinking water. It should be noted, however, that a significant increase in the pumping rate at the Farms system presents the potential for modifying the ground water gradient adjacent to the Farms' well field. This could increase the possibility that the contaminated plume located adjacent to Lake and Vinton Avenues could migrate toward the Farms' supply wells potentially leading to contamination of this system. This situation could be eliminated or mitigated by the timely treatment of the existing plume of ground water contamination. None of the alternative water supply options would reduce the mobility, toxicity or volume of contamination plume. However, the toxicity of the potable water of affected commercial and residential users would be reduced by providing potable water from another supply area. Although water supply systems are proven and reliable technologies, it is uncertain at this point whether the Farms Community water supply system could handle the increase in pumping from any additional supply wells installed as a result of the SA and, perhaps the HRM study areas. As noted above, only one of the three existing water supply wells is fully operational while a second supply well is operating at reduced capacity. The third supply well has been permanently discontinued due to lack of yield.

  The implementability of this alternative as well as the other two alternatives that require the construction of new or expansion of existing water supply systems is certainly feasible. As noted above, water supply systems are proven technologies, the implementation of which consists of standard engineering design and construction practices and protocols. One could assume that the equipment and personnel needed to construct such a system would be available. Site-specific concerns include the ability of the aquifer underlying the Farms area to provide adequate yields to account for the system expansion. Implementing this alternative would be contingent upon purchase and operation of the Farms system by the Town of Bedford. An additional requirement related to implementing this alternative would be acquiring all necessary state and local permits and/or approvals to install such a system to a new service area. Required permits include those of the New York State Department of Environmental Conservation and the Westchester County Department of Health. Transportation, storage and disposal needs would be applicable in the cases of alternatives relating to the expansion of existing or construction of new community water supply systems if treatment of the water supply is needed. Chemical storage may be required under these alternatives.

This alternative, therefore, will be retained for further consideration.

- Water Supply Alternative No. 2 – **Expansion of the Planned Ponds Development Water Supply System.**

As with Alternative No. 1, there exists uncertainty with respect to this alternative relative to whether expansion of the proposed Ponds community water supply system could meet the required increase in pumping resulting from any additional demand associated with the SA and HRM study areas. Ground water extraction at this site could be limited depending upon available capacity and yield. In addition, significant ground water extraction at the proposed Ponds Development well field location could adversely impact the adjacent contaminated plume resulting from the HRM site.

Aside from the concerns listed above, a review of the effectiveness and implementability of this alternative is similar to that described for Alternative No. 1. Therefore, this alternative will be retained for further consideration.

o **Water Supply Alternative No. 3 - Development of a New Community Water Supply System.**

Based upon information currently available, this alternative would be effective and implementable. Subject to the results of detailed pre-design studies and pump tests, the proposed location of a new community water supply system at the northern portion of Memorial Field appears to be able to provide adequate water supply within the range of acceptability of New York State Standards. This assumption is based upon a review of existing well logs, water supply information, and limited analyses of ground water samples from a supply well at Memorial Field. As previously discussed, the implementability and reliability of such options are proven. Therefore, this alternative will be retained for further consideration.

o **Water Supply Alternative No. 4 - Development of a Point-of-Use Treatment District (Filter District).**

Point-of-use devices are installed within residences, most commonly under the kitchen sink. A simple bypass of the existing cold water line provides water to the unit, which is attached to an extra kitchen faucet. In this way, only the water required for drinking and cooking is treated, thus reducing size and replacement requirements to a minimum. More expensive options are to treat all water intended for indoor use, or to treat all water delivered to the property for both indoor and outdoor use with a point-of-entry treatment unit (D&B Consulting Engineers, 1989).

Treatment units have been used to soften water for many years, but are now being employed to remove nitrate, pesticides, and volatile organic compounds (VOCs). Ion exchange, low pressure reverse osmosis, and granulated activated carbon (GAC) adsorption processes are adaptable to single and multi-family residences. These systems require a minimum of operating controls, can be actuated by water pressure, and can be automated, if desired.

Several point-of-use and point-of-entry devices have been field tested and have shown that commercial units are adaptable to household application. Ion exchange and reverse osmosis devices have been tested in New Hampshire.

Home GAC treatment units have been used for aldicarb removal on the North Fork of Suffolk County, New York (Moran, 1983), and for VOC removal in several locations, including Rockaway Township, New Jersey.

Operating and maintenance costs are an important consideration in the evaluation of the point-of-use/point-of-entry treatment option. Ion exchange resins and GAC must be periodically regenerated in place or removed and regenerated at a centralized location. The frequency of regeneration will depend in large part on the number and concentration of contaminants present in the feed water and the size of the unit. With reverse osmosis, the membranes must be replaced periodically.

Home reverse osmosis treatment units are currently available in a range of sizes, from under-the-counter units used to treat only drinking water to full-scale units capable of treating all the water used by an apartment complex. Several manufacturers are available, which ensures competitive capital costs and strong warranties. The small reverse osmosis units can effectively treat up to 5 gallons per day using normal system pressures. For larger capacities, booster pumps are required to increase the operating pressure across the reverse osmosis membrane. Servicing (membrane replacement) appears to be necessary at 6 to 12 month intervals.

This alternative would be effective in removing the toxic contaminants of concern to acceptable New York State Standards and, therefore, be protective of human health. The recommended option would be to treat all water intended for indoor use. This would ensure that the water being ingested (water used for drinking and cooking) or inhaled (water vapors resulting from showers and cooking) would meet applicable New York State Standards. Please refer to the aforementioned Health Risk Assessment dated February 1990 for additional information regarding this issue. In and of itself, this alternative would not be protective of the environment. However, if this alternative were linked with a pump and treat technology to remediate the contaminated ground water, protection of the environment would be addressed. Concern regarding adequate yield under this alternative would take on less significance as each of the affected commercial and residential users in the SA study area would be provided with point-of-use remediation for existing and fully operable well systems.

With respect to the implementability criterion, as noted above, point-of-use technology has been implemented for several different applications. The reliability and effectiveness of such a technology is directly related to use of the proper treatment medium, and proper installation and maintenance, among other factors. In addition, problems often arise with regard to administrative concerns. The Town of Bedford would most likely be required to create a Municipal Maintenance District to organize, implement and operate the Filter District. New York State currently has in place the legislation enabling municipalities to create such districts. Historically, however, this option has been demonstrated to be non-implementable as towns and/or private concerns are often unwilling to take on the responsibilities for managing such a system. Technical problems and liability relating to the replacement of filters prior to exhaustion are often cited as reasons for declining to manage such a system.

As discussed above, a Municipal Maintenance District would likely have to be formed to organize, coordinate and maintain such a system. Appropriate user fees would be calculated to ensure that there is an adequate work force to initiate and run this program on the Town of Bedford level.

Lastly, the transportation, storage and disposal issue would apply to this alternative because the "spent" treatment media must be replaced at each point-of-use location on a regular basis. These media would be contaminated with organic compounds from the contaminated ground water plume.

Because the development of a point-of-use treatment district is a viable alternative, it will be retained for further consideration.

<u>Summary</u>: Each of the four alternative water supply options has passed the initial screening with respect to effectiveness and implementability; this screening is summarized on Table No. 3-3. Therefore, these four alternatives will be retained for further detailed evaluation.

3.2.3 No-Action Alternative

Although the no-action alternative would not be effective relative to compliance with New York State standards, this alternative is being carried through every step of the screening of alternatives process for comparison to other action alternatives.

Table No. 3-3

SUMMARY OF INITIAL SCREENING FOR WATER SUPPLY ALTERNATIVES

Alternative Water Supply Option/ Screening Criteria	Effectiveness				Implementability				
	Protect Human Health and the Environment	Reduce Mobility, Toxicity and Volume	Handle Estimated Areas or Volumes	Proven and Reliable	Site Specific Concerns	Technically Reliable and Constructable	Ability to Obtain Permits	Availability of TSD Services	Availability of Equipment and Personnel
Alternative No. 1 - Expansion of the Farms System	Yes	Reduction in toxicity due to use of alternative water supply	Unknown re: Safe Yield Capability	Yes	Potential Problem with Adequate Yield, Plume*	Yes	Yes	Yes	Yes
Alternative No. 2 - Expansion of the Proposed Ponds System	Yes	Reduction in toxicity due to use of alternative water supply	Unknown re: Safe Yield Capability	Yes	Potential Problem with Adequate Yield, Plume*, self-contamination from disposal system	Yes	Yes	Yes	Yes
Alternative No. 3 - Construction of a New System	Yes	Reduction in toxicity due to use of alternative water supply	Yes, based upon available information	Yes	None, based upon available information*	Yes	Yes	Yes	Yes
Alternative No. 4 - Point-of-Use Treatment	Yes	Reduction in toxicity due to point-of-use treatment	Yes	Yes, with Scheduled Monitoring and Maintenance	None	Yes, with proper monitoring and maintenance	Yes	Yes	Yes
Alternative No. 5 - No-Action	No	No	No	No	N/A	N/A	N/A	N/A	N/A

*Note: Test well and pump test would be required in support of design.

1918E

4.0 DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

This section presents a detailed analysis of remedial action alternatives remaining after the screening process. The detailed analysis is being performed using the criteria listed below:

- o Technical evaluation including performance, reliability, implementability, and safety considerations;

- o Institutional evaluation assessing those issues outside of the technical evaluation including concerns of the State, local entities and the public;

- o Public health and environmental impact evaluation considering the ability to reduce risks or maintain low risks, the beneficial and adverse effects of the alternative, and whether the alternative is able to adequately protect human health and the environment in accordance with appropriate New York State Standards;

- o Cost evaluation including capital costs, operating and maintenance costs, and a present worth analysis.

The cost for various technologies is based on previous design studies and experience. In order to arrive at these costs, it is assumed that the contaminated water can be pumped at the rates estimated based on simplified assumptions. The level of detail for the estimate is consistent with a feasibility study and is only to be used as a relative measure for comparison with the alternatives presented. A more detailed and reliable cost estimate can only be assembled upon completion of design support testing, including a comprehensive field testing program which should include a pump test, chemical analysis, etc.

4.1 <u>Ground Water Remedial Alternatives</u>

The alternatives retained in Section 3 for further evaluation are presented in Table No. 4-1. The individual components of each alternative will be described conceptually and evaluated in detail. The individual components to be evaluated are as follows:

- o Ground Water Extraction
  - Long term remediation period

Section 4

TABLE 4-1 - REMEDIAL ACTION ALTERNATIVES FOR THE SHOPPING ARCADE AREA RETAINED FROM SECTION 3

ALTERNATIVE	EXTRACTION (YRS)	TREATMENT	DISPOSAL
1	3	Air stripping	Recharge
2	3	Air stripping	Discharge to sewer
3	3	Carbon adsorption	Recharge
4	3	Carbon adsorption	Discharge to sewer
5	3	Air stripping/ carbon adsorption	Recharge
6	3	Air stripping/ carbon adsorption	Discharge to sewer
7	---	No action	---
8	6	Air stripping	Recharge
9	6	Air stripping	Discharge to sewer
10	6	Carbon adsorption	Recharge
11	6	Carbon adsorption	Discharge to sewer
12	6	Air stripping/ carbon adsorption	Recharge
13	6	Air stripping/ carbon adsorption	Discharge to sewer

- Short term remediation period

- Ground Water Treatment
  - Air stripping
  - Carbon adsorption
  - Air stripping and carbon adsorption

- Disposal of Treated Water
  - Discharge to storm water drainage system
  - Discharge to injection wells
  - Discharge to infiltration gallery

- Water Supply
  - Public water
  - Point-of-use treatment

- No-Action

Ground water monitoring will be implemented during remediation to determine the progress of the aquifer restoration. The ground water monitoring program will be developed in accordance with the New York State ground water standards as goals for cleanup.

The analytical sampling and analysis would be conducted at least twice a year to determine the effectiveness of the cleanup. The types of analyses conducted would be consistent with results of the remedial investigation (RI) sampling. All existing monitoring wells, as well as extraction wells would be sampled.

Each of the technologies will be individually described and evaluated based on criteria described earlier.

4.1.1 Ground Water Extraction System

Ground water extraction involves pumping contaminated ground water from extraction wells for treatment. The extraction wells would be located in the downgradient portion of the contaminant plumes.

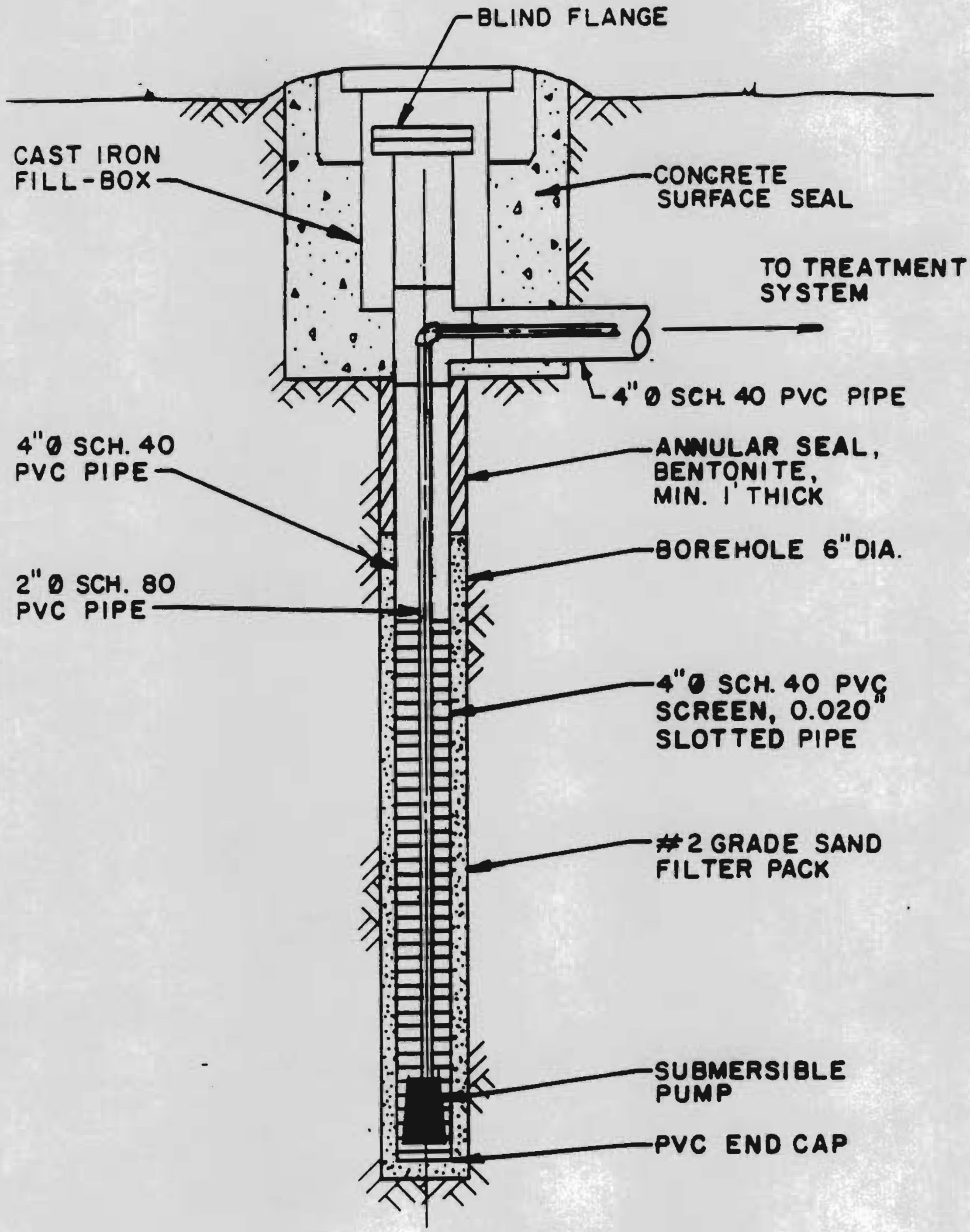
Based on the findings in the RI, it appears that the majority of contaminated ground water is in the bedrock with a small area of contaminated ground water in the overburden. Therefore, extraction wells would be placed in both the overburden and the bedrock. Typical well construction diagrams are presented for the overburden and bedrock wells in Figure Nos. 4-1 and 4-2 respectively. As discussed in Section 3.1.1, ground water in the overburden could be remediated in approximately 1.6 years by installing an extraction system consisting of 3 wells, each pumping at 5 gallons per minute. Figure No. 4-3 shows the proposed extraction well locations for this alternative. Remediation could be expedited to approximately 0.8 years if 6 wells pumping 5 gallons per minute are installed. Figure No. 4-4 shows extraction well locations for this alternative.

Ground water in the bedrock could be remediated in approximately 4.6 years by installing an extraction system consisting of 5 wells, each pumping at 10 gallons per minute. Figure Nos. 4-3 and 4-4 show extraction well locations for this alternative. Installing 10 extraction wells, each pumping at 10 gallons per minute would expedite remediation to approximately 2.3 years.

Bedrock and overburden extraction wells would operate concurrently as one system. The duration of remediation for the system as a whole would be approximately 6 years for a system of 8 extraction wells and 3 years for a system of 16 extraction wells.

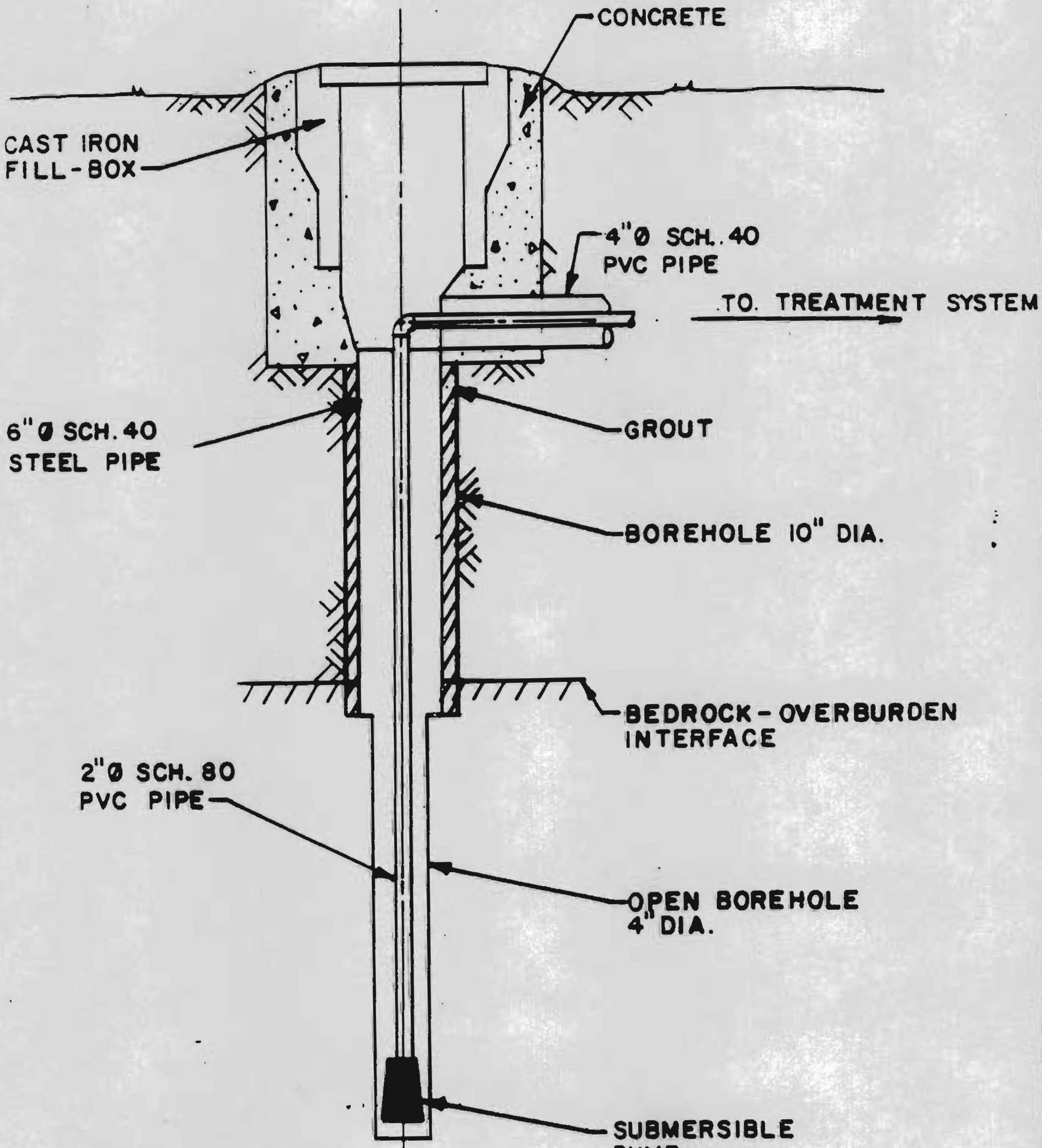
While these assumptions are based on professional experience, they should not substitute for site-specific hydrologic data. To obtain this data (in order to prepare a design for the most effective extraction system and the preferred method of aquifer recharge), pump testing of both the overburden and bedrock aquifers is necessary. In addition, ground water modeling could be used to determine the effective radius of influence of each extraction well as well as an appropriate pumping rate. This information could also be used to assess the impact the extraction system may have on other non-contaminated wells in the area. The hydraulic conductivity of the overburden is dependent, in part, on the grain-size distribution of soils comprising the overburden. The hydraulic conductivity of the bedrock is largely dependent on the presence of secondary permeability features, such as fractures and joints, etc.

FIGURE 4-1



OVERBURDEN WELL CONSTRUCTION

FIGURE 4-2



BEDROCK WELL CONSTRUCTION

FIGURE 4-3

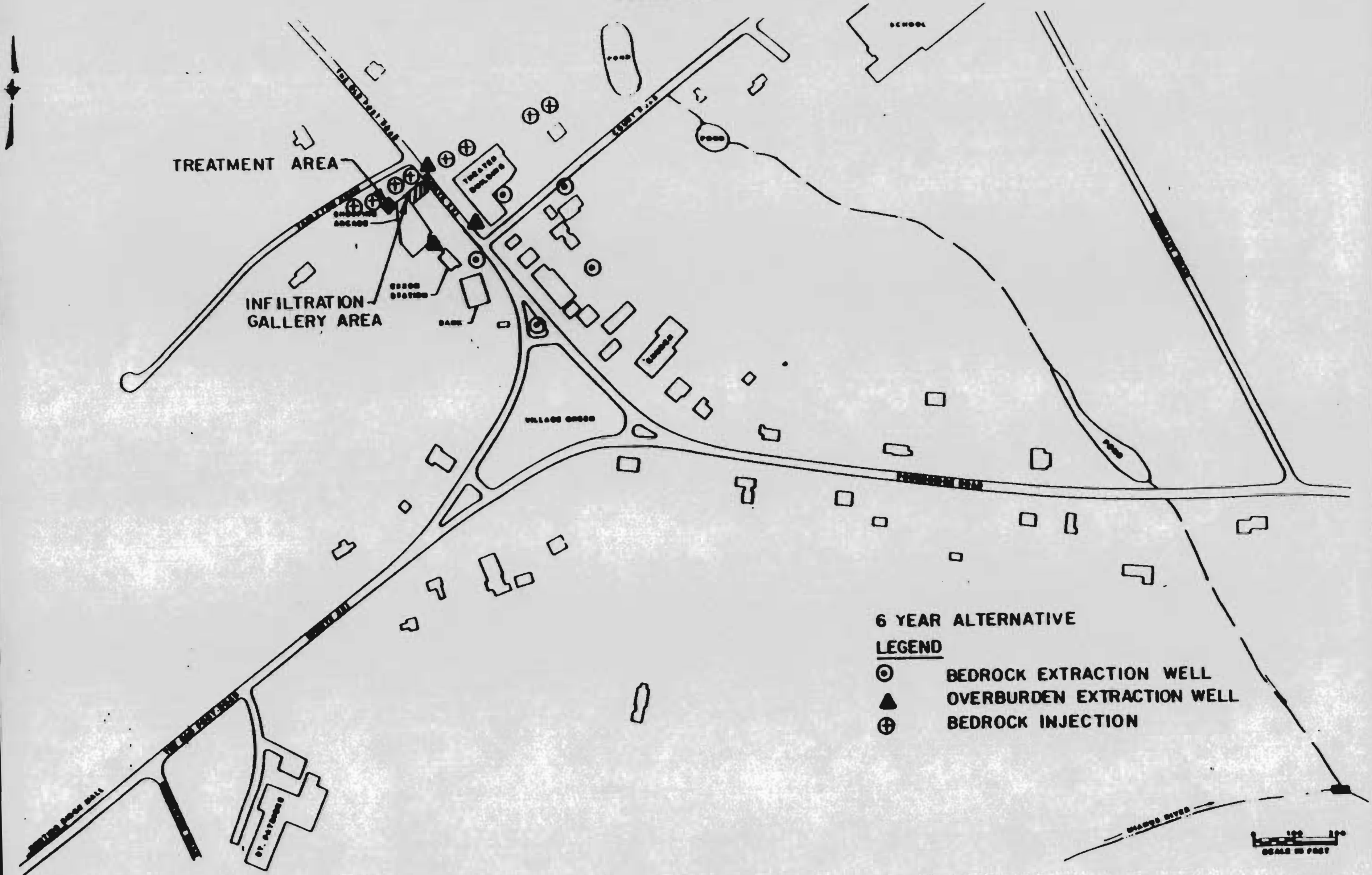
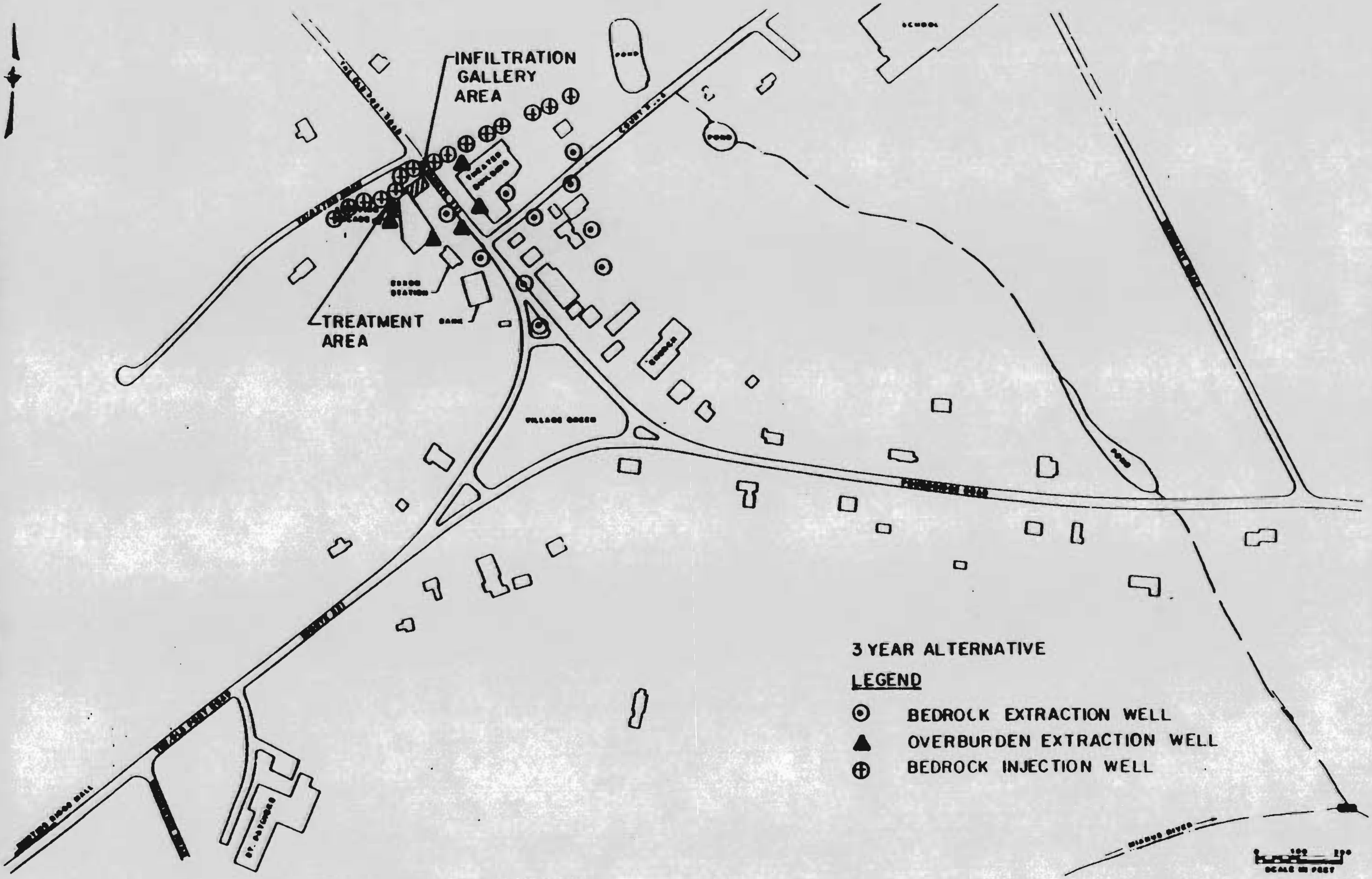

TREATMENT AREA
INFILTRATION GALLERY AREA
SCHOOL
POND
VILLAGE GREEN
ST. PATRICKS
6 YEAR ALTERNATIVE
LEGEND
BEDROCK EXTRACTION WELL
OVERBURDEN EXTRACTION WELL
BEDROCK INJECTION

FIGURE 4-4



SCS ENGINEERS

Technical Feasibility: Performance of the ground water extraction system can be evaluated on the basis of its effectiveness in minimizing contaminant migration and the required time of operation. Minimizing ground water contaminant migration off-site is the goal of the system. Both the 3 and 6 year remediation periods accomplish this. However, the 3 year alternative accomplishes the cleanup twice as fast.

Ground water extraction systems use relatively simple technologies and have been shown to operate successfully. From time to time, submersible pumps may require replacement. In addition, extraction wells may silt up and require redevelopment.

Institutional Analysis: Technically, implementation of the ground water extraction system should be relatively routine. If difficulties are encountered, they would most likely be institutional in nature, such as obtaining the necessary right-of-ways for well and pipeline installation. This can be minimized by siting facilities on public property.

Public Health and Environmental Effects: Safety for an operating ground water extraction system is evaluated in terms of contaminant releases to the atmosphere and potential surface discharges of pumped water due to system leakage prior to treatment. The extraction system is not airtight; releases from the system to the atmosphere will occur. Thus, volatile organic compounds may be released to the atmosphere. Due to relatively low concentrations of the contaminants in the ground water, and assuming only a small portion of water leakage, the concentrations of contaminants released to the atmosphere are expected to be below NYSDEC Ambient Guideline Concentrations (AGCs).

Should a leak in the piping system occur prior to treatment, there is a potential for the public to be exposed to contaminated ground water, and for migration of contaminants to surface water. Appropriate instrumentation, such as a shut-down switch initiated by a drop in system pressure, should minimize this risk. In addition, all piping will be placed underground and well heads will be secured. The use of double-walled pipe would reduce the possibility of release. However, such measures seem unwarranted given the relatively low concentrations of contaminants involved.

Cost Analysis: Capital costs for implementing a ground water extraction system are based on previous design studies and experience. The cost of acquisition of property for well installations or piping runs is not included in this analysis. The following assumptions were made in preparing this cost analysis:

- 3 Year Alternative
  - Six overburden extraction wells approximately 50 feet deep (6 inch diameter)
  - Ten bedrock extraction wells approximately 200 feet deep (6 inch diameter)
- 6 Year Alternative
  - Three overburden extraction wells approximately 50 feet deep (6 inch diameter)
  - Five bedrock extraction wells approximately 200 feet deep (6 inch diameter)

Costs for each alternative are detailed in Appendix B.

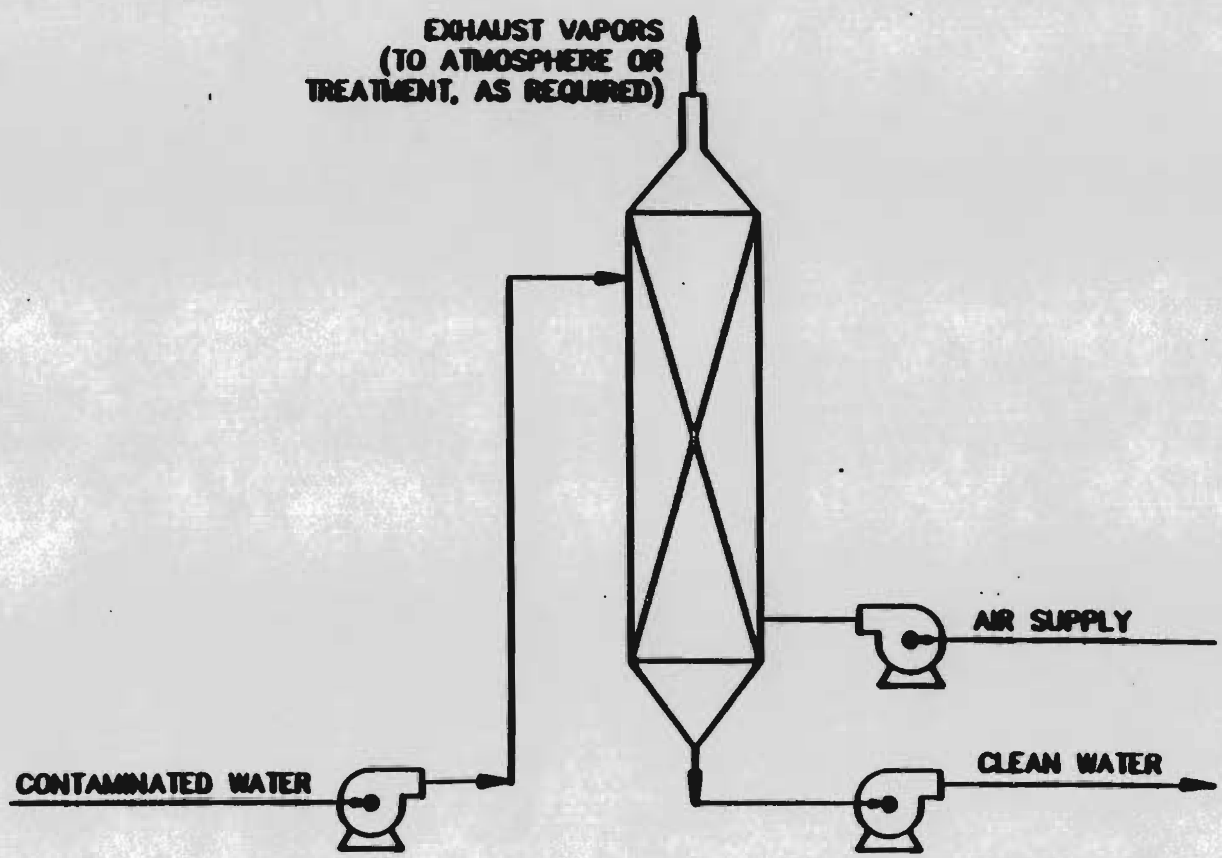
4.1.2 Ground Water Treatment – Air Stripping

Air stripping involves mass transfer of volatile organics from aqueous to gas phase. Air stripping is generally carried out in a stripping tower such as shown in Figure No. 4–5.

Air stripping can be performed with different process configurations such as counter–current packed towers, cross–flow towers, and diffused aeration. Counter–current packed towers are most commonly used for contaminated ground water treatment. Counter–current packed towers are designed such that contaminated water flows down through the tower filled with packing material and air moves up through the column counter–currently. Off–gases containing the contaminants are collected at the top and the treated effluent is released from the bottom of the tower. Treated water may be disposed of via aquifer recharge or the drainage system. Packing material provides a large surface area for mass transfer. The counter–flow configuration adds turbulence to the system to further aid the removal.

FIGURE 4-5

AIR STRIPPER



SCS ENGINEERS

Removal of contaminants from ground water is dependent on factors such as:

- o Volatility of the contaminant;
- o Water temperature;
- o Air-to-water ratio; and
- o Packing surface area.

An additional factor that would be addressed is the geochemistry of the ground water. At present, no data are available regarding the geochemistry of ground water at the site. If high sediment loading is encountered, then some sedimentation will be necessary before the ground water is treated in the air stripper. Similarly, if hardness is encountered in the ground water to the extent that it would interfere with the stripper operations, then some pretreatment will be necessary either to remove the hardness or to acidify the water so scaling in the stripper column will not occur. Design support testing of the ground water might be necessary to ensure smooth operations of the air stripper.

The volatility of a contaminant is a function of its Henry's Law Constant. In general, the higher the Henry's Law Constant for a given contaminant, the higher the removal efficiency by air stripping. Compounds with Henry's Law Constants above 0.1 are readily amenable to air stripping. Compounds with less than 0.1 value of Henry's constant may be removed by air stripping but only with some difficulty.

Water temperature plays an important role in the removal of volatile compounds. Generally, the higher the water temperature, the easier the compounds are removed due to the increased volatility at higher temperatures. In the case of low volatility compounds, raising the water temperature results in higher removal efficiencies.

Higher air-to-water ratios result in improved performance. There are two distinct disadvantages associated with raising the air-to-water ratio beyond reasonable boundaries: an increase in the required tower diameters; and, an increase in the required horsepower of a forced air blower. In addition, high volumes of effluent air streams would have to be treated if air pollution is a concern.

Surface area is a function of packing material for a given packed tower. The larger the surface area for contact with air, the higher the removal efficiencies.

Air stripping can be effectively used when resulting air pollution is not a major concern and treatment is for discharge waters. Air stripping has been demonstrated to perform at 95 to 99 percent (and higher) removal efficiencies. Greater removal efficiencies can be obtained with highly volatile, low solubility compounds.

If water is used for drinking purposes, further treatment by granular activated carbon is usually performed. Because air pollution is a major concern, a vapor phase carbon adsorption system will be added to clean the effluent air stream.

Air stripping has been widely used in remediation of ground water contaminated with VOCs. It is very effective in stripping highly volatile compounds from water and can reduce the contaminant levels to below detection limits. Air stripping has been found to be an economical and effective solution at numerous ground water remediation sites.

Contaminants in the ground water at the SA site are all VOCs and based on their physical and chemical properties, fairly easy to strip. Design of an air stripping tower involves the following parameters:

- Size of the tower (height and diameter);
- Flow rates (air and water);
- Operating temperatures;
- Type of packing materials; and
- Contaminant level reductions.

For the purpose of evaluation of different alternatives, design of an air stripping column at the SA site was based on the following criteria:

- Tower diameter = 2.5 feet
- Water flow rate = 160 GPM (3 yr extract.)
- Water flow rate = 80 GPM (6 yr extract.)
- Air flow rate = 2,139 CFM
- Water temperature = 11 degrees centigrade
- Packing material = 3.5 inch Lanpac

Appendix B shows the calculations involved in the sizing of an air stripping column. The design of an air stripping column is based on meeting NYSDOH MCLs and NYSDEC TOGS for ground water and water supply. For each contaminant, the more stringent of the two standards is applied to calculate the maximum column height needed. All the contaminants will be reduced to 0.7 ppb or lower with calculated removal efficiencies exceeding 99 percent.

As can be seen from the exhibits in Appendix B, inlet and desired outlet concentrations, along with above mentioned parameters, are entered as initial input into the model. The model then gives the maximum column height required for each individual contaminant based on the desired outlet concentration. The maximum column height calculated based on the initial input would then be the design column height. Outlet concentrations for each individual contaminant are then calculated for the design column height to give the final output.

The treatment equipment will be constructed and weatherized for year-round use. Upon completion of treatment activities, the treatment facility will be decontaminated and dismantled and the area regraded and revegetated if necessary.

This alternative is evaluated based on the preliminary conceptual design based on the above criteria.

Technical Feasibility: Air stripping systems are commonly used at many facilities and implementing this technology at the SA site should not be difficult. Air stripping is a relatively simple, proven technology, and has been demonstrated to operate successfully at many ground water remediation projects. To prevent freezing, the column can be fabricated from fiberglass material. In addition, placing the air stripping column inside a building (with temperature control) would further protect the system from freezing. Air stripping columns have relatively low maintenance and operational problems.

An air stripping system will be effective at removing VOCs from the ground water with calculated removal efficiencies exceeding 99 percent. Effectiveness of a stripping column is based on the temperature of both ground water and air. During winter, ground water temperatures are relatively constant and air temperatures can be considerably lower. The air stripping tower design is based on the lowest air temperature during the year to maintain continued performance. Winterizing the equipment and/or providing electric heat to maintain air temperatures at the design level are also effective. Also, a safety factor of 1.5 to 2 times the design column height provides enough buffer to assure efficient removal of the contaminants to below detection. As the remediation progresses, the contaminant levels in the ground water are expected to be lowered along with lowered levels in treated ground water. Based on the design, the time required for ground water remediation is expected to be a minimum of approximately 3 years.

Leveling of the ground and pouring concrete to provide a firm base for the stripping column will be required. The facility will need utilities such as electricity and telephone. Construction of this alternative will be planned in conjunction with any other remediation activities at the site such as construction of extraction wells.

Institutional Analysis: An approximately 2,500 square feet (50 foot by 50 foot) area will be needed for the treatment facility which will be fenced and protected. The location of a treatment facility is shown in Figure Nos. 4-3 and 4-4.

Based on the preliminary calculations, the projected maximum contaminant concentrations in the air stream at the emission discharge point with the exception of benzene and tetrachloroethylene, is below the NYSDEC Ambient Guideline Concentrations (AGCs). Modeling will be required to determine if the concentrations of those two contaminants are below AGCs at the property boundaries. A larger treatment facility area may be required to ensure that the concentrations of these contaminants do not exceed AGCs. Therefore, this alternative will be acceptable to NYSDEC Division of Air Resources subject to the modeling results. Since the projected maximum concentration at the emission discharge point is very low, the concentrations of benzene and tetrachloroethylene are expected to be below AGCs at the property boundary. Obtaining construction and operating permits from NYSDEC Division of Air Resources should not be difficult. This alternative should be acceptable to the public since it meets or exceeds NYSDEC air guidelines.

Public Health and Environmental Efforts: Ground water contamination levels at the SA site is relatively low and present very low short and long-term risks, if any, associated with potential leaks in the piping system. The stripping column will be located inside a building and secured with fencing.

The maximum concentration of contaminants in the air stream at the emission discharge point are as follows:

	Maximum Effluent Air Conc. (ug/m^3)	NYSDEC AGCs (ug/m^3)	Proposed NYSDEC AGCs (ug/m^3)
Benzene	4,400	100	0.12
Xylene	390	1,450	1,036
Toluene	350	7,500	8,929
Tetrachloroethylene	7,090	1,116	0.075
Trichloroethylene	470	900	0.45
1,2-dichloroethylene	640	—	1,880

The effluent air concentrations from the stripping column are before dispersion and with the exception of benzene and tetrachloroethylene, well below the NYSDEC AGCs. Further evaluation by use of modeling will be necessary to determine if the ambient air concentrations of benzene and tetrachloroethylene will be below NYSDEC AGCs at the property boundary. Because air pollution is a major concern, a vapor phase carbon adsorption system for the air stripper effluent is recommended.

The air stripping system will meet or in many instances, exceed the NYSDOH MCLs and NYSDEC TOGS for ground water and water supply, and therefore, in the long term, would have a positive effect on cleaning the contaminated ground water supply to acceptable levels. Occasional sampling of treated water will be necessary to confirm effectiveness of the operation.

Cost Analysis: Air stripping capital costs are based on previous design studies and experience. Costs for acquisition of property for treatment off-site is not included in this analysis. The cost analysis is based on locating the treatment facility on the SA property. The estimated capital costs associated with the implementation of this alternative are as follows:

o	Air stripping system	$50,000	
o	Shelter, including fencing	25,000	
o	Vapor Phase Carbon System	85,000 (3 years)	45,000 (6 years)
o	Design/engineering costs (@ 15% of subtotal)	24,000 (3 years)	18,000 (6 years)

o	Contingency costs (@ 5% of subtotal)	8,000 (3 years)	6,000 (6 years)
	Total Capital Costs (Estimated)	$192,000 (3 years)	$144,000 (6 years)

The estimated annual O&M costs associated with this option are as follows:

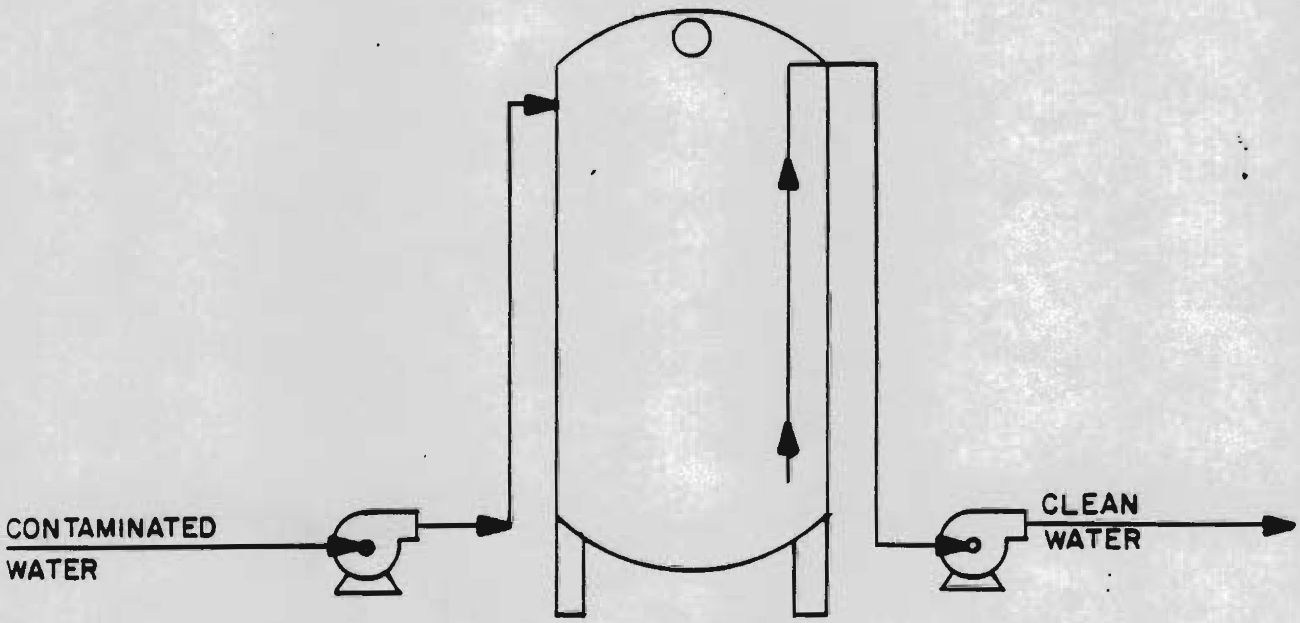
o	Carbon replacement/regeneration	$75,000 (3 years)	$38,000 (6 years)
o	Sampling and reporting (once a month)	4,800	
o	Laboratory Analysis (35 samples/year)	9,000	
o	Other O&M costs (maintenance, utilities) (@ 15% of capital costs)	28,800 (3 years)	21,600 (6 years)
	Total Annual O&M Costs (Estimated)	$117,600 (assume $118,000 [3 years]) $73,400 (assume $73,000 [6 years])	

Laboratory analysis includes one upstream sample and one downstream sample along with one quality control sample for each round.

4.1.3 Ground Water Treatment – Carbon Adsorption

Carbon adsorption is the process involving selective adsorption of organic compounds by physical and/or chemical forces onto the adsorbent carbon. Carbon adsorption is generally carried out in a column as shown in Figure No. 4-6.

FIGURE 4-6



CARBON ADSORPTION

Activated carbon is an excellent adsorbent due to the high surface area available within its structure. The high surface area to mass ratio provides the active sites required for adsorption. Carbon adsorption can be accomplished by batch, column or fluidized-bed operations with either fixed or counter-current moving beds as contacting system.

In a fixed bed single column system, contaminated water enters the inlet at the top, flowing downward through the bed and collected by the underdrain system. Backwashing is periodically necessary as the head losses can become excessive due to clogging by the suspended solids.

In counter-current moving-bed processes, contaminated water flows from the bottom and granular activated carbon is fed through the top. The carbon moves by gravity to the bottom. Effluent is collected at the top by screening and may enter another column and follow a similar flow path if multiple column design is implemented. Carbon flow through the column is pulsed rather than continuous.

In fluidized bed carbon adsorption, water flows upward with velocities high enough to keep carbon in suspension inside the system. The principle advantage of this system is that the suspended solids move through the carbon without clogging the carbon bed.

Removal of contaminants from ground water is dependent on several factors:

- o Contact time;
- o Pretreatment (high suspended solids, oil and grease);
- o Nature of contaminants; and
- o Surface area.

Contact time is of considerable importance, since enough time must be allotted for carbon to completely adsorb the contaminants from the water. Generally speaking, a 15 minute contact time is considered sufficient.

Pretreatment could play a significant role when high levels of suspended solids, oil, and/or grease are present. Suspended solids occupy active sites within the carbon thus reducing effective surface area contact. Oil and grease create a thin film over large areas thus rendering carbon ineffective by reducing adsorptive capacity and resulting in premature replacement of carbon.

Medium to high molecular weight and less soluble organics and inorganics are amenable to treatment by carbon adsorption. Polar compounds, low molecular weight compounds, alcohols, and highly soluble compounds are not effectively removed by carbon adsorption.

Larger surface area allows for sufficient time duration before carbon needs replacement. It also increases the contact time thus improving removal efficiencies.

Activated carbon adsorption can be used as a treatment by itself or as a post treatment for polishing. It is generally used as a treatment where non-detectable levels are desired for the contaminants. Carbon adsorption has been demonstrated to perform with greater than 99 percent removal efficiencies. Greater removal efficiencies can be achieved by increasing contact time. In most cases, ground water contamination is in low concentration ranges and less than a pound of carbon is needed per 1,000 gallons. The adsorbtive capacity of activated carbon is a function of the contaminant concentration in the water. The higher the concentration, the higher the carbon capacity.

If the treatment of water is for drinking purposes it may be necessary to install a pH control system for the initial period ranging from 2 days to 2 weeks after system start-up. The final treatment in the preparation of some carbons is a caustic wash. After system start-up, the pH of the water may rise significantly if the virgin carbon was not thoroughly washed. During this period, neutralization by a weak acid may be necessary. As the caustic is flushed by the water flow, pH treatment becomes unnecessary due to very low or insignificant pH fluctuations. If the system is intended to treat water for potable use, then virgin carbon must be used.

Carbon adsorption has been widely used in remediation of ground water contaminated with VOCs. It is very effective in adsorption of medium to high molecular weight compounds such as those found in the ground water at the SA Site. It has been found to be an effective solution at numerous ground water remediation sites.

Design of a carbon adsorption system involves the following parameters:

- o Contact time (residence time);
- o Nature of contaminants; and
- o Surface area.

For the purpose of evaluation of different alternatives, design of a carbon adsorption system at the SA site is based on the following criteria:

Water flow rate = 160 gpm (3 years extraction)
Water flow rate = 80 gpm (6 years extraction)

Carbon usage rates are calculated based on the Carbon Adsorption Isotherms for the Toxic Organics published by EPA and information obtained from some of the manufacturers. All the contaminants are expected to be reduced to below detection limits.

Appendix B shows the model inputs for calculation of the carbon usage rate on an annual basis for the SA Site.

Technical Feasibility: Carbon adsorption systems are commonly used at many facilities and implementing this technology at the SA site should not be difficult. Carbon adsorption has been demonstrated to operate successfully at many ground water remediation projects. To prevent freezing, carbon adsorption treatment would be located inside a building. Carbon adsorption systems have relatively low operating and maintenance problems. Monitoring of effluent water would be needed on a regular basis to detect breakthrough in the carbon. Initial pilot plant studies can predict breakthrough periods to provide some indication as to when sampling would be necessary.

Carbon adsorption will be effective in removing VOCs from the ground water with removal efficiencies exceeding 99 percent. Effectiveness of the carbon adsorption is based on contact time, surface area, and concentration of contaminants. Additional contact time will provide greater efficiency and additional carbon amounts will prevent earlier breakthrough. Based on extraction constraints, the time required for ground water remediation is expected to be a minimum of approximately 3 years.

Spent carbon is usually regenerated on-site or taken off-site for disposal as hazardous material. Based on the estimated quantity of carbon needed on an annual basis, it will be more economical to dispose or regenerate off-site. The facility will need utilities such as electricity and telephone. Construction of this alternative will be planned in conjunction with any other remediation activities deemed necessary at the site.

Institutional Analysis: An approximately 2,500 square feet (50 foot by 50 foot) area will be needed for the treatment facility which will be fenced and protected. The treatment facility may be built on-site or off-site. Alternate locations are shown in Figure Nos. 4-3 and 4-4.

Contaminant concentrations in the ground water are expected to be reduced to non-detectable levels. Therefore, this alternative should be acceptable to the NYSDEC and local entities as well as the public.

Public Health and Environmental Effects: Ground water contaminant levels at the SA site are relatively low and present very low short and long-term risks, if any, associated with potential leaks in the piping system. The carbon adsorption system will be located inside a building and secured with fencing.

Contaminant concentrations in the ground water are expected to be below detection limits, based on the preliminary estimate for carbon usage.

Special storage and handling will be necessary for spent carbon along with its proper disposal off-site. Proper training of the employees handling spent carbon may be necessary.

The carbon adsorption system will meet the NYSDOH MCLs and NYSDEC TOGS for ground water and water supply and, therefore, in the long term, would have positive effect on cleaning the contaminated ground water supply to the acceptable levels. Occasional sampling of treated water will be necessary to confirm the effectiveness of the system and predict breakthrough.

Cost Analysis: Carbon adsorption capital costs are based on carbon usage rates and previous design studies and experience. The cost of acquisition of property if treatment is performed off-site is not included in this analysis. The cost analysis is based on treatment facility being located on the SA property.

For estimation purposes, carbon costs are calculated at $1.20 per pound. Annual operating costs would involve replacement of carbon and regeneration of spent carbon estimated to cost $1.10 per pound. As with the air stripping, capital costs for the carbon adsorption system includes the cost of the building in which the carbon adsorption column will be enclosed.

The estimated anticipated costs associated with the implementation of this alternative are as follows:

3 Year Remediation

Capital Costs

o	Initial Capital Cost for Carbon Filters	$250,000
o	Shelter with fencing	25,000
o	Design/engineering costs (@ 15% of subtotal)	41,250
o	Contingency costs (@ 5% of subtotal)	13,750
	Total Capital Costs (Estimated)	$330,000

Annual O&M Costs

o	Sampling & reporting (once a month)	$4,800
o	Laboratory analysis (36 samples/year)	9,000
o	Carbon replacement/regeneration	229,000
o	Other O&M costs (utilities, etc.) (@ 10% of capital costs)	30,000
		$272,800 (assume $273,000)

6 Year Remediation

Capital Costs

o	Initial carbon required	$125,000
o	Shelter with fencing	25,000
o	Design/engineering costs (@ 15% of subtotal)	22,500
o	Contingency costs (@ 5% of subtotal)	7,500
	Total Capital Costs (Estimated)	$180,000

Annual O&M Costs

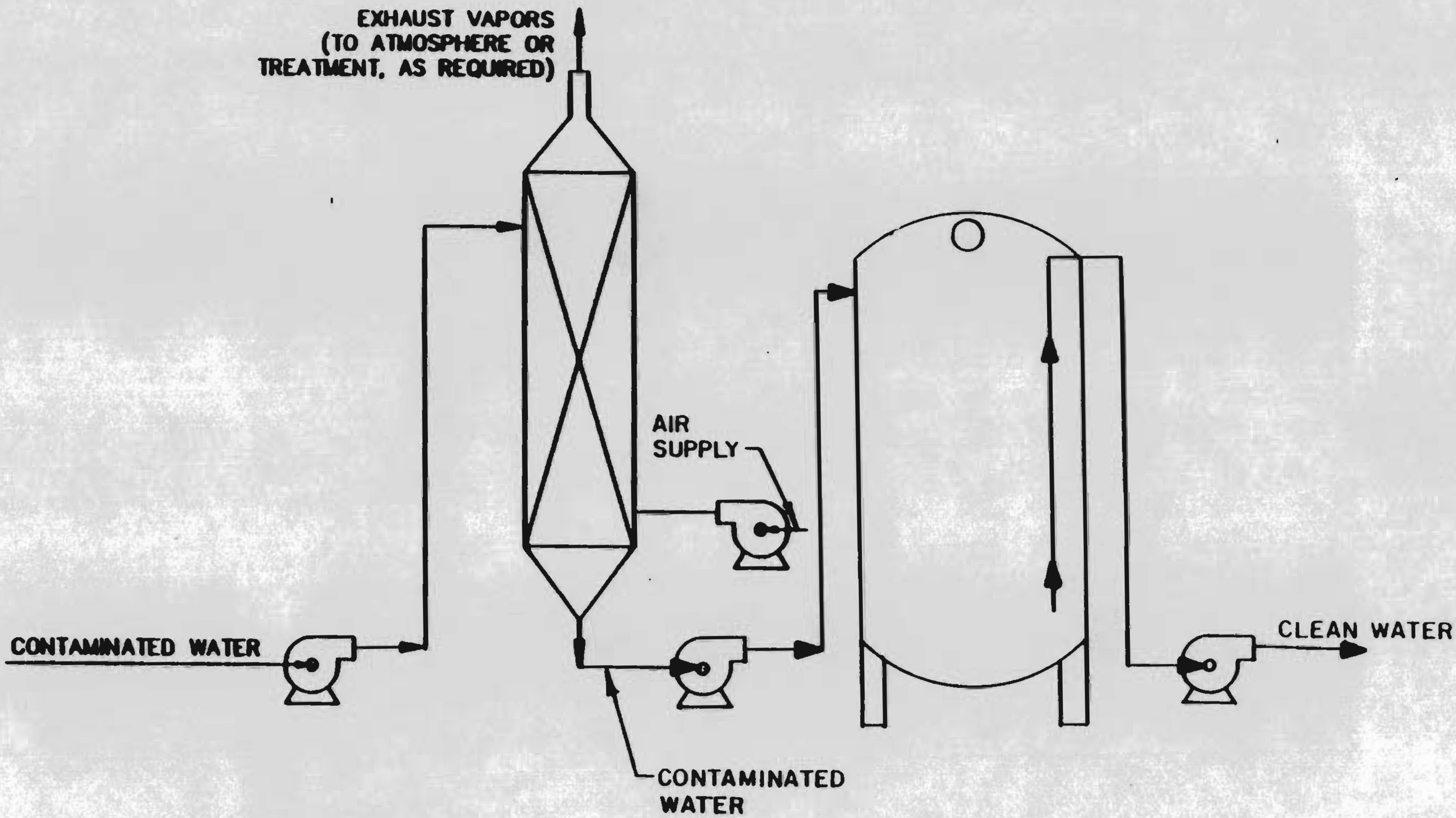
o	Sampling & reporting (once a month)	$4,800
o	Laboratory analysis (36 samples/year)	9,000
o	Carbon replacement/regeneration	115,000
o	Other O&M costs (utilities, etc.) (@ 10% of capital costs)	18,000
		$146,800 (assume $147,000)

Laboratory analysis includes one upstream sample and one downstream sample each month, along with one quality control sample for each round.

4.1.4 Ground Water Treatment – Air Stripping and Carbon Adsorption

Both of the above technologies have been described in Sections 4.1.2 and 4.1.3. Figure No. 4–7 presents the schematic for the combination of these two technologies.

FIGURE 4-7



AIR STRIPPER AND CARBON ADSORPTIONS

This alternative involves passing treated water from an air stripping column through an activated carbon column as a polishing step. Contaminants in minor concentrations (usually below 0.7 ppb) will be adsorbed in the carbon bed to below detectable levels. Water treated with air stripping followed by carbon adsorption can provide potentially potable water.

Technical Feasibility: As discussed earlier, implementation of both of these technologies at the SA site should not be difficult. Both air stripping and carbon adsorption systems have been demonstrated to operate successfully at various ground water remediation projects. Both systems will be enclosed inside a building. Sampling during the initial operating period will be necessary to confirm effectiveness of the system.

Air stripping will be effective at removing VOCs from the ground water with removal efficiencies exceeding 99 percent. The remaining concentration of VOCs above detection limits, if any, will be removed to below detectable limits with further carbon treatment, including treatment of the air stripper effluent with vapor phase carbon adsorption.

Based on extraction constraints, the time required for ground water remediation is expected to be a minimum of approximately 3 years.

Spent carbon will be sent off-site for regeneration or disposal. Utilities such as electricity and telephone will be needed at the site.

Institution Analysis: An approximately 2,500 square feet (50 foot by 50 foot) area will be needed for the treatment facility which will be fenced and protected. The treatment facility may be built on-site or off-site and these alternate locations are shown in Figure Nos. 4-3 and 4-4.

As discussed in Section 4.1.2 and 4.1.3, both of these technologies, on an individual basis, should be acceptable to NYSDEC. Obtaining construction and operating permits should not be difficult. Contaminant concentrations in the ground water, as a result of combination of these two technologies, is expected to be below non-detectable levels. Therefore, this alternative should be acceptable to the NYSDEC and local entities, as well as to the public.

Public Health and Environmental Effects: Detailed discussion of public health and environmental effects for the individual technologies can be found in Section 4.1.2 and 4.1.3. There are no additional concerns beyond those discussed in Sections 4.1.2 and 4.1.3.

Based on earlier discussions, the combination of air stripping followed by the carbon adsorption system will meet the NYSDOH MCLs and NYSDEC TOGS for ground water and water supply and therefore, in the long term, would have a positive effect on cleaning the contaminated ground water supply to the acceptable levels. Occasional sampling of the system will be necessary to confirm the effectiveness of the operation.

Cost Analysis: Air stripping capital and operating costs are assumed to be the same as in Section 4.1.2 for this analysis. Carbon costs were based on a rate of 10 percent of the estimated usage rate in Section 4.1.3. Total capital and operating costs for the 3 and 6 year remediations are as follows:

3 Year Remediation

Capital Costs

o	Air stripping system	$50,000
o	Initial carbon required	25,000 (liquid phase)
o	Initial carbon required	85,000 (vapor phase)
o	Shelter with fencing	25,000
o	Design/engineering costs (@ 15% of subtotal)	27,750
o	Contingency costs (@ 5% of subtotal)	9,250
	Total Capital Costs (Estimated)	$222,000

Annual O&M Costs

o Sampling and reporting (once a month)	$4,800
o Laboratory analysis (48 samples per year)	12,000
o Carbon replacement/regeneration	21,000 (liquid phase)
o Carbon replacement/regeneration	75,000 (vapor phase)
o Other O&M costs (maintenance, utilities), (@ 15% of capital costs)	33,300
Total Annual O&M Costs (Estimated)	$146,100 (assume $146,000)

6 Year Remediation

Capital Costs

o Air stripping system	$50,000
o Initial carbon required	12,500 (liquid phase)
o Initial carbon required	45,000 (vapor phase)
o Shelter with fencing	25,000
o Design/engineering costs (@ 15% of subtotal)	19,875
o Contingency costs (@ 5% of subtotal)	6,625
Total Capital Costs (Estimated)	$159,000

Annual O&M Costs

o	Sampling and reporting (once a month)	$4,800
o	Laboratory analysis (48 samples per year)	12,000
o	Carbon replacement/regeneration	11,500 (liquid phase)
o	Carbon replacement/regeneration	38,000 (vapor phase)
o	Other O&M costs (maintenance, utilities) (@ 15% of capital costs)	23,850
	Total Annual O&M Costs (Estimated)	$90,150 (assume $90,000)

Laboratory analysis includes one sample upstream of air stripping, one sample upstream of carbon adsorption, one sample downstream of carbon adsorption, and one quality control sample for each round.

4.1.5 Disposal of Treated Water – Aquifer Recharge

After treatment, the extracted ground water will be recharged into the aquifer at the upgradient edge of the plume. Recharge would take place either by deep well injection into the bedrock aquifer, or by an infiltration gallery. Ground water would be recharged at the same rate it was extracted.

The use of aquifer recharge with a pump and treat system has several advantages including:

- Assisting in the restoration of the hydrologic balance necessary for the establishment of future water supplies;
- Enhancing the hydraulic gradient created by the recovery wells;

- o Water injected into the aquifer will flush contaminants from the interstitial spaces in the soil and bedrock; and

- o Aquifer recharge may also reduce the amount of time required for remediation.

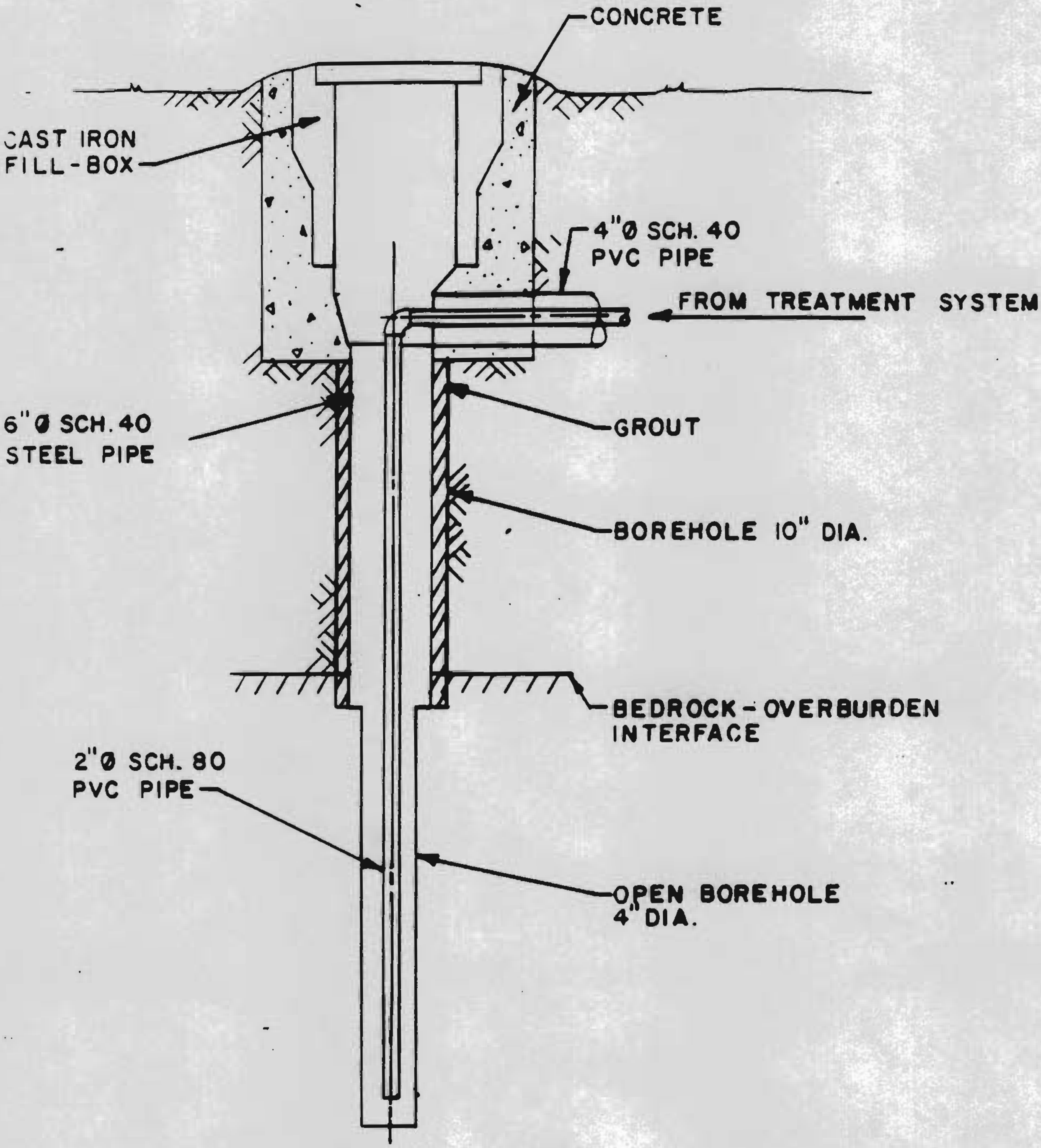
The injection wells would be completed in bedrock and cased through the overburden to bedrock. A typical injection well construction diagram is presented in Figure No. 4-8. The injection wells would be completed approximately 150 feet below the surface of the bedrock to ensure sufficient well surface area to handle the anticipated volumes of treated ground water. If the existing bedrock conditions do not allow for adequate recharge, a fracture zone would be created in the well using carefully controlled fracturing techniques. All injection wells would be placed at the upgradient edge of the contaminant plume. The proposed location of the injection wells for the 6 year remediation period are presented in Figure No. 4-3 and the proposed location of the injection wells for the 3 year remediation period are presented in Figure No. 4-4.

The infiltration gallery would be constructed in the overburden at the upgradient edge of the contaminant plume. The proposed location for the infiltration gallery is presented in Figure No. 4-3. The flow rates from the extraction wells vary from the 3 and 6 year remediation periods, therefore, the surface area required for infiltration in each alternative will vary. The surface area required for the 3 year alternative is approximately 1,800 square feet. The surface area required for the 6 year alternative is approximately 900 square feet. The depth for each gallery is approximately 10 feet.

The infiltration gallery would be filled with crushed stone which allows large volumes of water to be stored in the gallery while infiltration is taking place in the underlying overburden. A typical infiltration gallery construction diagram is presented in Figure No. 4-9.

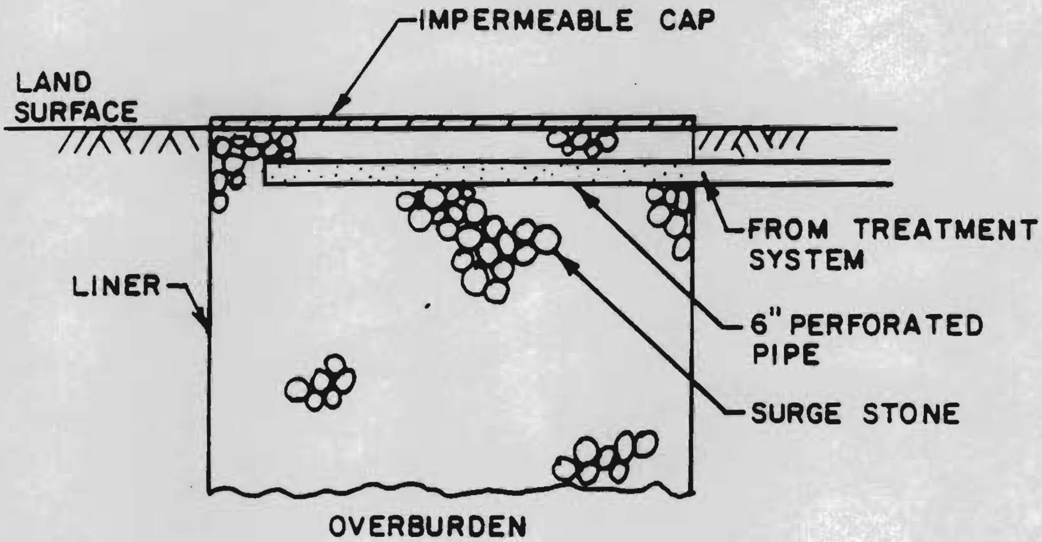
Technical Feasibility: The extraction of contaminated water and reinjection of treated ground water can effectively remediate contaminated ground water. In addition, the use of infiltration galleries or injection wells is effective in handling large volumes of water for injection into the aquifer. Also, injection of treated ground water into the aquifer reduces the impact that the extraction system may have on other wells in the area.

FIGURE 4-8



BEDROCK INJECTION WELL CONSTRUCTION

FIGURE 4-9



TYPICAL INFILTRATION GALLERY CONSTRUCTION DIAGRAM

(CROSS-SECTION)

Institutional Analysis: Technically, implementation of the ground water recharge system should be relatively routine. If difficulties are encountered, they would most likely be institutional in nature, such as obtaining right-of-ways for well and pipeline installation. This can be minimized by siting facilities on public property. Siting and construction of infiltration galleries must take into account depth to water, bedrock and adequate available surface area.

Public Health and Environmental Effects: For aquifer recharge systems such as injection wells and infiltration galleries, all piping will be placed underground and well heads will be secured. Also, the infiltration gallery will be capped to prevent overfill from rainfall events. The infiltration gallery and injections wells will also be equipped with overflow prevention controls.

Cost Analysis: Costs for disposal of treated ground water via aquifer recharge (infiltration gallery and injection well) are based on previous design studies and experience. The cost of acquisition of property for injection well or infiltration gallery locations is not included in this analysis. The following assumptions were made in preparing this cost analysis.

- 3 Year Alternative
  - Sixteen injection wells approximately 150 feet deep (6 inch diameter)
  - Infiltration gallery size required – 30 by 60 by 10 feet
  - Piping required – 5,250 lineal feet
- 6 Year Alternative
  - Eight injection wells approximately 150 feet deep (6 inch diameter)
  - Infiltration gallery size required – 20 by 45 by 10 feet
  - Piping required – 3,500 lineal feet

Costs for each alternative are detailed in Appendix B.

4.1.6 Disposal of Treated Water – Storm Drainage System

The disposal of the treated ground water to a storm water drainage system would consist of several drains and ditches in the area which carry storm run-off from roads and parking areas to several small tributaries of the Mianus River, with the storm run-off eventually discharging into the Mianus River.

Technical Feasibility: The alternative described here calls for discharging treated ground water to the existing storm drainage system instead of recharging this water to the aquifer. Without ground water recharge, local water supply wells may be impacted through lowering of the water table. Design support testing involving a pump test and ground water modeling would be necessary to determine the impact of this alternative on the area ground water.

The storm drainage system is already in place and capable of handling the quantity of ground water to be extracted. New pipelines to connect to this system should be buried below the frost line to prevent freezing.

Institutional Analysis: If difficulties are encountered, they will most likely be institutional in nature. Contaminant concentrations must meet NYSDEC standards.

Public Health and Environmental Effects: Contaminant concentrations in the treated ground water are expected to be below non-detectable levels. Therefore, this alternative should be acceptable to NYSDEC, and local governments, as well as to the general public.

Cost Analysis: Costs for disposal of treated ground water via a storm water drainage system are based on previous design studies and experience. The cost of acquisition of property for piping runs is not included in this analysis. The following assumptions were made in preparing the cost analysis:

- 3 Year Alternative
  - Piping required – 5,250 lineal feet
- 6 Year Alternative
  - Piping required – 3,500 lineal feet

Costs for each alternative are detailed in Appendix B.

4.1.7 Summary of Cost Evaluation of Alternatives

Table No. 4-2 summarizes capital and operating costs for each of the technologies previously discussed in this section along with the present worth analysis. Breakdown of costs for most of the technologies are attached in Appendix B. Table No. 4-3 provides the total costs incurred for extraction, treatment, disposal and water supply for each of the alternatives.

4.2 Water Supply Alternatives

The water supply alternatives presented in Section 3.0 will be described and evaluated in detail in this Section. The individual alternatives to be evaluated are as follows:

- o Expansion of the Existing Bedford Farms Community Water Supply System;
- o Expansion of the Planned Ponds Development Water Supply System;
- o Development of a New Community Water Supply System;
- o Development of a Point-of-Use Treatment District (Filter District).

4.2.1 Alternative No. 1 - Expansion of the Existing Bedford Farms Community Water Supply System

Detailed Description: This alternative would consist of the expansion of the existing Bedford Farms Community Water Supply System (known as "the Farms") to incorporate service to those affected commercial and residential users within the SA study area (see Figure No. 4-10).

As indicated in Subsection 3.1.4, the present system supplies potable water to approximately 81 users and consists of three water supply wells. Based upon information recently obtained from the Westchester County Department of Health as well as other private concerns, only one well is fully operational while a second well is operating at reduced capacity. The third well has been permanently decommissioned because of lack of yield. This system is also comprised of one 5,000 gallon hydropneumatic storage tank, two 15,000 gallon underground storage tanks operated by booster pumps, and underground piping, either four inches or six inches in diameter to supply its users.

TABLE 4-2 COST ANALYSIS OF ALTERNATIVES

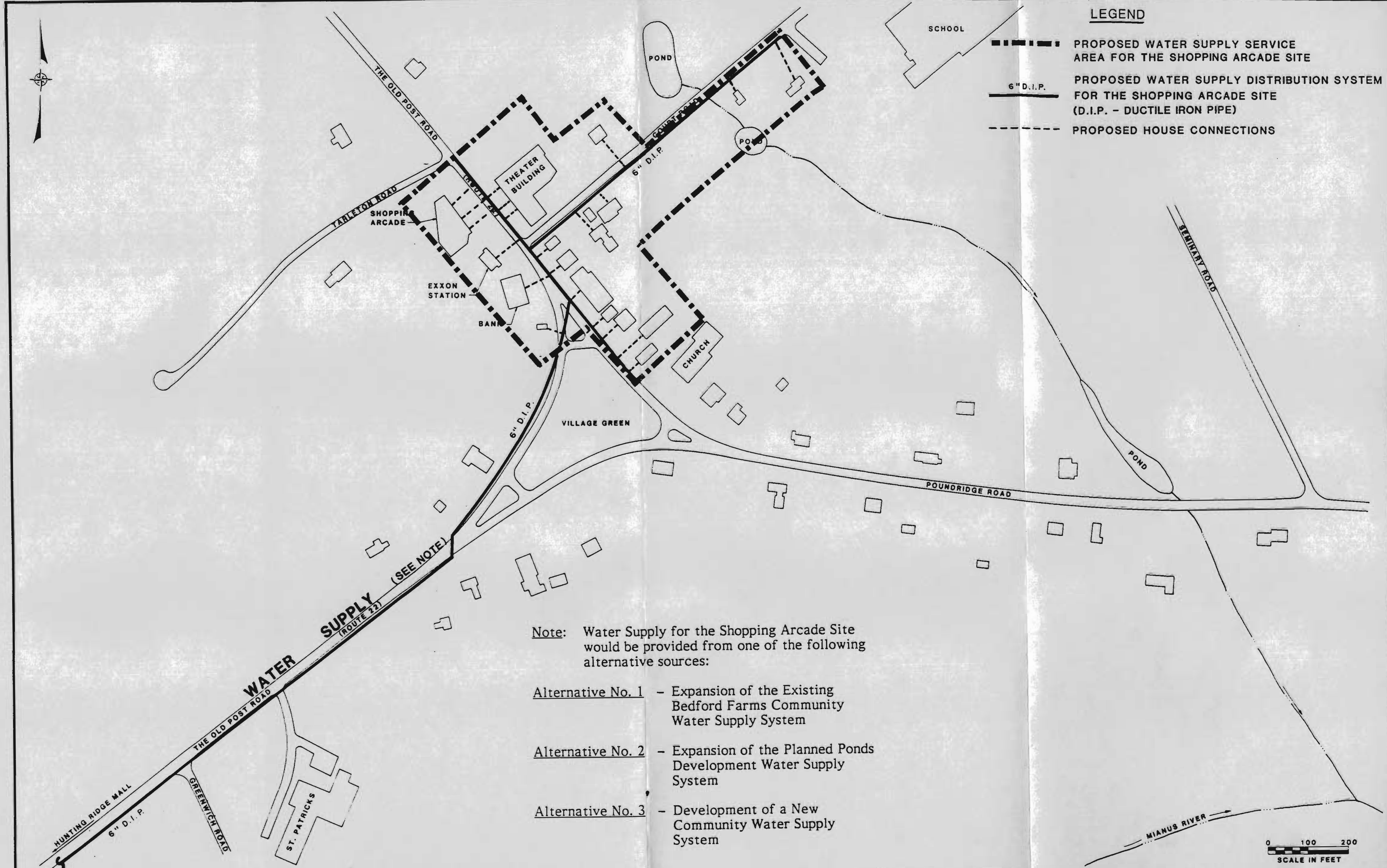
TECHNOLOGY	NUMBER OF YEARS	CAPITAL COSTS	O & M COSTS	O & M PRESENT WORTH*	TOTAL COSTS
Extraction Wells (16)	3	$369,900	$94,900	$244,567	$614,000
Extraction Wells (8)	6	$189,950	$47,800	$220,975	$411,000
Recharge Wells (16)	3	$310,850	$21,760	$56,076	$367,000
Recharge Wells (8)	6	$162,300	$11,361	$52,521	$215,000
Infiltration Galleries	3	$110,250	$7,718	$19,889	$130,000
Infiltration Galleries	6	$62,400	$4,368	$20,193	$83,000
Storm Drainage	3	$41,250	$2,888	$7,441	$49,000
Storm Drainage	6	$27,500	$1,925	$8,899	$36,000
Air Stripping[Vapor Recovery (VR)]	3	$192,000	$118,000	$304,098	$496,000
Air Stripping[Vapor Recovery (VR)]	6	$144,000	$73,000	$337,472	$481,000
Carbon Adsorption	3	$330,000	$273,000	$703,548	$1,034,000
Carbon Adsorption	6	$180,000	$147,000	$679,566	$860,000
Air Stripping (w/VR) & Carbon Adsorption	3	$222,000	$146,000	$376,257	$598,000
Air Stripping (w/VR) & Carbon Adsorption	6	$159,000	$90,000	$416,061	$575,000

*Present Worth Analysis is performed using an 8 percent interest rate.

Total costs are rounded to the nearest thousand.

TABLE 4-3 COST SUMMARY

ALTERNATIVE	EXTRACTION	AIR STRIPPING	CARBON ADSORBTION	AIR STRIP/ CARBON	DISPOSAL (INFILTRATION)	DISPOSAL (STORM)	TOTAL COST
1	$614,000	$496,000			$130,000		$1,240,000
2	$614,000	$496,000				$49,000	$1,159,000
3	$614,000		$1,034,000		$130,000		$1,778,000
4	$614,000		$1,034,000			$49,000	$1,697,000
5	$614,000			$598,000	$130,000		$1,342,000
6	$614,000			$598,000		$49,000	$1,261,000
7							$137,000
8	$411,000	$481,000			$83,000		$975,000
9	$411,000	$481,000				$36,000	$928,000
10	$411,000		$860,000		$83,000		$1,354,000
11	$411,000		$860,000			$36,000	$1,307,000
12	$411,000			$575,000	$83,000		$1,069,000
13	$411,000			$575,000		$36,000	$1,022,000



Note: Water Supply for the Shopping Arcade Site would be provided from one of the following alternative sources:

Alternative No. 1 – Expansion of the Existing Bedford Farms Community Water Supply System

Alternative No. 2 – Expansion of the Planned Ponds Development Water Supply System

Alternative No. 3 – Development of a New Community Water Supply System

NO.	DATE	REVISION	INT.

UNAUTHORIZED ALTERATION OR ADDITION TO THIS DOCUMENT IS A VIOLATION OF SECTION 7209 OF THE NEW YORK STATE EDUCATION LAW.

PROJECT ENGINEER: DRAWN BY: DESIGNED BY: CHECKED BY:

Dvirka and Bartilucci

BEDFORD VILLAGE WELLS
REMEDIAL INVESTIGATION & FEASIBILITY STUDY
WESTCHESTER COUNTY, NEW YORK
SHOPPING ARCADE SITE

ALTERNATIVE NOS.1,2 & 3
ALTERNATIVE WATER SUPPLY SYSTEM
FOR SHOPPING ARCADE SITE

PROJECT NO. 842
DATE
SCALE AS NOTED
DRAWING NO. 4-10

In order for the expansion of the Farms system to be a viable alternative, assurance must be made that the safe yield of the aquifer would not be exceeded. Such assurance can be given by assessing the capacity of water-bearing zones underlying the projected well field location utilizing information presently available and/or information to be obtained from test wells, to be installed should this alternative be chosen for implementation. In addition, any expansion must comply with applicable New York State requirements and guidelines regulating community water supply systems. Guidelines include those recommending that the wells and pumps for these systems be sized at ten times the average daily flow rate (from "Recommended Standards for Water Works," 1987).

Based upon the 1988 Public Service Commission Report on Water Usage for the Farms System, the actual amount of water supplied by the Farms Community Water Supply System was 6,459,000 gallons for the calendar year 1988, which equals an average daily water usage of 17,696 gallons per day. Using this figure and a standard multiplier of four to calculate maximum usage, one can estimate the maximum hourly water usage rate to be 2,949 gallons per hour, or 49.15 gallons per minute (GPM). A separate calculation was made on the water usage using standard assumptions of per capita use for the approximate 81 residential units in the Farms service area. These calculations have resulted in an average daily water usage of 32,400 gallons per day and a maximum hourly water usage of 5,400 gallons per hour, or 90 GPM. For the purposes of this feasibility study, the maximum water usage on a GPM rate will be assumed to be an average of the two figures calculated above, or approximately 70 GPM.

With respect to the projected water usage for the SA study area, calculations were made using standard assumptions of per capita use for potable water usage at eight residential units, the commercial units of the Shopping Arcade, a gas station, a bank, a theater and a firehouse. The average daily water usage was calculated to be 15,200 gallons per day. The maximum hourly water usage rate, therefore, is 2,533 gallons per hour or 42.2 GPM.

Based upon the previous discussion, the water quantity requirements for the expanded Farms community water supply system would equal the sum of the present usage plus the estimated usage of the SA service area; this sum equals a maximum rate of 112 GPM. As already noted in this report, only the supply well with a 100 GPM capacity is fully operational with a second supply well providing water in the range of 30 to 60 GPM.

Any expansion would need to comply with applicable New York State guidelines which recommend the sizing of pumps and wells to be ten times the average daily flow rate. The average daily flow rate associated with this expansion would be the sum of the actual present usage plus the estimated usage calculated for the SA service area, or a total of 32,896 gallons per day. Pursuant to the New York State guidelines, therefore, sizing of the expanded system would be ten times this figure or 328,960 gallons per day, which equals 228 GPM (approximate).

The expansion would necessarily include the installation of at least one water supply well sized at 100 GPM, additional pumps and pumphouses, additional potable water supply storage facilities (hydropneumatic storage tanks), and the construction of water service lines to the affected commercial and residential users. The minimum pipe size for water mains is 6-inches, as required by New York State guidelines. Work sheets that support the aforementioned calculations are included in Appendix A.

Technical Feasibility: This alternative, as well as the two other alternative water supply options dealing with expansion of an existing or installation of a new water supply system are technically feasible for implementation. That is, these systems are historically proven, available and are operated safely and in an environmentally sound manner. In addition, they are relatively easy to implement and can be installed in a timely manner.

While the anticipated performance and reliability of such systems are normally sound, there are certain concerns associated with Alternative No. 1 - Expansion of the Farms System.

- The construction of an additional well or wells at this location will increase drawdown, thereby decreasing pumping levels in all likelihood. The current operational status of the Farms system indicates that there may be a problem with ground water yield of the aquifer underlying the Farms system.

- The increase in pumping at this location may affect the flow of the contaminated plume of ground water associated with the HRM, which has been identified as existing immediately west of the Farms Water Supply System at Lake and Vinton Avenues, and could result in contamination of the potable water supply of the expanded Farms system by tetrachloroethene and its breakdown compounds. As a result, treatment of the water from the Farms supply wells in the future may be necessary.

- The existing on-line distribution system would have to be integrated with a new distribution system.

- Any discussion of technical feasibility must consider the added needs associated with the HRM study area. Providing potable water to these users would increase the needed maximum quantity from 112 GPM to approximately 160 GPM. Based upon New York State guidelines, sizing of such a system is recommended to be 10 times the average daily flow rate which equates approximately to 346 GPM. Please refer Appendix A for more detailed information.

- The relatively small size of the existing Farms well field (an approximate 200 foot square) would likely preclude the installation of another major, high-capacity supply well. If installation was to be performed, it would likely overtax the immediate safe yield and recharge of the underlying aquifer. A possible alternative would be to choose a new site for the additional well(s) or for the entire Bedford Farms Water Company well field. The feasibility of this option for the current owner would have to be investigated.

Institutional Analysis: It is NYSDEC policy to provide State monies for construction and/or expansion of publicly owned systems and not for private concerns. Therefore, in order to receive financial assistance from the State to implement this alternative, the Town of Bedford must first purchase this system from the Farms owner. There have been indications in the past that the Farms owner/operator may be willing to sell/transfer this system to the Town. An advantage to implementing this alternative is that the Farms is an existing system and, as such, some limited immediate use may be available. In addition, this system is in relatively close proximity to the affected SA study area.

Relative to acceptance of this alternative by the State, local entities and the general public, any alternative that would replace the present contaminated water supply with a supply that meets applicable New York State Standards would be readily acceptable, including a new site for additional wells on Town-owned property (Memorial Park).

Public Health and Environmental Effects: None of the alternative water supply options reduce ground water contamination associated with the SA through actual remediation of the identified plume. The reduction in risks would be due to the replacement of the water supply. As such, a beneficial effect would result from the replacement of the contaminated water supply with "clean" water or water meeting the levels of applicable New York State Standards.

The adverse effects of this alternative would be related to leaving the contaminated ground water as is; that is, not implementing a "pump and treat" technology to remediate the plume of contaminated ground water. If such is the case, the contaminated plume may, at some point in the future, adversely impact other downgradient users. In addition, expansion of the Farms community water supply system could be impacted by the contaminated ground water plume associated with the HRM as movement of that contaminated plume toward the Farms' water supply could be caused by an increase in pumping. While the immediate or short-term impacts would be beneficial to all concerned, there could, therefore, be long-term adverse impacts with respect to contaminated ground water movement into the Farms' water supply.

Cost Analysis: This cost analysis has been prepared with the assumption that only one of the three existing supply wells would be operational at its rated capacity once construction of the expanded system is completed. On this basis, one additional well with a 100 GPM capacity must be installed to ensure adequate provision of potable water to all users in the expanded service area. Therefore, the estimated anticipated capital costs associated with this alternative, assuming no cost for site acquisition, are as follows:

o	Construction of one 100 foot deep supply well with pump system	$35,000
o	Site piping, metering and chlorination	8,000
o	Treatment system for volatile organic compounds (VOCs) (if necessary in the future)	80,000
o	Additional electrical work	10,000
o	Approximately 4,800 feet of distribution piping (6 inch diameter)	144,000
o	Control building and site work	12,000
o	Service connections (approximately 21 at $500 per connection)	10,500
o	New stand-by generator	15,000
o	Design/Engineering costs (at 15% of subtotal)	47,175
o	Contingency costs (at 5% of subtotal)	15,725
	Total Capital Costs (Estimated)*	**$377,400**

* Start-up costs are included in the above estimated capital costs. An additional capital cost not included because of a lack of information on the Bedford Farms Community Water Supply System is the cost associated with necessary changes to the existing piping distribution system.

The operation and maintenance (O&M) costs associated with this alternative include the normal O&M costs for this type of system, as well as costs associated with the treatment of volatile organic compounds in the ground water, if required. Therefore, the estimated anticipated yearly O&M costs associated with this alternative are as follows:

o	Added field labor and VOC unit operation	$20,000
o	Electrical service	9,000
o	Chemical treatment (chlorination)	1,500
o	Required laboratory sampling and analyses	7,800
o	Automotive/travel expenses (gasoline, oil, insurance, depreciation)	3,000
o	Financing costs (assume 10% interest, 30-year loan)	39,743
	Total Annual O&M Costs (Estimated)	**$81,043**

The present worth analysis represents the sum of the capital costs plus the adjusted O&M costs over a 30-year period, based upon an 8 percent discount rate. The calculated present worth equals $1,289,782.

An estimate of the cumulative costs associated with expanding the Farms system to serve affected users of both the SA study area as well as the HRM study area is also being presented in this section. As noted above, more detailed information can be found in Appendix A.

Capital Costs

o	Capital costs to expand Farms system to include SA users	$377,400
o	Construction of one additional 100 foot deep supply well with pumping system	35,000
o	Additional distribution piping to service HRM users	84,000
o	Additional service connections for HRM study area (approximately 26 at $500 per connection)	13,000
o	Additional stripping tower capacity for VOC treatment (if required in the future)	30,000
o	Additional Design/Engineering costs	24,350
o	Additional Contingency costs	8,100
	Total Capital Costs (Estimated)	**$571,800**

Operation and Maintenance Costs

o	Added field labor and VOC unit operation	$25,000
o	Electrical service	12,000
o	Chemical treatment (chlorination)	2,500
o	Required laboratory sampling and analyses	16,800
o	Automotive/travel expenses (gasoline, oil, etc.)	3,000
o	Financing costs	60,215
	Total Annual O&M Costs (Estimated)	**$119,515**

The present worth analysis for implementing Alternative No. 1 – Expansion of the Farms Community Water Supply System, at both the SA and HRM study areas equals $1,917,300.

Although the discussion presented in Section 3.1.4 of this report expressed concern regarding available yield at this location and, for that reason it is believed that fire protection capabilities could not be included in the expanded Farms system, the following discussion will summarize the fire protection recommendations together with the costs associated with implementing such a system.

The minimum recommendation of the Insurance Service Office, Inc. for a water supply system servicing residential units is for a capacity of 250 GPM at 20 pounds per square inch (psi) pressure, 6 inch water mains, plus 2 hour storage capacity (30,000 gallons). This minimum recommended system would correspond to a fire insurance rate for the homeowner that would be only slightly better than having no fire protection at all. The optimum recommended system for a residential area is a system with a capacity of 1,000 GPM at 20 psi with 6 inch water mains, plus 2 hour storage capacity (120,000 gallons). This system would correspond to the lowest fire insurance rate. For commercial units, the Insurance Services Office recommends a system with a 2,000 to 2,500 GPM capacity with 8 inch water mains. Fire hydrant spacing is recommended at 400 foot intervals for residential areas and 300 foot intervals for commerical areas.

The added costs associated with the expansion of the Farms system to include a recommended fire protection system for both the SA and HRM study areas equals $280,000. Although 8-inch water mains are recommended for commercial areas, for the purposes of this expansion which includes both residential and commercial areas, only ı water mains are being proposed. This fire protection system would include the lation of two additional supply wells and pumps, a 120,000 gallon storage unit, two er pumps, added stand-by generator capacity, additional piping, the installation of ximately 10 fire hydrants, plus added electrical service. Assuming that all of these would be capital cost outlays, the present worth analysis for implementing native No. 1 – Expansion of the Farms Community Water Supply System, at both the d HRM study areas to include fire protection equals $2,197,300.

4.2.2 Alternative No. 2 – Expansion of the Planned Ponds Development Water Supply System

Detailed Description: This alternative would consist of incorporating the water needs of those affected commercial and residential users within the SA study area ne planned Ponds Development Water Supply System (see Figure No. 4–1). As nced on this figure, a conceptual design of the proposed Ponds Development service included in Appendix C of this document.

s indicated in Subsection 3.1.4, the planned system was projected to supply potable to approximately 50 townhouses and 9 estate houses. The Draft Environmental Statement (DEIS), prepared by Chas. H. Sells, Inc. in August of 1988, concludes ere exists a more than adequate supply of ground water at this location to supply velopment. Additional wells can be added, yielding 30 to 50 GPM, for off-site according to the DEIS.

ny expansion must comply with applicable New York State requirements and nes regulating community water supply systems. Guidelines include those nending that the wells and pumps for these systems be sized at ten times the e daily flow rate, and the minimum pipe size utilized for water mains to be 6 inches.

ased upon information elicited from the DEIS, the average water use projected for nds Development was calculated to be 18,500 gallons per day. This equates to a m hourly water usage of 3,083 gallons per hour, or 51.4 GPM. Again, a separate tion was made on water usage for the proposed Ponds development using standard tions for per capita use. These calculations have indicated an average daily water f 19,950 gallons per day and a maximum hourly water usage of 3,325 gallons per 55.4 GPM. For the purposes of this study, the water usage will be assumed to be

- The iron content from a sample taken from a test well at the proposed production site was 31 mg/l, which is well above the 0.3 mg/l New York State Standard for ground water. This sample also indicated relatively elevated levels of manganese (0.5 mg/l), color (30 units), and turbidity (25 units). These results were attributed to a turbid sample, yet remain a concern.

- Concentrations of tetrachloroethylene and 1,1,1-trichloroethane in the test sample were 4 parts per billion (ppb) each. These concentrations are slightly less than the New York State Department of Health drinking water standards of 5 ppb for each of these contaminants. However, the New York State Department of Environmental Conservation's April 1987 Division of Water Quality Technical Operational Guidance Series (TOGS) sets a guidance value for tetrachloroethylene in ground water at 0.7 ppb. It should also be noted that an increase in the pumping rate may cause the contaminated ground water plume associated with the HRM Site to move toward the water supply aquifer underlying the proposed Ponds water supply system.

- The time frame for construction of this system could be a limiting factor relative to providing potable water to affected residential and commercial users in the SA study area in a timely manner. In addition, at this time there is no guarantee that the development and water supply system will be constructed.

- There could be a potential problem with nitrogen contamination in the ground water. This would be due to the proposed centralized community subsurface disposal system (leaching fields) located upgradient from the proposed location for the water supply system. In addition, it is expected that significant fertilizer use will occur at residential units surrounding and upgradient of the well field.

- Due to the increased pumping rate associated with this alternative, pollution could be significant, thereby increasing costs for treatment of volatile organics, nitrogen, etc., in the future.

- Any discussion of technical feasibility must consider the added needs associated with the HRM study area. Providing potable water to these users would increase the needed quantity from 96 GPM to approximately 143 GPM. Based upon New York State guidelines, sizing of such a system is recommended to be

10 times the average daily flow rate which equates approximately to 357 GPM. Please refer to Appendix A for more detailed information.

Institutional Analysis: As noted for Alternative No. 1, this option is feasible with respect to institutional issues assuming that the Town of Bedford would purchase this water supply sytem from the owner. It will be assumed that all necessary permits and approvals will be applied for and obtained in a timely manner. In addition, the proposed location for this system is in relatively close proximity to the affected supply area. With respect to acceptance of this alternative by the State, local entities and the general public, such an alternative is likely to achieve acceptance, as previously discussed.

Public Health and Environmental Effects: As noted under the previous alternative discussed, this option would reduce risks to human health by replacing the contaminated ground water supply to users in the area of concern with "clean" potable water. This option, therefore, would create a beneficial short-term impact. There could be adverse long-term impacts, however, due to the movement of contaminated ground water resulting from past activities at the HRM towards the proposed Ponds water supply system.

Relative to adverse effects, the necessary increase in ground water pumping associated with this option could increase water supply contamination in the long-term. These impacts potentially include an increase in the iron content, the nitrogen content, as well as increased concentrations of volatile organic compounds.

Cost Analysis: The increase in costs associated with the expansion of the proposed Ponds Water Supply System relates to the design and installation of three 40 GPM water supply wells with associated equipment and services. The estimated anticipated capital costs, assuming no land acquisition, are as follows:

o	Construction of three additional 40 GPM supply wells/pump systems	$90,000
o	Site piping, metering and chlorination	10,000
o	Additional treatment capacity for VOCs (if required in the future)	30,000
o	Additional electrical work	16,000
o	Approximately 5,700 feet of distribution piping (6 inch diameter)	171,000
o	Service connections (approximately 21 at $500 per connection)	10,500
o	Monitoring well program (4 wells) necessitated by increased pumping	20,000

o	Design/Engineering costs (at 15% of subtotal)	52,125
o	Contingency costs (at 5% of subtotal)	17,375
	Total Capital Costs (Estimated)*	**$417,000**

*Note: Start-up costs are included in the above estimated capital costs.

The estimated O&M costs assume that ground water treatment will eventually be necessary at this location. The estimated anticipated yearly O&M costs are as follows:

o	Added field labor and VOC unit operation	$12,000
o	Electrical service	10,800
o	Chemical treatment (chlorination)	1,500
o	Required laboratory sampling and analyses	3,900
o	Monitoring well sampling and analyses	2,000
o	Automotive/travel expenses (gasoline, oil, insurance, depreciation)	1,500
o	Financing costs (assume 10% interest, 30-year loan)	43,914
	Total Annual O&M Costs (Estimated)	**$75,614**

The present worth analysis represents the sum of the capital costs plus the adjusted O&M costs over a thirty year period, based upon an 8 percent discount rate. The calculated present worth equals $1,268,262.

An estimate of the cumulative costs associated with expanding the Ponds system to serve affected users of both the SA study area as well as the HRM study area is also being presented in this section. As noted above, more detailed information can be found in Appendix A.

Capital Costs

o	Capital costs to expand the Ponds system to include SA users	$417,000
o	Construction of one additional 100 foot deep supply well with pumping system	90,000
o	Additional distribution piping to service HRM users	60,000
o	Additional service connections for HRM study area (approximately 26 at $500 per connection)	13,000

o	Additional stripping tower capacity for VOC treatment	15,000
o	Additional Design/Engineering costs	26,700
o	Additional contingency costs	8,900
	Total Capital Costs (Estimated)	**$630,600**

Operation and Maintenance Costs

o	Added field labor and VOC unit operation	$15,000
o	Electrical service	13,500
o	Chemical treatment (chlorination)	2,500
o	Required laboratory sampling and analyses	8,400
o	Monitoring well sampling and analyses	2,800
o	Automotive/travel expenses (gasoline, oil, etc.)	1,500
o	Financing costs	66,407
	Total Annual O&M Costs (Estimated)	**$110,107**

The present worth analysis for implementing Alternative No. 2 - Expansion of the proposed Ponds Development Water Supply System, at both the SA and HRM study areas equals $1,870,185.

The same fire protection recommendations described under Alternative No. 1 - Expansion of the Farms Community Water Supply System, would also apply in this case. Therefore, including the additional capital cost outlay of $280,000 for fire protection, the present worth analysis for implementing Alternative No. 2 equals $2,150,185.

4.2.3 Alternative No. 3 - Development of a New Community Water Supply System

Detailed Description: This alternative would consist of the construction of an entirely new community water supply system to service, at a minimum, the affected commercial and residential users of the SA study area (see Figure No. 4-1).

In order for this alternative to be feasible, the safe yield of the aquifer underlying the proposed well field location must not be exceeded. Based upon information currently available (including existing well logs, water supply information, and the 1985 Ground

Water Assessment of the Town of Bedford prepared by Leggette, Brashears and Graham), a more than adequate water supply is available at the location presently being considered; that area being the northern portion of Memorial Field. However, a test well would be required to confirm these assumptions should this alternative be chosen.

The new community water supply system is expected to consist of two gravel packed supply wells, each at an approximate depth of 150 feet with each well expected to yield approximately 100 GPM. Each well will be served by a submersible pump. In addition, such a system is likely to include two 2,000 gallon or one 4,000 gallon hydropneumatic storage tank, one generator set for standby power, a chlorination system (hypo feeder), associated piping, metering, instrumentation, electrical service, wiring and an attendant building/structure.

As previously discussed in this report, the average daily water usage needed to service the affected residential and commercial users within the SA study area is approximately 15,200 gallons per day, which calculates to a maximum hourly rate of 42.2 GPM. New York State guidelines recommend that system pumps and supply wells be sized at ten times the average daily flow rate or approximately 106 GPM and the minimum pipe size utilized for water mains to be 6 inches.

Technical Feasibility: All of the reasons supporting the technical feasibility of Alternative Nos. 1 and 2 would be equally applicable in the case of a new community water supply system. In addition, the negative aspects discussed under the two expansion scenarios would not apply here. Based upon all information available, the yield of potable ground water from the deep aquifer underlying the Memorial Field location would more than suffice to supply affected SA users. There is sufficient area to construct such a system (well field, control house, parking facilities, maintenance building, generator building, pump house, administration building, and water storage facilities) and it is likely that construction could be accomplished in a timely manner. Lastly, based upon ground water flow and the anticipated siting of this new system, infiltration of contaminants from the subject plume associated with the HRM is not likely.

A test well will be required, however, should this option be chosen. Such a well is necessary to verify information regarding yield, water quality, etc.

Any discussion of technical feasibility must consider the added needs associated with the HRM study area. Providing potable water to these users would increase the needed quantity from 42.2 GPM to approximately 90 GPM. Based upon New York State guidelines, sizing of such a system is recommended to be 10 times the average daily flow rate which equates to approximately 223 GPM. Please refer to Appendix A for more detailed information.

Institutional Analysis: The land under consideration for this water supply system is owned by the Town of Bedford, precluding any acquisition or condemnation processes. In addition, should the Town of Bedford opt to implement a municipal water supply system, there would be no need to purchase private existing systems. Although initial construction cost outlays must be made, costs could be recovered through water billings and/or the district tax base. In addition, initial financing costs would likely be less than the alternatives previously discussed in this report due to the sale of municipal tax-free capital improvement bonds.

The transmission costs would be slightly higher than the other alternatives already discussed due to the location of the water supply system in relation to users in the area of concern (although providing service to users in both the SA and HRM study areas may be as cost-effective as the other alternatives described in this report). It may be cost-effective to provide water supply services to other users along the transmission route, if appropriate. (It should be noted that low levels of toluene were found in private water supply wells along Route 22.)

As previously discussed in this report, any alternative that provides water, the quality of which complies with applicable New York State Standards, would be acceptable to the State, local entities and the general public. This alternative, however, would be more acceptable to the Town of Bedford as water supply would be under the direct aegis of the Town rather than a private concern.

Public Health and Environmental Effects: It would appear that this alternative would provide beneficial health and environmental impacts, both short-term and long-term. Unlike the other alternatives previously discussed in this report, there is no indication that the water contained within the aquifer underlying Memorial Field will become contaminated by the plume resulting from past activities at the SA (or the HRM). This site appears to be distant enough from the SA and HRM study areas not to influence the contaminated plumes resulting from past activities. This contamination will, in all likelihood, be addressed by a separate treatment technology.

However, existing water quality must be assessed with test well samples should this option be chosen for implementation.

Cost Analysis: The estimated and anticipated capital costs associated with the construction of a new community water supply system at the Memorial Field site are as follows:

o	Construction of a test well	$25,000
o	Construction of two 100 GPM supply wells and associated pump systems	75,000
o	Site piping, metering and chlorination	25,000
o	Construction of two 2,000 gallon storage tanks	8,000
o	Electrical service with a stand-by generator	20,000
o	Construction of a control building, and site work	23,000
o	Approximately 5,500 feet of distribution piping (6 inch diameter)	165,000
o	Service connections (approximately 21 at $500 per connection)	10,500
o	Design/Engineering costs (at 15% of subtotal)	52,725
o	Contingency costs (at 5% of subtotal)	17,575
	Total Capital Costs (Estimated)*	**$421,800**

* Start-up costs are included in the above estimated capital costs.

The estimated anticipated yearly O&M costs associated with this option are as follows:

o	Field operation (labor)	$30,000
o	Field operation (benefits)	15,000
o	Office staff (part time)	10,000
o	Electrical service	7,200
o	Chemical treatment (chlorination)	1,500
o	Required laboratory sampling and analyses	400
o	Automotive/travel expenses (gasoline, oil, insurance, depreciation)	5,000
o	Financing costs (assume 8% interest municipal bonds)	37,140
	Total Annual O&M Costs (Estimated)	**$106,240**

The present worth analysis represents the sum of the capital costs plus the adjusted O&M costs over a thirty year period, based upon an 8 percent discount rate. The calculated present worth equals $1,617,850.

An estimate of the cumulative costs associated with serving affected users of both the SA study area as well as the HRM study area is also being presented in this section. As noted above, more detailed information can be found in Appendix A.

Capital Costs

o	Capital costs to construct a new community water supply system to serve SA users	$421,800
o	Construction of one additional 100 foot deep supply well with pumping system	37,500
o	Additional distribution piping to service HRM users	105,000
o	Additional service connections for HRM study area (approximately 26 at $500 per connection)	13,000
o	Additional Design/Engineering costs	23,325
o	Additional Contingency costs	7,775
	Total Capital Costs (Estimated)	**$608,400**

Operation and Maintenance Costs

o	Field operation (labor)	$30,000
o	Field operation (benefits)	15,000
o	Office staff (part time)	11,000
o	Electrical service	9,000
o	Chemical treatment (chlorination)	2,500
o	Required laboratory sampling and analyses	1,000
o	Automotive/travel expenses (gasoline, oil, etc.)	5,000
o	Financing costs	53,570
	Total Annual O&M Costs (Estimated)	**$127,070**

The present worth analysis for implementing Alternative No. 3 - Development of a New Community Water Supply System, at both the SA and HRM study areas equals $2,038,954.

The same fire protection recommendations as described under Alternative No. 1 - Expansion of the Farms Community Water System, would also apply in this case. Therefore, including the additional capital cost outlay of $280,000 for fire protection, the present worth analysis for implementing Alternative No. 3 equals $2,318,954.

4.2.4 Alternative No. 4 – Development of a Point-of-Use Treatment District (Filter District)

Detailed Description: This alternative would consist of the installation and ongoing maintenance of ground water treatment units at all affected commercial and residential point-of-use (or point-of-entry) locations. Based upon the chemical compounds for which treatment is needed, the ground water treatment units would consist of a granular activated carbon filter designed to remove the contaminants of concern to a level within the acceptable range of applicable New York State Standards.

According to the February 1990 Health Risk Assessment for the SA, a public health risk exists from use of the existing contaminated water supply through exposure via ingestion (drinking) and inhalation (inhaling vapors resulting from showering). As such, this alternative will assume that point-of-entry treatment will be employed. That is, all water intended for indoor use would be treated by a granular activated carbon treatment system.

In order for this option to be effective, the Town of Bedford would have to appropriate funds for the creation of a municipal maintenance district to implement and monitor such an alternative.

If one were to consider linking this program with a "pump and treat" alternative, the Filter District would have to be maintained either for a 3 or 6-year period, depending on the "pump and treat" alternative selected. After such time, use of the filters would be discontinued.

Technical Feasibility: Point-of-use/point-of-entry treatment units must be utilized in accordance with the manufacturer's monitoring and maintenance requirements. Such units are readily available and can be installed quickly, thereby providing an immediate solution to a potable water supply problem. From information provided by the Calgon Carbon Corp. of Pittsburgh, Pennsylvania, one of the major firms that provides granular activated carbon filters, the contaminants of concern regarding the Shopping Arcade Site have been shown to be removed by these filters to concentrations that meet applicable New York State standards. That is, for tetrachloroethylene, trichloroethene and 1,2-dichloroethene, these filters have been shown to remove these contaminants (with concentrations of up to 70 mg/l) to less than 1 ug/l.

There are, however, several issues that should be noted with respect to utilizing point-of-use/point-of-entry treatment units.

- Granular activated carbon filters have the potential for the growth of bacteria.
- After time, upon exhaustion of the carbon, these units fail to adsorb, or may desorb thereby passing/releasing contaminants into the water supply.
- Accessibility of these units may be a limiting factor with respect to the sampling and carbon replacement requirements.
- Although technically feasible, if point-of-use/point-of-entry treatment is implemented, it should be noted that this alternative would not be a solution to remediate the source of contamination (the contaminated ground water plume).

Inclusion of affected commercial and residential users from the HRM study area in this alternative would not create or excerbate any problems associated with the technical implementability of this technology. That is, the implementation of this alternative at the SA study area is independent of what occurs at the HRM study area.

Institutional Analysis: The creation of a centralized municipal maintenance district would likely be necessary to implement this alternative. Such a district would be advantageous in the implementation of this option, and the monitoring and maintenance of the treatment units. This entity would be responsible to ensure that the requisite personnel and equipment are available as needed.

Monitoring and maintenance is especially important under this alternative. The problem created by the installation of a large number of units throughout numerous locations, as well as the fact that these treatment units give no reliable indication of having reached capacity or saturation points to the need for management oversight. This can be accomplished by replacement of the filter units on a regular time period related basis (conservative replacement is recommended), flow/contaminant concentration related basis (this would require a flow meter as part of the treatment system), and/or regularly scheduled sampling and analysis to monitor the effectiveness of the unit.

Another responsibility of the district relates to treatment, storage and disposal services with respect to the "spent" carbon filters. The district must either properly dispose of these used filters or alternately arrange for these filters to be regenerated for reuse, for some purpose other than use for water supply treatment.

A number of problems can be associated with the implementation of this alternative. One problem relates to the monitoring requirements for several different types of facilities such as houses, apartments, stores, etc. Even among similar facilities, water usage would not be consistent and, therefore, scheduled monitoring would be location-specific. This would impact the testing/monitoring schedule. It is assumed that a minimum of one to two years would be needed to establish use patterns on an individual basis. Secondly, the psychological effect on users drinking treated contaminated water is intangible. In addition, as previously noted in this report, towns and private concerns have historically been reticent with respect to managing a filter district because of liability concerns, both with regard to contaminant breakthrough before filter replacement thereby being responsible for people drinking contaminated water, as well as damage of private property during installation and maintenance of the filters.

<u>Public Health and Environmental Effects</u>: As previously noted in this report, all of the options discussed under this alternative water supply study would be beneficial to the public in that each option would reduce public health risks by replacing the contaminated water supply with an alternate supply or by treating the contaminated water at its point-of-use. In this latter case, the water would be required to be treated to within the acceptable range of applicable New York State Standards.

While the short-term impacts of this alternative would certainly be beneficial from a public health standpoint, implementation of this alternative can at best be considered a temporary solution. That is, this treatment technology does not truly address the source of contamination or contaminant migration but attempts to address the contamination at the user end-point. This option would best be considered as an interim measure to be linked with a ground water "pump and treat" technology for ultimate remediation of the source of contamination. That is, use of a GAC filter should be considered as an interim measure until either the potable water supply is remediated to the appropriate New York State Standards (assuming the length of time to remediate the water supply is reasonable) and/or an alternate source of water supply is provided to effected residences for the long-term.

In addition, the reliability of this alternative as it relates to health concerns is directly related to the ability of the district to perform its responsibilities, especially the monitoring and maintenance requirements (filter replacement and sampling and analysis program).

Cost Analysis: The estimated anticipated capital costs associated with the implementation of this alternative are as follows:

o	Furnish and install 18 filter units	$67,150
o	Piping changes to separate indoor use from total site use	4,500
o	Design/Engineering costs (at 15% of subtotal)	10,748
o	Contingency costs (at 5% of subtotal)	3,583
	Total Capital Costs (Estimated)	**$85,981**

The estimated annual O&M costs associated with this option are as follows:

o	Labor (part time)	$20,000
o	Transportation	2,000
o	Laboratory testing (2 points per unit), twice	21,600
o	Carbon filter replacement (10 units)	2,000
o	Carbon filter disposal (8 units)	4,800
o	Financing costs (assume 8% interest municipal bonds)	7,571
	Total Annual O&M Costs (Estimated)	**$57,971**

The present worth analysis represents the sum of the capital costs plus the adjusted O&M costs over a thirty year period, based upon an 8 percent discount rate. The calculated present worth equals $738,619. In addition, calculations have been made relative to the use of such a filter district for both a 3 and 6-year period, in the case where this alternative would be linked with a ground water "pump and treat" alternative. An 8 percent discount rate was also utilized for these calculations. The calculated present worth for the 3-year program equals $235,372 and for the 6-year program equals $353,981.

An estimate of the cumulative costs associated with providing point-of-use/point-of-entry treatment for affected users of both the SA study area as well as the HRM study area is also being presented in this section. More detailed information can be found in Appendix A.

Capital Costs

o	Capital costs for treatment units for affected SA users	$85,981
o	Capital costs for treatment units for affected HRM users	79,325
o	Additional Design/Engineering costs	11,899
o	Additional Contingency costs	3,966
	Total Capital Costs (Estimated)	**$181,171**

Operation and Maintenance Costs

o	Labor (part time)	$30,000
o	Transportation	4,000
o	Laboratory testing (2 points per unit), twice	62,400
o	Carbon filter replacement (41 units)	8,200
o	Carbon filter disposal (11 units)	6,600
o	Financing costs (assume 8% municipal bonds)	15,952
	Total Annual O&M Costs (Estimated)	**$127,152**

The present worth analysis for implementing Alternative No. 4 - Development of a Point-of-Use Treatment District, at both the SA and HRM study areas equals $1,612,648. If this alternative is linked with a ground water pump and treat alternative, the filter district would be needed for either a 3-year or 6-year period. The calculated present worth for the 3-year program equals $508,842 and for the 6-year program equals $768,995.

4.3 No-Action Alternative

As stated previously in this document, the no-action alternative is being carried through the entire selection process for comparison to other action alternatives, although by selecting the no-action alternative, compliance with applicable New York State standards would not be achieved.

Section 5

5.0 CONCEPTUAL DESIGN OF PREFERRED ALTERNATIVES

5.1 Introduction

The purpose of the conceptual design section of the feasibility study report is to provide a discussion of the administrative and regulatory concerns along with the engineering principals and other technical requirements included as components of the design, operation and maintenance, and monitoring of the preferred remedial alternative(s) selected for implementation at the Shopping Arcade Site. Topics to be addressed in this Section include a discussion regarding the selection of preferred alternatives, remedial alternative components, required design support activities, site layout considerations, the coordination of various remedial design activities, the projected schedule for the design and implementation of the alternatives, applicable permit and regulatory considerations along with a brief discussion of any monitoring programs. In summary, the conceptual design presents an outline of the management plan or work plan for implementing a successful remedial design leading to remedial construction.

The topics identified above will be presented on an alternative–specific basis for the ground water extraction and treatment program, the alternative water supply option and the point–of–use treatment alternative.

5.2 Preferred Alternative For Ground Water Treatment

Ground Water Remedial Alternatives

The individual components to be evaluated as part of the conceptual design include:

- o Ground Water Extraction
  - Long term remediation period
  - Short term remediation period
- o Ground Water Treatment
  - Air stripping
  - Carbon adsorption
  - Air stripping and carbon adsorption

- o Disposal of Treated Water

  - Discharge to storm water drainage system
  - Discharge to injection wells
  - Discharge to infiltration gallery

Each component mentioned will be discussed briefly on a comparative basis based on the criteria developed in Section 4.

Ground Water Extraction System

The two ground water extraction alternatives consist of a 3 year remediation period and a 6 year remediation period. Theoretically, both remediation periods could effectively remediate the contaminated ground water identified within the study area. The cost of the two alternatives is relatively close; therefore, the 3 year remediation alternative is recommended since the quality of the ground water is projected to achieve New York State standards and guidance values within a considerably shorter time frame.

Ground Water Treatment

The analysis of the three ground water treatment technologies presented in Section 4, including air stripping, carbon adsorption, and a combination of air stripping and carbon adsorption indicated that air stripping alone would be effective in removing the organic contaminants from the ground water. In addition, this alternative is the most cost effective, and operation and maintenance (O&M) costs are significantly lower than for the other alternatives.

Air stripping combined with carbon adsorption is also effective in treating contaminated ground water. However, based on preliminary calculations it does not appear that contaminant concentrations in the off-gas of the air stripper would require additional treatment utilizing carbon adsorption. The addition of a carbon adsorption component to this treatment option nearly doubles the cost of the air stripping technology alone. However, the carbon adsorption system would add an additional factor of safety.

Carbon adsorption alone is also an effective treatment technology for the contaminants identified in the ground water in the study area. However, the relatively low contaminant concentrations in the ground water does not warrant using carbon alone. In addition, this was the most expensive alternative analyzed.

The air stripping system is recommended since this system can effectively remediate contaminated ground water and has a low capital cost and low O&M costs as compared to the other alternatives.

Disposal of Treated Water

Three alternatives for disposal of treated water were presented in Section 4. These include the analysis of the discharge to an existing storm water drainage system, discharge to injection wells, and discharge to an infiltration gallery.

Discharging treated ground water to the existing storm water drainage system serving the Shopping Arcade is the most cost effective of the alternatives analyzed. However, there are several concerns with this alternative. The first concern is that the drainage system may not have the design capacity capable of adequately conveying the discharge during periods of heavy rainfall. A hydrologic study of the drainage area should be conducted to determine if the drainage system can handle the projected discharge volumes. In addition, the discharge of the treated ground water to surface water bodies may adversely affect the local ground water table and the overall remediation effort by discharging water out of the drainage basin and effectively lowering the ground water table. Additional hydrogeologic testing would be needed to determine the impact of discharging to surface water bodies on the local ground water table. This would not be consistent with New York State policy of restoring the aquifer to its best intended usage.

The use of an infiltration gallery would effectively handle the anticipated volumes of treated ground water. However, site conditions may prevent the implementation of an infiltration gallery. Additional soil borings would be required to determine a suitable location for an infiltration gallery. Also, the infiltration gallery would require periodic maintenance which may involve removing the cap to flush out fines.

The injection wells are the most expensive alternative and possibly the most difficult system to maintain.

Discharge to the storm water drainage system would be a preferred system if the aquifer is not adversely effected, and if existing surface water channels have the capacity to handle the indicated flows. However, since it is likely that the local ground water table would be adversely impacted by diverting flows outside the drainage basin, the infiltration gallery or injection well alternative is the preferred system.

In summary, the ground water remedial alternatives recommended are as follows:

- o Ground Water Extraction
  - Ten-year remediation period

- o Ground Water Treatment
  - Air stripping

- o Disposal of Treated Water
  - Reinjection of treated ground water to recharge aquifer using injection wells. If design support testing shows that use of injection wells is not feasible, infiltration galleries will be used.

5.2.1 Remedial Alternative Components

The preferred remedial alternative discussed above has a number of design, construction, and operation and maintenance considerations which require discussion prior to the design phase of the project. These include:

- o Site security
- o Site access
- o Site fencing
- o Warning signs
- o Air monitoring requirements
- o Ground water monitoring requirements
- o Vapor controls
- o Ground water extraction system
- o Aquifer recharge system
- o Air stripping system

The above components will be discussed later in this section.

5.2.2 Design Support Testing

5.2.2.1 General

Several design support testing activities must be conducted prior to completion of the final design and construction of the preferred remedial alternative. The design support testing will focus on determining the physical properties of the overburden and bedrock aquifers in the area for use in designing the ground water extraction and treatment system. These tests should include the following:

- An aquifer pump test to determine the transmissivity and storage capacity of the aquifers.

- Slug tests on several existing ground water monitoring wells to determine the hydraulic conductivity of the aquifers.

- A pilot test of the injection wells to determine the feasibility and operational parameters for each well.

- Air monitoring and modeling of the air stripper discharge to assess impact on air quality and the need for a vapor phase carbon adsorption system.

Additional design support activities include:

- Existing limits of contamination
- Ground water monitoring
- Property boundaries, easements and access
- Utilities
- Treatability studies

5.2.2.2 Existing Limits of Contamination

The limits of the contamination were delineated during the remedial investigation. The monitoring wells should be resampled to determine the present extent of the contamination. Additional monitoring wells may be necessary, depending on the results of the ground water sampling.

5.2.2.3 Ground Water Monitoring

As mentioned above, the overburden and bedrock monitoring wells installed during the remedial investigation should be resampled to determine the present extent of the contamination. In addition, water level readings should be taken regularly to assess seasonal variations of the ground water table.

5.2.2.4 Property Boundaries, Easement and Access

Property boundaries are available on Bedford Village, New York tax maps. However, the property boundaries should be verified by field survey. Temporary and permanent easements need to be defined before design. Easements along the Old Post Road, Tarleton Road and a portion of the Shopping Arcade parking lot are proposed to be used.

5.2.2.5 Utilities

There are existing water and electric utilities available at the Shopping Arcade site for the proposed treatment system and temporary buildings. Service availability for extraction wells will have to be field checked during the preliminary design.

5.2.2.6 Treatability Studies

Analytical testing of ground water for specific geochemical parameters needs to be performed to determine if any pretreatment will be required before the water enters the treatment system. These tests would include at a minimum:

- Hardness
- Total suspended solids
- Metals

5.2.3 Site Layout

The following sections describe the general site layout and locations of the proposed remediation facilities.

5.2.3.1 Treatment and Staging Locations

The proposed location of the ground water treatment facilities is in the northeast corner of the Shopping Arcade parking lot. The treatment facility and associated buildings will require an area of approximately 2,500 square feet. The proposed location of the injection wells will be along the north side of the Shopping Arcade and theater building. These locations were chosen based on the need for an upgradient location for the injection wells and treatment system. In addition, the area is densely populated and the parking lot provides sufficient space with little impact on surrounding residents and the businesses located within the Shopping Arcade. Also, the area is located on an existing road, thereby providing ease of access for equipment and utilities. A conceptual design layout of the treatment facilities is presented in Figure No. 5-1.

5.2.4 Applicable Permits, Regulations and Standards

Several permits will be required for the construction and operation of the preferred remedial alternatives. The permits required will include:

- Appropriate and applicable building permits from the Town of Bedford.

- Permit for air discharge from air stripping: NYCRR Part 212, Form 76-19-3 Process, Exhaust or Ventilation System Application to Construct or Certificate to Operate.

- Applicable permits for ground water extraction and injection from the New York State Department of Environmental Conservation and the Westchester County Health Department.

5.3 Preferred Alternative Water Supply Options

The information presented in Section 4.0 relative to alternative water supply options has been summarized in Table No. 5-1. Based upon this information, the implementation of any of these alternatives would be feasible. However, there is an order of ranking, as discussed below.

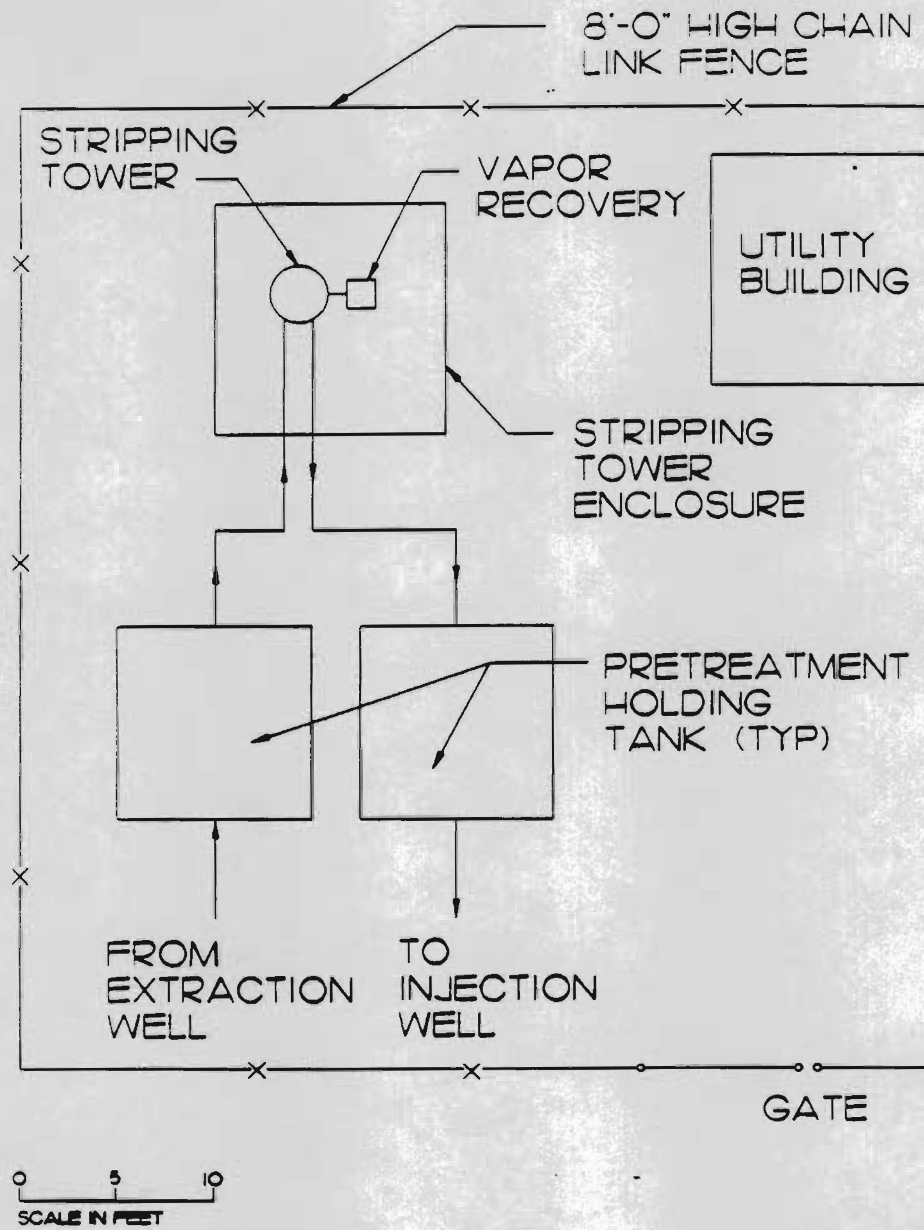


Figure 5-1. Treatment Facility Conceptual Design

Table No. 5-1

SUMMARY OF DETAILED SCREENING FOR WATER SUPPLY ALTERNATIVES

Alternative Water Supply Option/ Screening Criteria	Technical Feasibility					Institutional Analysis		
	Anticipated Performance	Safety	Availability	Timeliness	Proven Technology	Ability to Obtain Permits	Privatization	State, Local and Public Acceptance
Alternative No. 1 - Expansion of the Farms System	Increase in pumping could cause a problem re: yield, quality	Yes (with possible treatment)	Yes (if yield is adequate)	Dependent upon system owner/ operator	Yes	Yes	Yes	Based upon available information, it appears to be acceptable.
Alternative No. 2 - Expansion of the Proposed Ponds System	Potential problems re: yield, quality	Yes (with possible treatment)	Yes (if yield is adequate)	Not currently available	Yes	Yes	Yes	Appears acceptable.
Alternative No. 3 - Construction of a New System	Test well required	Yes	Yes	Dependent upon the Town of Bedford	Yes	Yes	Possible	Appears acceptable.
Alternative No. 4 - Point-of-Use Treatment	Potential problems with bacteria growth, carbon exhaustion	Yes (with monitoring and maintenance)	Yes	Dependent upon creation of a filter district	Yes	Yes	Possible	Town concerns regarding acceptability.
Alternative No. 5 - No-Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not acceptable

1649E

Table No. 5-1 (continued)

SUMMARY OF DETAILED SCREENING
FOR WATER SUPPLY ALTERNATIVES

Alternative Water Supply Option/ Screening Criteria	Public Health and Environmental Effects						Cost Analysis		
	Ability to Reduce Risks	Beneficial Effects	Adverse Effects	Short-term Impacts	Long-term Impacts	Attains New York State Standards	Capital Costs	Operation and Maintenance Costs	Present Worth Analysis
Alternative No. 1 - Expansion of the Farms System	Yes	Yes	Potential adverse effects relative to contamination of the water supply	Adverse impacts during construction	Potentially adverse relative to water supply contamination	Yes	$377,400	$81,043	$1,289,782
Alternative No. 2 - Expansion of the Proposed Ponds System	Yes	Yes	Potential adverse effects relative to contamination of the water supply	Adverse impacts during construction	Potentially adverse relative to water supply contamination	Yes	$417,000	$75,614	$1,268,262
Alternative No. 3 - Construction of a New System	Yes	Yes	Loss of public park land	Adverse impacts during construction	Beneficial	Yes	$421,800	$106,240	$1,617,850
Alternative No. 4 - Point-of-Use Treatment	Yes	Yes	Possible, with poor maintenance	Beneficial	Potentially adverse with improper monitoring and maintenance	Yes, with maintenance	$85,981	$57,971	$738,619
Alternative No. 5 - No-Action	No	None	Yes, continued exposure to contaminated water supply	None	None	No	N/A	N/A	N/A

Several issues should be noted prior to summarizing and comparing the alternative water supply options. First, should one of these options be chosen, it will be linked with an alternative designed to address treatment of the contaminated plume as discussed above. Even though an alternative water supply may be provided to affected users within the study area, New York State would require that the contaminated ground water be remediated to achieve applicable state standards and guidance values.

Secondly, should any of these alternative water supply options be chosen, it is likely that the chosen option would be implemented for both the SA and the HRM study areas. As such, a number of the concerns raised during the screening of alternatives would be magnified. These concerns include the unknown yield capability of the aquifers, and movement of the contaminated ground water plume toward the water supply due to an increase in pumping.

Each of the four alternative water supply options has been shown to be technically feasible. There are, however, some concerns and unknowns that should be highlighted. These concerns include the potential movement of the contaminated ground water plume into the area of ground water supply resulting from an increase in pumping for Alternative Nos. 1 and 2. With respect to Alternative No. 4, potential bacteria growth and premature breakthrough of the carbon filter systems could cause water quality problems. Therefore, a strict monitoring and maintenance schedule under this alternative would be necessary. With regard to Alternative Nos. 1, 2 and 3, unknowns relate to the amount of available potable water underlying each prospective area. In this regard, it appears that the greatest concern would be at the existing Bedford Farms Water Company well field and the least concern at the proposed Memorial Field well field, respectively.

With respect to the institutional analysis, each of the four alternatives appears to be feasible for implementation. A potential problem under this screening criteria relates to the liability issues and the required treatment, storage and disposal services under Alternative No. 4. In addition, in order to implement either Alternative Nos. 1 or 2, the Town of Bedford would first have to purchase the community water supply system from the owner and establish a municipal water supply district.

Each of these alternatives could protect human health and the environment in that they could attain or exceed applicable New York State Standards. However, concerns have been raised with respect to potential long-term adverse impacts. Alternative Nos. 1 and 2, with an increased projection in pumping, could result in the movement of a contaminated ground water plume towards the water supply areas. Treatment would be perceived by the public as less desirable than drinking "clean" water. For Alternative No. 4, poor maintenance and/or insufficient monitoring could cause adverse effects due to breakthrough of contaminants through the filter systems. In addition, the liability concerns regarding the creation of a filter district could preclude the implementation of this alternative.

Finally, the cost analysis ranking is provided below from most to least economical. With the exception of Alternative No. 4 – Development of a Filter District, this ranking is based upon the present worth analysis over a thirty year period and assuming an 8 percent diseount rate. Costs were also calculated over both a 6 and 3-year period to correspond to the "pump and treat" alternative.

- Alternative No. 4 – Development of a Filter District
- Alternative No. 2 – Expansion of the Planned Ponds Water Supply System
- Alternative No. 1 – Expansion of the Existing Farms Water Supply System
- Alternative No. 3 – Development of a New Water Supply System

Conclusions and Recommendations

Although Alternative No. 3 is the most costly, this alternative is ranked as a component of the preferred option of the three alternative water supply options. Although the costs are somewhat higher than Alternative Nos. 1 and 2, the other positive concerns far outweigh the increase in cost. In addition, Alternative No. 4 is the preferred alternative to be implemented as an interim measure until either completion of the "pump and treat" program or connection of all affected users to a community water supply system.

With respect to technical feasibility, the location of the proposed Memorial Field well field appears capable of providing an ample water supply for both the projected SA and HRM study areas. In addition, increased pumping in this area should not cause the movement of the contaminated plume associated with the SA (or HRM) study area towards the water supply underlying Memorial Field. The same cannot be said with any certainty for the existing Farms water supply system or the Planned Ponds Development water supply system. With respect to the Filter District alternative, although there are certain technical problems associated with such a technology, proper monitoring and maintenance would mitigate the possibility of encountering these problems and is recommended as an interim remedial action while design of the "pump and treat" and alternative water supply systems are undertaken.

The institutional analysis has indicated that Alternative Nos. 1, 2 and 3 are all more or less feasible with respect to implementation. However, there are likely to be reservations and concerns on a local level with implementation of Alternative Nos. 1 and 2 due to the possible need for treatment in the future. In addition, the Town would have to purchase these systems from the owners in order to be eligible for financial assistance towards the expansion of the supply system from the State of New York. As mentioned above, there are certain institutional problems associated with Alternative No. 4 – Development of a Filter District. These relate to the creation of a municipal maintenance district, liability concerns, and arranging for the proper disposal of the spent filters.

Table No. 5-2 summarizes the concerns associated with each alternative and presents estimated costs for implementing each option, both for the SA study area by itself and for the SA study area together with the HRM study area. Based upon the information presented herein, it is recommended that Alternative No. 3 – Development of a New Community Water Supply System at the Bedford Memorial Field and Alternative No. 4 – Development of a Filter District be selected as the preferred alternatives.

5.3.1 Community Water Supply System

As noted above, the recommendation is being made to implement Alternative No. 3 – Development of a New Community Water Supply System at the Bedford Memorial Field as the preferred alternative.

The preferred remedial alternative consists of the following components which must be considered during the design phase of the project prior to construction:

- Clearing, Grading and Drainage
- Building Structure/Pump House
- Three Production Wells
- One Hydropneumatic Tank
- Three Submersible Pumps
- One Generator Set for Stand-by Power
- Chlorination System
- Piping, Metering, Other Instrumentation
- Electrical Service, Wiring
- Security Fencing and Site Security
- Ground Water Monitoring System
- Review of Flood Records

Table No. 5-2

ALTERNATIVE WATER SUPPLY DECISION MATRIX

Alternative	Cost ($1,000) Capital	Cost ($1,000) Present Worth	Technical Concerns	Institutional Concerns	Public Health/Environmental Concerns
No. 1 - Expansion of the Farms System					
o SA alone	$377	$1,290	Potential problem with available ground water capacity, water quality.	Property size could be a limiting factor. Reservations due to possible future treatment.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.
o Cummulative with Hunting Ridge Mall	$572	$1,917	Problems noted above exacerbated due to increase in pumping associated with Shopping Arcade Site	Property size could be a limiting factor. Reservations due to possible future treatment.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.
No. 2 - Expansion of the proposed Ponds System					
o SA alone	$417	$1,268	Potential problem with water quality re: iron, nitrates, VOCs. This system not presently available.	Reservations due to possible future treatment.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.
o Cummulative with Hunting Ridge Mall	$631	$1,870	Problems noted above exacerbated due to increase in pumping associated with Shopping Arcade Site	Reservations due to possible future treatment.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.

Table No. 5-2 (continued)

ALTERNATIVE WATER SUPPLY DECISION MATRIX

Alternative	Cost ($1,000) Capital	Present Worth	Technical Concerns	Institutional Concerns	Public Health/Environmental Concerns
No. 3 - Development of a New System					
o SA alone	$422	$1,618	A test well must be installed.	None, based upon available information.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.
o Cummulative with Hunting Ridge Mall	$608	$2,039	A test well must be installed.	None, based upon available information.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.
No. 4 - Development of a Filter District					
o SA alone	$86	$739	Bacterial growth, filter exhaustion and containment breakthrough.	Potential monitoring and maintenance problems, liability concerns associated with a Filter District; unit accessibility.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.
o Cummulative with Hunting Ridge Mall	$181	$1,613	Bacterial growth, filter exhaustion and containment breakthrough.	Potential monitoring and maintenance problems, liability concerns associated with a Filter District; unit accessibility.	Although this alternative would reduce the public health threat from carcinogenic compounds, the environmental concerns would remain due to existing ground water contamination. In addition, public health risk may be a future concern.

Table No. 5-2 (continued)

ALTERNATIVE WATER SUPPLY DECISION MATRIX

Alternative	Cost ($1,000) Capital/Present Worth		Technical Concerns	Institutional Concerns	Public Health/Environmental Concerns
No. 5 - No-Action					
o SA alone	0	0	--	--	This alternative would allow to remain a water supply system with a public health risk from carcinogenic compounds. In addition, migration of the contaminated plume resulting from the HRM would continue.
o Cummulative with Hunting Ridge Mall	0	0	--	--	This alternative would allow to remain a water supply system with a public health risk from carcinogenic compounds. In addition, migration of the contaminated plume resulting from the HRM would continue.

5.3.1.1 Design Support Testing

5.3.1.1.1 General

Design support activities will be required prior to final design and implementation of this alternative. These are primarily field activities and are necessary in order to obtain additional information where data gaps presently exist. Design support activities requiring further investigation include test well installation and pump testing; determination of property boundaries, easements and access; identification of utility locations; and treatability studies.

5.3.1.1.2 Test Well Installation and Pump Testing

In order to accurately determine the site-specific ground water yield associated with this location, a test well must be installed and a pump test(s) performed. This well will be installed in the same general location and at the depth below ground surface where the maximum yield of ground water is anticipated (estimated to be 150 feet).

5.3.1.1.3 Property Boundaries, Easements and Access

Property boundaries are available from the Town of Bedford, New York tax maps. These boundaries will be verified by a field survey and/or from recorded deeds. As noted previously in this report, the Memorial Field property is owned by the Town of Bedford. Access to the property will be via Greenwich Road.

5.3.1.1.4 Utilities

Existing electric utilities are available from New York State Electric and Gas for service to the proposed facility. Service capability will be verified during the preliminary design phase of the project.

5.3.1.1.5 Treatability Studies

Treatability studies and pilot testing may be required to determine whether water treatment will be necessary and, if so, the extent of the treatment program.

Ground water samples will be collected from the test well described above and those samples will be analyzed for Target Compound List plus 30 parameters (TCL +30) as well as drinking water parameters as required by the Westchester County Health Department (WCHD). In addition, analysis will be conducted for total suspended solids, pH, hardness and iron content. Such analyses will determine what, if any, pretreatment requirements are likely to be implemented.

If treatment is determined to be needed, bench scale studies will be conducted. Depending upon the number and types of contaminants identified, the treatment technology that removes the "worst" contaminants will be the first technology considered during the bench scale study. The contaminants identified in the ground water are traced through the treatment system to determine the efficiency of such a system. It is possible that other or additional treatment technologies would also have to be tested.

If necessary, pilot scale testing may be performed subsequent to the bench scale test(s) to verify the processes, refine the design criteria and obtain a more accurate estimate of the operation and maintenance (O&M) costs needed.

5.3.1.2 Site Layout

As described previously in this report, the proposed location for this community water supply system is within the Bedford Village Memorial Park, located on Greenwich Road in Bedford Village, New York. Specifically, the proposed location is at the northwestern portion of the Memorial Park at Lot 34 and consists of approximately 5.6 acres of land.

5.3.1.3 Applicable Permits, Regulations and Standards

The construction of a new community water supply system involves the coordination of a number of entities including governmental agencies.

Regulations, standards, and/or guidance values have been discussed previously in this document primarily under Section 2.1.3, New York State standards.

Permits that must be applied for and obtained prior to operation include those required by the New York State Department of Environmental Conservation and the Westchester County Department of Health. The specific permitting requirements are as follows:

- o NYSDEC Application for a Public Water Supply Permit
- o NYSDEC State Environmental Quality Review (SEQR) Application for Permit
- o NYSDOH Application for Approval of Plans for Public Water Supply

The Westchester County Health Department will also be involved in the permitting process in coordination with the state permit program. Applications for local building and construction permits from the Town of Bedford will be submitted to the Building Department.

5.3.2 Filter District

Implementation of a Filter District for affected residential and commercial water supply users within the SA study area will be initiated to last for a period of time until a "clean" water supply is made available, either by a "pump and treat" system to remediate the contaminated ground water or by connection to an alternate community water supply system.

This preferred remedial alternative would consist of the following components at each residential and commercial unit:

- o Piping changes to accommodate the filter at "point-of-entry"
- o A granular activated carbon filter to treat incoming ground water.

5.3.2.1 Design Support Testing

5.3.2.1.1 General

Design support activities will be required prior to implementation of this alternative. Specifically, treatability studies will be necessary, as described below.

5.3.2.1.2 Treatability Studies

Treatability studies and bench tests will be required to determine the efficiency of the filter media relative to removal of the contaminants of concern.

As such, water samples will be collected from select private wells (which will be determined based upon data obtained during the remedial investigation) and will be analyzed before and after passing through the treatment medium. If the samples collected are found to be less contaminated then the highest levels found during the remedial investigation, it may be necessary to prepare "spiked" samples to effectuate a worst-case scenario.

Additional testing for physical parameters such as pH, hardness, total suspended solids and iron content will also be undertaken in order to ascertain the degree of any pretreatment required.

5.3.2.2 Applicable Permits, Regulations and Standards

Although regulatory permits would not be required for the installation and utilization of individual point of entry carbon filters, the Town of Bedford will create a Filter District to coordinate this program.

This district will coordinate the installation of these filters at the affected residential and commercial properties, monitor water usage, establish a site-specific sample and analysis program to track filter efficiency, and act as an information clearinghouse to respond to concerns of those in the district. The primary reason for establishing such a filter district is to ensure compliance with New York State drinking water standards.

5.4 Coordination of Remedial Activities and Scheduling

The activities associated with the preferred remedial activities will require a phased and coordinated effort in order that the ground water within the Shopping Arcade study area be successfully remediated. The three preferred alternatives discussed previously in this section can be implemented independently; however, implementation of the remedial alternative(s) ultimately selected should commence immediately after approval of such selection occurs. The sequence of remedial activities and the projected schedule is discussed below for the ground water "pump and treat" alternative, the alternate water supply option, and the implementation of a point-of-use filter district.

5.4.1 Ground Water Remediation

Implementation of the alternative consisting of ground water extraction, treatment by air stripping, and reinjection by wells will include the following activities, listed in the order of occurrence and with a projected time table.

Activity	Schedule Range
Design Support Testing	0 to 8 months
Obtain Necessary Permits	0 to 6 months
Construction of Treatment and/or Water Supply Facilities	8 to 26 months
Start-Up	26 to 28 months
System Performance Monitoring	26 to 32 months
Ground Water Monitoring	26 months +

5.4.2 Alternative Water Supply District

Implementation of this alternative will include the following activities and schedule:

Activity	Schedule Range
Creation of Municipal Water Supply District	0 to 6 months
Design Support Testing	0 to 8 months
Obtain Necessary Permits	0 to 6 months
Construction of Treatment and/or Water Supply Facilities	8 to 26 months
Start-Up	26 to 28 months
System Performance Monitoring	26 to 32 months
Ground Water Monitoring	26 months +

5.4.3 Filter District

Implementation of a Filter District will include the following activities and schedule:

Activity	Schedule Range
Creation of a Filter District	0 to 6 months
Design Support Testing	0 to 6 months
Construction/Installation	6 to 18 months
Start-Up	18 to 20 months
System Performance Monitoring	18 months +

5.4.4 Summary

Based upon our best estimate, therefore, it is likely to take on the order of 2 to 2-1/2 years to complete design and initiate and complete construction and start operation of these alternatives.

Section 6

6.0 REFERENCES

Dvirka and Bartilucci, Remedial Investigation Report for the Bedford Village Wells Hunting Ridge Mall Site, June 1989.

Dvirka and Bartilucci and Sadat Associates, Health Risk Assessment for the Bedford Village Wells Hunting Ridge Mall Site, June 1989.

USEPA, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final, OSWER Directive 9355.3-01, Office of Emergency and Remedial Response, Washington, D.C., October 1988.

USEPA, Handbook for Remedial Action at Waste Disposal Sites (Revised), EPA/625/6-85/006, Office of Emergency and Remedial Response, Washington, D.C., October, 1985.

USEPA, Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites, EPA/540/G-88/003, Office of Emergency and Remedial Response, Washington, D.C., December 1988.

USEPA, Guidance Document for Providing Alternate Water Supplies, EPA/540/G-87/006, Office of Emergency and Remedial Response, Washington, D.C., February 1988.

Leggette, Brashears and Graham, Inc., Ground Water Assessment-Town of Bedford, New York, December 1985.

Chas. H. Sells, Inc., Draft Environmental Impact Statement for Bedford Ponds, August 1988.

Eugene L. Grand and W. Grant Ireson, Principles of Engineering Economy, Fourth Edition, 1964.

Dvirka and Bartilucci, Suffolk County Comprehensive Water Resources Management Plan, January 1987

Insurance Services Office Inc., Guide for Fire Suppression Rating Schedule, 1980.

Great Lakes Upper Mississippi River Board of State Public Health and Environmental Managers, Recommended Standards for Water Works, 1987.

Appendix A

APPENDIX A

WORK SHEETS – ASSUMPTIONS AND PROJECTED COSTS FOR ALTERNATIVE WATER SUPPLY OPTIONS

1952E

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No. 1 of 19
By RTB Date 7-10-92
Chkd. by ____ Date ____

Project: BEDFORD VILL. - R.I. & F.S. Job No 842
Subject: 842-08A - DEV OF ALT. - HUNTING RIDGE

I EXIST. FARMS COMM. WATER SUPPLY SYSTEM

A) BEDFORD FARMS WATER CO - (NOT IN SUGGESTED WATER SUPPLY SERVICE AREA)

① ACTUAL WATER USAGE
P.S.C. REPORT 1988 USAGE

TOTAL 6,459,000 GPY

81 CUSTOMERS

AVE. DAILY - 6,459,000 ÷ 365 = 17,696 GPD (ACT.)

MAX. DAY - 2.5 × 17,696 = 44,240 GPD

MAX. HR - 17,696 × 4 ÷ 24 = 2,949 GPH
OR 49.15 gpm

② ESTIMATED WATER USAGE (BEDFORD FARMS)

AVE. DAILY 81 × 100 GPD/C × 4 CAP/HOUSE = 32,400 GPD
MAX DAY - 2.5 × 32,400 = 81,000 GPD

MAX HR - 4 × 32,400 ÷ 24 = 5,400 GPH
OR 90 gpm

③ EXISTING FACILITIES

		ORIGINAL	PRESENT
WELL No 1 - 1954	CAPACITY	60 gpm	?
" " 2 - 1954	"	24 gpm	-0-
" " 3 - 1966	"	100 gpm	100 gpm

1 - HYD. TANK - CAPACITY - ?
2 - STORAGE TANKS - 15,000 GALLONS EACH
BOOSTER PUMP

DATA FROM J.P. HARRIS WELL Co.
GEORGE GROSSMAN

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet № 2 of ____
By RTB Date 7-11-89
Chkd. by ____ Date ____

Project: BEDFORD VILL - R.I. & F.S. Job № ____
Subject: 842-08A - DEV. OF ALT. HUNTING RIDGE

I

B) ① WATER REQUIREMENTS - ("SUGGESTED WATER SUPPLY SERVICE AREA")

AVE. DAILY USE - ESTIMATED

21 HOMES - 21 × 4 CAP/HOUSE × 100 =	8,400 GPD (EST.)
* MALL -	3,500 " "
GAS STATION -	100 " "
** RESTAURANT - 100 SEATS × 30 GPD/SEAT	3,000 " "
HARDWARE STORE - 5 CAP. × 25 GPD/C	125 " "
*** PERRENIAL GARDENS - 300 GPM × 6 HRS.	1,800 GPD "

AVE. DAILY FLOW - 16,925 GPD (EST.)

MAX. DAY 16,925 × 2.5 : 42,312 GPD (EST.)

MAX HR. 16,925 × 4 ÷ 24 = 2,821 GPH
OR ÷ 60 47.0 gpm

* MALL - SUPERMARKET - 10 FIXT. × 100 GPD 1,000 GPD
APPROX. 6 STORES - 12 FIXT. × 100 GPD · 1,200
4-5 OFFICES - EST 25 GPD/C × 20 C 500 "
2,700 "
OR 0.1 GPD/SQ.FT × 350 × 100 3,500 } USE LARGER

** - ESTIMATED 100 SEATS

*** - ESTIMATED 1 HOSE FLOW @ 5 gpm FOR 6 HRS -
(COULD BE MUCH MORE)

ADD - POSSIBLE NEW STORES - (ADJACENT TO HARDWARE)
"BISTRO" RESTAURANT (ACROSS RT. 22 FROM HARDWARE)

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet № 3 of ____
By RTB Date 7-11-8-
Chkd. by ____ Date ____

Project: BEDFORD VILL. - RI & FS Job № 842
Subject: 842-08A - DEV. OF ALT. - HUNTING RIDGE

c) EXPAND THE EXISTING FARMS COMMUNITY WATER SUPPLY SYSTEM (BEDFORD FARMS WATER CO.) ALT NO. 1

① WATER QUANTITY REQUIREMENTS

ADDED CAPACITY FOR "SUGGESTED WATER SUPPLY SERVICE AREA" - AT HRM — 47.0 gpm (EST.)

PRESENT USE AT FARM'S COMMUNITY — 69.6 gpm
(AVE. OF 49.15 & POSS. 90)

TOTAL 116.6 gpm

NOTE: 10 STATE STANDARDS REQUIRES SIZING OF WELLS AND PUMPS TO BE 10 TIMES AVE. DAILY FLOW

ADDED CAPACITY TO BEDFORD FARMS W.C.
10 × 16,925 = 169,250 ÷ 24 = 7,052.1 GPD = 117.5 gpm

DESIGN CAPACITY FOR PRESENT W.C. (SHOULD BE)
10 × 17,696 = 176,960 ÷ 24 = 7,373.3 GPD = 122.9 gpm

TOTAL 240.4 gpm

Dvirka and Bartilucci CONSULTING ENGINEERS

Sheet No 4 of ____
By RTB Date 7-11-8
Chkd. by ____ Date ____

Project: BEDFORD VILL. R.I. & F.S. Job No 84
Subject: 842-08A - DEV. OF ALT. - HUNTING RIDGE

D) EXPAND THE PLANNED PONDS COMMUNITY WATER SUPPLY SYSTEM (ALT NO. 2)

① WATER QUANTITY REQUIREMENTS

ADDED CAPACITY FOR "SUGGESTED WATER SUPPLY SERVICE AREA"

47.0 g
117.5 g

10 STATE ST'DS

ESTIMATED "PONDS" WATER USE
FROM SELLS REPORT - 18,500 GPD (AVE)

MAX. DAY 18,500 × 2.5 = 46,250 GPD

MAX. HR. 18,500 × 4 ÷ 24 = 3,083 GPH
OR 51.4 GPM

10 STATE ST'DS - 10 × 18,500 ÷ 24 = 7708.3 GPH OR 128.5 g

OR FROM D&B CALCULATIONS

50 TOWN HOUSES @ 300 GPD - 15,000
9 ESTATE HOUSES @ 550 GPD - 4,950
19,950 GPD

MAX. DAY 19,950 × 2.5 = 49,875 GPD

MAX. HR 19,950 × 4 ÷ 24 = 3,325 GPH
OR 55.4 GPM

10 STATE ST'DS · 10 × 19,950 ÷ 24 = 8312.5 GPD
OR 138.5 g

TOTAL WELL SUPPLY NEEDED -
MAX HR'LY RATE - 100.2
10 STATE ST'D RATE - 256.0

NEED MINIMUM - 3 - 40 GPM WELLS
" MAXIMUM - 7 - 40 GPM "

ALL RECOMMENDATIONS ON PG. 6, E② APPLY

② ADVANTAGES - ⓐ NEW SYSTEM - CAN SIZE PIPING & NUMBER OF WELLS TO SUITE
ⓑ CENTRAL SOURCE OF SUPPLY
ⓒ CENTAL TREATMENT OF CONTAMINATION (PROBABLE)

③ DISADVANTAGES - ⓐ STORAGE CAN BE PROBLEM (ABOVE GROUND)
ⓑ NO. OF WELLS @ 40 GPM MIGHT BE LIMITED
ⓒ IRON CONTENT IN TEST SAMPLE IS 31 mg/L

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No. 5 of ____
By RTB Date 2-11-9_
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE R.I. & F.S. **Job No.** 842
Subject: 842-08A - DEV. OF ALT. - HUNTING RIDGE

(d) PCE & 1,1,1-TRICHLOROETHANE AT 4 ppb WITH PLUME MOVING IN ITS DIRECTION

(e) TIME FRAME - MIGHT BE LONG - C.H. SELLS REPORT STATES THAT THEY "HAVE BEEN ADVISED BY THE HYDROLOGIST (GEOTOXI ASSOC. INC.) THAT A FORECAST OF THE ADDITIONAL AVAILABLE SUPPLY ON A DAILY BASIS FOR THE PLANNABLE FUTURE, CANNOT BE FIRMLY ESTABLISHED UNTIL THE FIRST WELL IS OPERATIVE AND FURTHER TEST MADE."

(f) POSSIBLE NITROGEN PROBLEM WITH AQUIFER FROM INDIVIDUAL VS CENTRAL COMMUNITY TYPE SUBSURFACE DISPOSAL SYSTEM. CONCERN BY GTA AND RECOMMENDS MONITORING PROGRAM. COULD BE INTENSIFIED WITH NEW RECOMMENDED LOCATION OF WELL TO CENTRAL AREA (TW #3 ON SKETCH)

(g) POLLUTION COULD BE SIGNIFICANT WITH PROPOSED PUMPING RATE TO SERVE "PONDS DEVELOPMENT" BUT WILL BE INTENSIFIED AT HIGHER RATE (ALMOST DOUBLED TO SERVE "SUGGESTED WATER SUPPLY SERVICE AREA"). TREATMENT FOR V.O.C. & NITROGEN IS A PROBABLE REQUIREMENT. COST OF G.A.C. RESIDUAL WASTE & OTHER WASTE STREAM MATERIAL DISPOSAL IS HIGH, AS WELL AS TREATMENT.

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No. 6 of ____
By RTB Date 7/12/
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE R.I. & F.S. Job No. 84
Subject: 842-08A DEV. OF ALT. - HUNTING RIDGE

E) DEVELOP A NEW COMMUNITY WATER SUPPLY SYSTEM (ALT. NO. 3)

① EST. CAPACITY REQUIREMENTS (SUGGESTED WATER SUPPLY SERVICE AREAS ONLY)

	MAX HRLY RATE	10 STAT ST'DS
HUNTING RIDGE MALL -	44.8 gpm	117.5 g
SHOPPING ARCADE (SEE PG. 8)	42.2 gpm	105.7 g
	87.0 gpm	223.2 g

② RECOMMENDATIONS: LOCATE SUPPLY N.E. CORNER MEMORIAL FIELD,
3 WELLS - GRAVEL PACKED - 100 GPM EACH - 150± L
1 HYDROPNEUMATIC TANK - MIN 2,000 GAL
PREF. 4,000 "
3 SUBMERSIBLE PUMPS, PITLESS ADAPTER, ETC
1 GENERATOR SET (STANDBY POWER)
CHLORINATION (HYPO FEEDER)
PIPING, METER, INSTRUMENTATION
ELECTRIC SERVICE, WIRING
BUILDING STRUCTURE

③ ADVANTAGES - ⓐ MUNICIPAL DISTRICT - RELATIVELY DEEP AQUIFIER
ⓑ NEW SYSTEM - CAN SIZE PIPING AND NUMBER OF WELLS TO SUITE
ⓒ LOW V.O.C. AND NITRATES SHOULD BE LOW THUS AVOIDING TREATMENT COSTS
ⓓ POTABLE, CENTRAL SOURCE OF SUPPLY
ⓔ COST RECOVERABLE THROUGH WATER BILLINGS OR DISTRICT TAX BASE.
ⓕ LAND OWNED BY BEDFORD VILLAGE, NO ACQUISITION OR CONDEMNATION REQ'D.

④ DISADVANTAGES - ⓐ TEST WELL REQ'D
ⓑ TRANSMISSION COSTS SLIGHTLY HIGH DUE TO WELL SOURCE AND ULTIMATE USE IN CONTAMINATED AREAS TO BE SERVED - (MIGHT BE ECONOMICAL TO ADD SERVICES ALONG TRANSMISSION ROUTE)
ⓒ INITIAL CONSTRUCTION COSTS.

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 7 of ____
By RTB Date 7/12/89
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE R.I. & F.S. Job No 842
Subject: 842-08A DEV. OF ALT. - HUNTING RIDGE MI... -

F) DEVELOP A POINT-OF-USE TREATMENT DISTRICT [FILTER DISTRICT] (ALT No 4)

① SOME OF THE ESTABLISHMENTS ALREADY HAVE SMALL G.A.C. FILTER UNITS INSTALLED TO BE CONSIDERED AS A VIABLE ALTERNATIVE WE WOULD RECOMMEND THIS ONLY BE CONSIDERED AS A MUNICIPAL MAINTENANCE DISTRICT, WITH "IN-HOUSE" EMPLOYEES OR CONTRACTED OUT WITH A FIRM SPECIALIZING IN THIS FIELD.

② ADVANTAGES -
ⓐ MUNICIPAL DISTRICT
ⓑ LOW INITIAL COST FOR TREATMENT FILTER UNITS
ⓒ IMMEDIATE "QUICK SOLUTION" TO PRESENT POLLUTION PROBLEM

③ DISADVANTAGES
ⓐ LARGE NUMBER OF SMALL UNITS SPREAD OUT IN NUMEROUS LOCATIONS
ⓑ YEARLY MAINTENANCE COST AND EXPENSIVE TESTING IS PROHIBITIVE
ⓒ RELIABILITY OF HEALTH SAFETY IS DIRECTLY RELATED TO ABILITY OF PERSONNEL OF OUTSIDE CONTRACTOR AND TESTING COULD BE QUESTIONABLE.
ⓓ MONITORING OF REMOVAL OF THE CONTAMINATED CARBON COULD BE CUMBERSOME PROBLEM FOR VILLAGE AND HEALTH DEPT.
ⓔ PIPING CHANGES IN EACH ESTABLISHMENT OR HOUSE SO AS TO TREAT ONLY SANITARY OR DRINKING WATER USED COULD BE EXPENSIVE PROBLEM.
ⓕ FREQUENCY OF TESTING DIFFERENT FOR EACH TYPE OF FACILITY. WOULD TAKE MINIMUM 1 TO 2 YEARS OR MORE TO ESTABLISH USE PATTERNS.
ⓖ APPROACH IS "BAND-AID" TYPE AND NOT LONG TERM SOLUTION.
⑩ PSYCHOLOGICAL EFFECT OF DRINKING "TREATED" CONTAMINATED WATER IS INTANGIBLE

F) DEVELOP A POINT-OF-USE TREATMENT DISTRICT [FILTER DISTRICT] (ALT NO 4)

① SOME OF THE ESTABLISHMENTS ALREADY HAVE SMALL G.A.C. FILTER UNITS INSTALLED TO BE CONSIDERED AS A VIABLE ALTERNATIVE WE WOULD RECOMMEND THIS ONLY BE CONSIDERED AS A MUNICIPAL MAINTENANCE DISTRICT, WITH "IN-HOUSE" EMPLOYEES OR CONTRACTED OUT WITH A FIRM SPECILIAZING IN THIS FIELD.

② ADVANTAGES -
ⓐ MUNICIPAL DISTRICT
ⓑ LOW INITIAL COST FOR TREATMENT FILTER UNITS
ⓒ IMMEDIATE "QUICK SOLUTION" TO PRESENT POLLUTION PROBLEM

③ DISADVANTAGES
ⓐ LARGE NUMBER OF SMALL UNITS SPREAD OUT IN NUMEROUS LOCATIONS
ⓑ YEARLY MAINTENANCE COST AND EXPENSIVE TESTING IS PROHIBATIVE
ⓒ RELIABILITY OF HEALTH SAFETY IS DIRECTLY RELATED TO ABILITY OF PERSONNEL OF OUTSIDE CONTRACTOR AND TEST. COULD BE QUESTIONABLE.
ⓓ MONITORING OF REMOVAL OF THE CONTAMINATED CARBON COULD BE CUMBERSOME PROBLEM FOR VILLAGE AND HEALTH DEPT.
ⓔ PIPING CHANGES IN EACH ESTABLISHMENT OR HOUSE, SO AS TO TREAT ONLY SANITARY OR DRINKING WATER USED COULD BE EXPENSIVE PROBLEM.
ⓕ FREQUENCY OF TESTING DIFFERENT FOR EACH TYPE OF FACILITY. WOULD TAKE MINIMUM 1 TO 2 YEARS OR MORE TO ESTABLISH USE PATTERNS.
ⓖ APPROACH IS "BAND-AIDE" TYPE AND NOT LONG TERM SOLUTION.

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 8 of ____
By RTB Date 7/12/8
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE R.I. & F.S. Job No 842
Subject: 842-08B DEV. OF ALT - SHOPPING ARCADE

II A) ① WATER REQUIREMENTS - ("SUGGESTED WATER SUPPLY SERVICE AREA)

AVE. DAILY USE - ESTIMATED

8 HOMES - OFFICE - SHOPS - x 200	1,600 GPD
* SHOPPING ARCADE	1,150 "
EXXON STATION - 2 @ 400	800 "
** BANK BLD'G -	2,100 "
*** THEATER BLD'G	7,750 "
**** FIREHOUSE	1,000 "
COUNTY COURT HOUSE 2 @ 400	800 "
AVE DAILY FLOW	15,200 GPD (EST.

*	5 STORES - 3 @ 2 FIXT. x 100 GPD/FIX.	600 GPD
	- EAT IN DELI -	400 "
	- BARBER -	250 "
	SUB TOTAL	1,250 "
**	BANK - 2 BATHROOMS @ 400	800 GPD
	APPROX 3 STORES @ 2 FIXT. x 100	600 "
	DELI -	300 "
	OFFICES - 4 @ 25 GPD/C x 16C	400 "
	SUB. TOTAL	2,100
***	THEATER - 200 SEATS @ 5 GPD/SEAT	1,000 "
	REST - BAR - 40 " @ 35 " "	1,400 "
	2 STORES - @ 2 FIXT x 100 GPD/FIXT	200 "
	BARBER -	250 "
	DELI - EAT IN	400 "
	40 APARTMENTS - 20 @ 75 GPD	1,500 "
	20 @ 150 GPD	3,000 "
	SUB. TOTAL	7,750 "
****	TRUCK WASHING HOSE BIBS - 2 @ 100	200 "
	2 BATHROOMS @ 400	800
	SUB. TOTAL	1,000

(HIGHER IF MEETING OR DINNER)

TOTAL AVE. DAILY FLOW - 15,200 GPD

MAX. DAY - 15,200 x 2.5 = 38,000 GPD

MAX. HR. - 15,200 x 4 = 60,800 GPD = 42.

10 STATE ST'DS - 10 x 15,200 = 152,200 GPD = 105.

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet № 9 of ______
By RTB Date 7-13-8
Chkd. by ______ Date ______

Project: BEDFORD VILLAGE R.I. & F.S. Job № ______
Subject: 842-08B DEV. OF ALT - SHOPPING ARCADE

II B) EXPAND THE EXISTING BEDFORD FARMS COMMUNITY WATER SUPPLY SYSTEM (ALT. NO. 1)

① WATER QUANTITY REQUIREMENTS (WITH H.R. MALL)
(SEE SHEET 3)

	MAX HR RATE	10 STATE ST'DS
FARMS W.C. AND HUNTING RIDGE MALL	116.6 gpm	240.4 gp
ADD SHOPPING ARCADE (SEE SHEET 3)	42.2 gpm	105.7 gp
	158.8 gpm	346.1 gp

AT VERY LEAST ONE, OR PREFERABLE TWO, ADDITIONAL WELLS WOULD HAVE TO BE ADDED TO SYSTEM, TO INCREASE CAPACITY BY 100 TO 200 gpm.

② ADVANTAGES -
ⓐ COMMUNITY WATER SYSTEM - LIMITED IMMED. USE
ⓑ EXISTING SYSTEM

③ DISADVANTAGES -
ⓐ INCREASED PUMPING AT THIS SITE COULD CAUSE INCREASE IN V.O.C. THUS REQUIRING TREATMENT
ⓑ ADDITIONAL WELLS AT THIS SITE WILL INCREASE DRAWDOWN LOWERING PUMPING LEVELS.
ⓒ EXISTING SYSTEM WOULD HAVE TO BE INTEGRATED WITH NEW DISTRIBUTION SYSTEM.
ⓓ YIELD AT EXISTING W.C. SITE LIMITED BY GROUNDWATER RESOURCES (I.E. RECHARGE OF AQUIFER).
ⓔ NITRATE LEVEL AT APPROX. 1.4 mg/L NOW - SLIGHTLY ELEVATED. INCREASED SITE PUMPING COULD INCREASE N.

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 10 of ____
By R.T.B Date 7-13-8_
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE R.I. & F.S. Job No ____
Subject: 842-08B DEV. OF ALT - SHOPPING ARCADE

II C) EXPAND THE PONDS DEVELOPMENT WATER SUPPLY SYSTEM (ALT. NO. 2)

① SAME ADVANTAGES AS ON SHEET 4, D) ②

② " DIS " " " " 4 & 5, D) ③
AND PROHIBATIVE, DUE TO LACK OF SUPPLY AT CENTRAL "PONDS" SITE AND INCREASED PRESSURE REQUIREMENTS AND CONTROL.

D) DEVELOP A NEW COMMUNITY WATER SUPPLY SYSTEM (ALT. NO.

① SAME AS SHEET 6, E) ①, ②, ③, ④

E) DEVELOP A POINT-OF-USE TREATMENT DISTRICT [FILTER DISTRICT] (ALT. NO. 4)

① SAME AS SHEET 7, F) ①, ②, ③

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 11 of ____
By RTB Date 7-25-?
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE - R.I. & F.S. Job No 842
Subject: 842-08A & 08B DEV. OF ALT. HRM & SA

III COST ANALYSIS

A) HUNTING RIDGE MALL

ALT. NO 1 - EXPAND EXISTING BEDFORD FARMS COMMUNITY WATER SUPPLY SYSTEM (ADD 100± GPM WELL CAPACITY)

CONSTRUCTION COSTS

a) WELL CONSTRUCTION WITH PUMPS — ONE ROTARY 100'	$35,000.00
b) SITE PIPING, METERING, CHLORINATION —	8,000.00
c) TREATMENT OF V.O.C. (PROBABLE) —	80,000.00
d) ELECTRIC (NEW SERVICE, ETC.) —	10,000.00
e) DISTRIBUTION PIPING - 2,800 @ 30.00/FT (6"-4"-2")	84,000.00
f) SMALL CONTROL BUILDING & SITE WORK	12,000.00
g) SERVICE CONN. - APPROX. 25 @ $500	12,500.00
	$241,500.00

GENERATOR - ?
DIST. PIPE CHANGES ON EXIST. ?
} NEED INFO FROM RW

ALT. NO. 2 - EXPAND THE PLANNED PONDS COMMUNITY WATER SUPPLY SYSTEM. (ADD 3-40 GPM WELLS)

CONSTRUCTION COSTS (ADDITIONAL)

a) WELL CONSTRUCTION WITH PUMPS - 3 ROTARY 400'	$90,000.00
b) SITE PIPING, METERING, CHLORINATION	10,000.00
c) TREATMENT OF V.O.C. (FOR ADDED 120 GPM)	30,000.00
d) ELECTRIC (ADDITIONAL) (6"-4"-2")	6,000.00
e) DISTRIBUTION PIPING - 2,000' @ 30.00/FT	60,000.00
f) SERVICE CONN - APPROX 25 @ $500	12,500.00
	$214,500.00
g) MONITORING WELL PROGRAM - (4) (NECESSITATED BY ADDITIONAL CONCENTRATED PUMPING)	20,000.00
	234,500.00

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 12 of ____
By RTB Date 7-25-9
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE R.I. & F.S. **Job No** 84

Subject: 842-08A & 08B DEV. OF ALT. HRM & S.A.

III — COST ANALYSIS

A) HUNTING RIDGE MALL

ALT. No. 3 - DEVELOP A NEW COMMUNITY WATER SUPPLY SYSTEM (NO V.O.C. TREATMENT REQ'D)

TEST WELL	$10,000.00
a) WELL CONSTRUCTION WITH PUMPS 2 ROTARY - 150	75,000.00
b) SITE PIPING, METERING, CHLORINATION.	25,000.00
c) STORAGE TANKS (2 - 2000 GALLON HYDRO'S)	8,000.00
d) ELECT. WITH GEN. SET	20,000.00
e) SITE WORK	3,000.00
f) CONTROL BLD'G (SMALL)	20,000.00
g) DIST. PIPING 4100' @ 30$/FT	123,000.00
h) SERVICE CONN. 25 @ $500	12,500.00
	$296,500.00

ALT. No. 4 DEVELOP POINT-OF-USE TREATMENT DISTRICT (FILTER DISTRICT)

a) FURNISH AND INSTALL UNITS -	
21 HOME UNITS @ $1,675.00	$35,175.00
+ 10 SMALL STORES @ 1,675.00	16,750.00
+ 3 LARGE UNITS @ 6,300	18,900.00
b) PIPING CHANGES TO SEPERATE DRINKING & POT. WATER 34 @ $250.00	8,500.00
c) FIRST YEAR'S OPERATING COSTS	
LABOR - (PART TIME -)	10,000.00
TRANSP. -	2,000.00
LAB. TESTING - 34 UNITS x 2 TESTS x $300/SAMPLE (2 POINTS EACH)	19,800.00
CARBON REPLACEMENT - 31 @ 200.00	6,200.00
& DISPOSAL - 3 @ 600.00	1,800.00
	140,125.00

COST DATA DEVELOPED FROM DESIGN ENGINEER'S INC. AND CALGON CARBON CORP. INFORMATION

ALT. No 5 - NO - ACTION ALTERNATIVE

NO COST INVOLVE TO MUNICIPALITY

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 13 of ____
By RTB Date 8-1-89
Chkd. by ____ Date ____
Project: BEDFORD VILLAGE R.I. & F.S. Job No 842
Subject: 842-08A & 08B

III COST ANALYSIS

B) SHOPPING ARCADE

ALT. NO 1 - EXPAND THE EXISTING BEDFORD FARMS COMMUNITY WATER SUPPLY SYSTEM (ADD 100± GPM WELL CAPACITY)

CONSTRUCTION COSTS — $291,500.00
(SEE PAGE 11 - DIST. PIPING TO BE APPROX. 3,600' - ADD 800' @ 30.00/FT — 24,000.00
$265,500.00

ALT. NO 2 - EXPAND THE PONDS DEVELOPMENT WATER SUPPLY SYSTEM

CONST. COSTS — 214,500.00
(SEE PAGE 11 - DIST. PIPING TO BE APPROX. 5,500' - ADD 3,500' @ $30/FT) — 105,000.00
$319,500.00

ALT. NO 3 - DEVELOP A NEW COMMUNITY WATER SUPPLY SYSTEM

CONST. COSTS — $296,500.00
(SEE PAGE 12 - DIST. PIPING TO BE APPROX 5,300' - ADD 900' @ 30.00/FT — 27,000.00
$323,500.00

ALT. NO. 4 - DEVELOP A POINT-OF-USE TREATMENT DISTRICT (FILTER DISTRICT)

a) FURNISH & INSTALL UNITS
10 SMALL UNITS @ $1,675.00 — 16,750.00
8 LARGE UNITS @ $6,300.00 — 50,400.00
b) PIPING CHANGES - 18 @ 250. — 4,500.00
c) FIRST YEARS OPERATING COST:
LABOR (PART TIME) } ADMINISTRATION — 10,000.00
TRANSP. — 2,000.00
LAB TESTING - 18 UNITS x 2 POINTS x $300.00 — 21,600.00
CARBON REPLACEMENT & DISPOSAL 10 @ 200 — 2,000.00
8 @ $600 — 4,800.00

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 14 of ___ REVISED 8-31-8_
By RTB Date 8-1-89
Chkd. by ___ Date ___
Project: Bedford Village R.I. & F.S. Job No 842
Subject: 842-08A & 08B

III COST ANALYSIS

B) SHOPPING ARCADE
ALT NO. 4 (CONT.)

$112,050.00

COST DATA DEVELOPED FROM DESIGN ENG'S INC., AND CALGON CARBON CORP. INFORMATION

ALT. NO. 5 - NO-ACTION ALTERNATIVE

NO COST

C) COMBINED COST (HRM WITH SA)

ALT. NO. 1 - HRM - 241,500.00
+ S.A - ADD 1-WELL 35,000.00
" DIST. PIPING - 24,000.00
" STRIPPING TOWER 40,000.00
$340,500.00

ALT. NO. 2 - HRM 239,500.00
+ SA - ADD 3-40GPM WELLS - 90,000.00
" DIST. PIPING - 105,000.00
" STRIPPING TOWER - 30,000.00
$459,500.00

ALT. NO 3 - HRM $296,500.00
+ SA - ADD 1 WELL 37,500.00
ADD - DIST. PIPING (3000') 90,000.00
$424,000.00

ALT. NO 4
HRM 140,125.00
SA (NO ADM. GST.) 100,050.00
$240,175.00

ALT. NO. 5
NO COST

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No. 14 of ______
By RTB Date 8-1-8_
Chkd. by ______ Date ______

Project: Bedford Village R.I. & F.S. Job No. 84_
Subject: 8-42-08A & 08B

III COST ANALYSIS

B) STRIPPING ARCHUE
ALT NO. 4 (CONT.)

$112,050.00

COST DATA DEVELOPED FROM DESIGN ENG'S INC., AND CALGON CARBON CORP. INFORMATION

ALT. NO. 5 - NO-ACTION ALTERNATIVE

NO COST

C) COMBINED COST (HRM WITH SA)

ALT. NO. 1	- HRM -	241,500.00
	+ S.A - ADD 1-WELL	35,000.00
	" DIST. PIPING	24,000.00
	" STRIPPING TOWER	40,000.00
		$340,500.00
ALT. NO. 2	- HRM	234,500.00
	+ SA - ADD 3-40GPM WELLS -	90,000.00
	" DIST. PIPING -	105,000.00
	" STRIPPING TOWER -	30,000.00
		$459,500.00
ALT. NO 3 -	HRM	$296,500.00
	+ SA - ADD 1 WELL	37,500.00
	DIST. PIPING	27,000.00
		$361,000.00
ALT. NO 4	HRM	140,125.00
	SA (NO ALUM. CLR.)	100,050.00
		$240,175.00

ALT. NO. 5 NO COST

Dvirka and Bartilucci CONSULTING ENGINEERS

Sheet Nº 15 of ____
By RTB Date 8+8
Chkd. by ____ Date ____

Project: BEDFORD VILL. - R.I. & F.S. Job Nº 842
Subject: 842-9A & 10A SCREENING & EVAL. OF ALT. - HRM

IV SCREENING & EVALUATION OF ALTERNATIVES - HRM

1) EXPAND EXISTING BEDFORD FARMS COMMUNITY WATER SUPPLY SYSTEM -

FROM THE INFORMATION AVAILABLE IT APPEARS THAT EXPANSION OF THIS SYSTEM WILL REQUIRE DRILLING AT LEAST ONE NEW SUPPLY WELL OF APPROXIMATELY 100 GPM. THE SITE OF THE EXISTING WELL FIELD IS RELATIVELY SMALL (200'x200') AND TO DRILL ANOTHER MAJOR HIGH CAPACITY WELL AT THIS SITE WOULD BE OVERTAXING THE IMMEDIATE SAFE YIELD AND RECHARGE AND PROBABLY CAUSE AN INCREASE IN THE V.O.C. & N LEVELS, AND NECESSITATE TREATMENT. IT WOULD BE PREFERABLE THAT A NEW WELL SITE BE CHOSEN, AND THIS MAY NOT BE FEASIBLE, OR DESIREABLE, BY THE OWNER. THE DISADVANTAGES, ALONG WITH IT'S COST ($241,500.00) FAR OUTWEIGH THE ADVANTAGES, AND THIS ALTERNATIVE IS HIGHLY SUSPECT. (SEE SHEET 9).

2) EXPAND THE PLANNED PONDS COMMUNITY WATER SUPPLY SYSTEM

BASED UPON CHAS. H. SELLS, INC D.E.I.S. IT IS HIGHLY QUESTIONABLE IF A WATER SUPPLY OF SUFFICIENT QUANTITY AND ACCEPTABLE QUALITY CAN BE OBTAINED. TEST WELL DATA AND SUBSEQUENT ENGINEERS REPORT STATES THAT "PROPERLY CONSTRUCTED GRAVEL PACKED WELLS AT THESE LOCATIONS WOULD PRODUCE A MINIMUM OF FORTY GALLONS PER MINUTE, EACH" PROPERLY CONSTRUCTED "REVERSE-ROTARY" LARGE GRAVEL ENVELOPE WELLS SHOULD PRODUCE HIGHER YIELDS IN THIS FINE FORMATION BUT IT WILL ACCELERATE THE V.O.C. PLUME IN ITS DIRECTION THUS CAUSING IMMEDIATE NEED FOR TREATMENT. THE EXISTING TEST WELL AT THE PROPOSED PRODUCTION SITE SHOWS A PCE (MINIMUM DETECT.) LEVEL OF 4 ppb (VS ALLOWABLE OF 5 ppb N.Y. STATE "GUIDELINE") AND HIGH LEVELS OF IRON (31 PPM), Mn (0.5 ppm), COLOR (30 UNITS) AND TURBIDITY (25 UNITS). PROPOSED COMMUNITY SEWAGE DISPOSAL LEACHING FIELDS ARE IMMEDIATELY UPSTREAM OF THE PROPOSED WELL SITE AND THIS WOULD ADD

TO V.O.C. POLLUTION WITH NITRATES. COST FOR SUPPLYING WATER TO THE HUNTING RIDGE MALL AREA WOULD BE A MINIMUM OF $234,500 WITH NITROGEN REMOVAL, DUE TO SELF POLLUTION, AN ADDITIONAL COST.

TIME FRAME FOR ABILITY TO SUPPLY WATER WOULD BE RELATIVELY LONG AND IN FACT COULD BE A REAL PROBLEM IF WELL FIELD SITE PRODUCTION IS LIMITED AS SUSPECTED BY SELLS D.E.I.S. REPORT.

IN GENERAL THIS IS A POOR ALTERNATIVE DUE TO COST AND QUANTITY - QUALITY LIMITATIONS OF SITE. THE DEVELOPER MIGHT BE MORE CONCERNED WITH SUPPLYING WATER TO SATISFY SELLING THE "PONDS HOUSING" THAN SUPPLY THE HUNTING RIDGE MALL CONTAMINATED AREA.

3) DEVELOP A NEW COMMUNITY WATER SUPPLY SYSTEM -

PRELIMINARY INDICATIONS LEND ITSELF TO SELECTION OF A WELL FIELD SITE IN THE VACINITY OF THE TOWN OWNED "MEMORIAL FIELD" AREA. SAMPLE LOCATION A37 INDICATES GOOD GROUND WATER QUALITY FROM THE EXISTING WELL. GOOD WATER BEARING FORMATIONS TO A DEPTH OF APPROXIMATELY 150 FT. BELOW THE SURFACE PROBABLE EXIST, AS INDICATED FROM THE MONITORING WELL INFORMATION AVAILABLE. IT IS HIGHLY RECOMMENDED TO DRILL A TEST WELL FIRST AND DETERMINE YIELD AND WATER QUALITY INFORMATION. SUGGESTED LOCATION OF THIS SITE TO BE BETWEEN THE TENNIS COURTS AND SOCCER FIELD AT AN ELEVATION OF APPROX 362 TO 363 (100 YEAR FLOOD ELEV. 360). THE TEST WELL SHOULD BE MINIMUM 6" DIA., CABLE TOOL CONSTRUCTION & SPLIT SPOON SAMPLES EVERY 10 FEET, CHANGES OF FORMATION AND EV. 5 FEET IN THE BOTTOM 25 FEET. WITH FAVORABLE RESULTS THIS TEST WELL WOULD BE UTILIZED AS A WATER SUPPLY FOR FUTURE ROTARY SUPPLY WELL DRILLING OPERATIONS, AS WELL AS AN IMMEDIATE SOURCE OF WATER IN LIMITED QUANTITIES. INITIAL COST FOR COMPL. CONSTRUCTION WOULD BE HIGH (UP TO $296,500.00) BUT FOR A REASONABLE SMALL ADDITIONAL CAPITAL EXPENDITURE ($37,5..) THE SHOPPING ARCADE SERVICE AREA COULD BE SERVED AS WELL AS OTHERS INTIGRATED INTO THE SYSTEM.

TO V.O.C. POLLUTION WITH NITRATES. COST FOR SUPPLYING WATER TO THE HUNTING RIDGE MALL AREA WOULD BE A MINIMUM OF $234,500 WITH NITROGEN REMOVAL, DUE TO SELF POLLUTION, AN ADDITIONAL COST.

TIME FRAME FOR ABILITY TO SUPPLY WATER WOULD BE RELATIVELY LONG AND IN FACT COULD BE A REAL PROBLEM IF WELL FIELD SITE PRODUCTION IS LIMITED AS SUSPECTED BY SELLS D.E.I.S. REPORT.

IN GENERAL THIS IS A POOR ALTERNATIVE DUE TO COST AND QUANTITY - QUALITY LIMITATIONS OF SITE. THE DEVELOPER MIGHT BE MORE CONCERNED WITH SUPPLYING WATER TO SATISFY SELLING THE "PONDS HOUSING" THAN SUPPLY THE HUNTING RIDGE MALL CONTAMINATED AREA.

3) <u>DEVELOP A NEW COMMUNITY WATER SUPPLY SYSTEM</u> -

PRELIMINARY INDICATIONS LEND ITSELF TO SELECTION OF A WELL FIELD SITE IN THE VICINITY OF THE TOWN OWNED "MEMORIAL FIELD" AREA. SAMPLE LOCATION A37 INDICATES GOOD GROUND WATER QUALITY FROM THE EXISTING WELL. GOOD WATER BEARING FORMATIONS TO A DEPTH OF APPROXIMATELY 150 FT. BELOW THE SURFACE PROBABLE EXIST, AS INDICATED FROM THE MONITORING WELL INFORMATION AVAILABLE. IT IS HIGHLY RECOMMENDED TO DRILL A TEST WELL FIRST AND DETERMINE YIELD AND WATER QUALITY INFORMATION. A SUGGESTED LOCATION OF THIS SITE TO BE BETWEEN THE TENNIS COURTS AND SOCCER FIELD AT AN ELEVATION OF APPROX 362 TO 363 (100 YEAR FLOOD ELEV. 360). THE TEST WELL SHOULD BE MINIMUM 6" DIA., CABLE TOOL CONSTRUCTION & SPLIT SPOON SAMPLES EVERY 10 FEET, CHANGES OF FORMATION AND E.I 5 FEET IN THE BOTTOM 25 FEET. WITH FAVORABLE RESULTS THIS TEST WELL WOULD BE UTILIZED AS A WATER SUPPLY FOR FUTURE ROTARY SUPPLY WELL DRILLING OPERATIONS, AS WELL AS AN IMMEDIATE SOURCE OF WATER IN LIMITED QUANTITIES. INITIAL COST FOR COMP CONSTRUCTION WOULD BE HIGH (UP TO $296,500.00) BUT FOR A SMALL ADDITIONAL CAPITAL EXPENDITURE THE SHOPPING ARCADE SERVICE AREA COULD BE SERVED AS WELL AS OTHERS INTEGRATED INTO THIS SYSTEM.

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 17 of ____
By RTB Date 8-3-89
Chkd. by ____ Date ____

Project: Bedford-Village - R.I. & F.S. Job No 842
Subject: 842-9A-10A Screening & Eval. of Alt - HRM

Economics Would Dictate That As Many Consumers As Possible Be Served From This Supply Facility.

4) <u>Develop A Point-of-Use Treatment District (Filter District)</u>

Initial Low Installation Costs Would Indicate That This Approach Be Implemented. (Total Cost For Installation of $79,325.00). However, Yearly Operating Costs Estimated At Some $60,800.00 Are A Prohibiting Factor, As Well As The Accessability of G.A.C. Units For Bi-Yearly Sampling (minimum) And Carbon Rebeding. This Methodology To Solve The Problem Is At Best A Short-Term Solution, Cumbersome And Not In The Public's Best Interest. From An Economical Point of View, At The End of 10 Years, Some $60,800.00/Year or $608,000.00 Total Will Be Spent (Not Including An Inflation Factor) For Maintenance With Very Little Fixed Assest Value.

5) <u>No-Action Alternative</u> -

By Definition This Would Generate "No Cost" To The General Public or Municipality, But Rather Leave It To The Individual Owners To Provide The Type And Degree of Treatment, If Any. If Full Full Point-of-Use Treatment Is Obtained Then Overall Costs Would Be Similar To 4) With Possible Slight Savings From Operating Costs In That Administration Could Be Done By Individual Users. Health Implications on Individuals Ingesting Water Within The Present Contaminated Area Is And Will Be Large If Treatment Is Not Implemented And Tediously Maintained.

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet No 18 of ____
By RTB Date 8-3-8_
Chkd. by ____ Date ____

Project: Bedford Village - R.I. & F.S. Job No 84_
Subject: 842-9B & 10B Screening & Eval. of Alt - S.A.

V Screening & Evaluation of Alternatives - S.A.

1) Same As Sheet 15 But Cost Is $265,500.

2) Same As Sheets 15 & 16 But Cost Is $319,500.

3) Same As Sheets 16 & 17 But Cost Is $323,500.

4) Same As Sheet 17 But Cost Is $71,650 for Installation And $40,400 For Yearly Operating Cost or Total of $112,050.00

5) Same Sheet 17

Dvirka and Bartilucci
CONSULTING ENGINEERS

Sheet № 19 of ____
By RTB Date 5-3-8
Chkd. by ____ Date ____

Project: BEDFORD VILLAGE R.I. & F.S Job № 84
Subject: 842-10A & 10B EVALUATION OF ALT. HRM & SA

CONCLUSIONS

THE PURPOSE OF THE EVALUATION PROCESS IS TO DETERMINE THE SAFEST, MOST RELIABLE (QUANTITY & QUALITY) AND ECONOMICAL SOURCE OF WATER SUPPLY FOR THE CONTAMINATED AREAS.

WITH THIS IN MIND IT IS RECOMMENDED TO DEVELOP A NEW COMMUNITY WATER SUPPLY SYSTEM, OWNED BY THE LOCAL MUNICIPALITY.

ECONOMICS WOULD DICTATE THAT BOTH THE HUNTING RIDGE MALL AND THE SHOPPING ARCADE AREAS BE SERVED FROM A SINGLE SOURCE WELL PRODUCTION SITE LOCATED BETWEEN THE TENNIS COURTS AND SOCCER FIELD AT MEMORIAL FIELD, (POSSIBLY) OWNED BY THE TOWN OF BEDFORD. NEW SERVICES, OUTSIDE THE CONTAMINATED AREAS, COULD BE ADDED AS WELL AS POSSIBLY INTEGRATING THE BEDFORD FARMS WATER CO. INTO THE SYSTEM. THE INCLUSION OF THE PROPOSED "POND'S HOUSING" WATER SUPPLY SHOULD BE FURTHER STUDIED AS IT SEEMS THAT ITS STATUS AT PRESENT IS EXTREMELY DELICATE AND SUBJECT TO ORGANIC AND INORGANIC QUALITY PROBLEMS.

THE SELECTION OF THE SITE FOR THE RECOMMENDED COMMUNITY WATER SUPPLY SYSTEM AT MEMORIAL FIELD IS BASED UPON THE BELIEF THAT A COARSE AND FINE SAND AQUIFIER EXISTS TO A DEPTH OF APPROXIMATELY ONE HUNDRED FIFTY FEET (150') OR MORE BELOW GRADE. ANALYSIS ON WATER FROM A SMALL WELL AT THE SITE INDICATES NO EVIDENCE OF POLLUTION, BUT A TEST WELL IS RECOMMENDED TO ASCERTAIN COMPLETE INFORMATION FOR DETERMINING THE EXPECTED QUANITY AND QUALITY DATA. THIS DATA WOULD BE UTILIZED TO DESIGN THE PROPOSED GRAVEL PACKED WELLS, WITH EXPECTED YIELDS OF 100 GPM.

FIRE PROTECTION REQUIREMENTS

INSURANCE SERVICES OFFICE
GERRY FASTER
201-267-0359

RESIDENTIAL - 6" MAINS
RECOMMENDED 1,000 GPM @ 20 psi (LOWEST FIRE INSURANCE RATE)
+ 2HR STORAGE

MINIMUM 250 GPM @ 20psi (HIGEST FIRE INSURANCE RATE)
+ 2 HR STORAGE (PRACTICALLY AS NONE)

HYDRANT SPACING - 400' (TO COVER 160,000 FT^2) FOR RESIDENTIAL

- 300' (TO COVER 120,000 FT^2) FOR COMMERCIAL

FOR COMMERCIAL - RECOMMEND 2,000 GPM TO 2,500 GPM - 8" MAINS

INSTALL DRY HYDRANTS - ? FARMS HAS HYDRANTS BUT DON'T DARE USE.

MR. SLACK - BEDFORD PLANNING - NO IDEA - MOST AREAS USE A POND OR NOTHING

RICK MEGNA - BLD'G
914 666-8040
666 3911

LARRY JOHANAS
WATER

NOW USE SWIMMING POOL OR POND -
120,000 GAL STORAGE
1000 GPM FOR 2 HRS

BUT WOULD TAKE 250 GPM + STORAGE

FIRE PROTECTION - (IF CAN GET ADDITIONAL CAPACITY)

ADDED COST - (MIN.)
250 GPM WITH 30,000 GAL STORAGE

2	ADD. WELLS & PUMPS	—	75,000
1	30,000 GALLON STORAGE 250 GPM x 120 MIN (2 HRS)	—	50,000
2	BOOSTER PUMPS	— 2 @ 4,000	8,000
L.S.	ADDED GEN. CAPACITY	—	5,000
L.S.	PIPING	— L.S.	10,000
10	HYDRANTS — SA & MRM	— 10 @ 2,000	20,000
L.S.	ADD. ELECTRIC		5,000
			$173,000

PREFERED (BEDFORD WATER DEPT.)
250 GPM OR 1,000 GPM
WITH 120,000 GALLON STORAGE

2	ADD. WELLS & PUMPS		75,000
1 -	120,000 GALLON STORAGE 1000 GPM x 120 MINS (2 HRS)		100,000
2 -	BOOSTER PUMPS	2 @ 15,000	30,000
L.S.	ADDED GEN. CAPACITY		20,000
L.S.	PIPING		20,000
10	HYDRANTS		20,000
L.S.	ADDED ELECTRIC		15,000
			$280,000

Appendix B

APPENDIX B

WORK SHEETS – TECHNICAL CALCULAITONS

AND PROJECTED COSTS FOR GROUND WATER

EXTRACTION, TREATMENT AND DISPOSAL ALTERNATIVES

1952E

TABLE A-1. SHOPPING ARCADE
COST ESTIMATE FOR INFILTRATION GALLERIES

	Quantity	Unit Price	Total Price
6 Year Alternative			
Backhoe	3 days	500/day	1,500
Washed Surge Stone (4" - 6") Gravel	500 tons	15/ton	7,500
Truck (10 cu. yd.)	3 days	300/day	900
Soil Disposal	500 tons	50/ton	25,000
Piping (6"/PVC)	3,500 lin. ft.	7.86/lin. foot	27,500
Total			62,400
O&M (7% Capital)		Annual	4,368
3 Year Alternative			
Backhoe	3 days	500/day	2,500
Washed Surge Stone (4" - 6") Gravel	1,000 days	15/ton	15,000
Truck (10 cu. yd.)	5 days	300/day	1,500
Soil Disposal	1,000 days	50/ton	50,000
Piping (6"/PVC)	5,250 lin. ft.	7.86/lin. foot	41,250
Total			110,250
O&M (7% Capital)		Annual	7,718

TABLE A-2. SHOPPING ARCADE
COST ESTIMATE FOR PIPING - 8 EXTRACTION WELLS

	Quantity	Unit Price	Total Price
Piping (6"/PVC)	3,500 feet	7/foot	24,500
Backhoe	6 days	500/day	3,000
Total			27,500

For 16 extraction wells, multiply by 1.5 ($41,250).

TABLE A-3. SHOPPING ARACADE
COST ESTIMATE FOR 16 EXTRACTION WELLS*

	Quantity	Unit Price	Total Price
Capital Costs			
Mob/Demob	1	10,000	10,000
Decon	64 hours	100/hour	6,400
Drilling	2,300 feet	75/feet	172,500
Casing	800 feet	24/foot	19,200
Pumps (3 hp)	16	3,000/each	48,000
Instrumentation	16	425/each	6,800
Steel Riser (10")	2,300 feet	10/foot	23,000
Well House (10'x15')	16	4,000/each	64,000
Electrical (hook-up)	1	20,000	20,000
Total			369,900
O&M			
Maintenance (7% Capital)		Annual	25,900
Electricity (7% Capital)			69,000
Total Annual Cost			94,900

* Wells six inch diameter. Six wells pumping 5 gpm at average depth of 50 feet. Ten wells pumping 10 gpm at average depth of 200 feet.

TABLE A-4. SHOPPING ARCADE
COST ESTIMATE FOR 16 RECHARGE WELLS*

	Quantity	Unit Price	Total Price
Capital Costs			
Mob/Demob**	--	--	--
Decon	64 hours	100/hour	6,400
Drilling	2,400 feet	75/foot	180,000
Casing (4")	800 feet	24/foot	19,200
Pumps (3 hp)	--	--	--
Instrumentation	--	--	--
Steel Riser (10")	--	--	--
Well House (10'x15')	16	4,000/each	64,000
Electrical (hook-up)	--	--	--
Piping (6"/PVC)	525 lin. ft.	7.86/lin. foot	41,250
Total			310,850
O&M			
Maintenance (7% Capital)		Annual	21,760

* Wells 150 feet in depth; gravity injection.
** Assumes drilled same time as extraction wells.

TABLE A-5. SHOPPING ARACADE
COST ESTIMATE FOR 8 EXTRACTION WELLS*

	Quantity	Unit Price	Total Price
Capital Costs			
Mob/Demob	1	10,000	10,000
Decon	32 hours	100/hour	3,200
Drilling	1,150 feet	75/feet	86,250
Casing (4")	400 feet	24/foot	9,600
Pumps (3hp)	8	3,000/each	24,000
Instrumentation	8	425/each	3,400
Steel Riser (10")	1,150 feet	10/foot	11,500
Well House (10'x15')	8	4,000/each	32,000
Electrical (hook-up)	1	10,000	10,000
Total			189,950
O&M			
Maintenance (7% Capital)		Annual	13,300
Electricity (7% Capital)			34,500
Total Annual Cost			47,800

* Wells six inch diameter. Ten wells pumping 5 gpm at average depth of 50 feet. Five wells pumping 10 gpm at average depth of 200 feet.

TABLE A-6. SHOPPING ARCADE
COST ESTIMATE FOR 8 RECHARGE WELLS*

	Quantity	Unit Price	Total Price
Capital Costs			
Mob/Demob**	--	--	--
Decon	32 hours	100/hour	3,200
Drilling	1,200 feet	75/foot	90,000
Casing (4")	400 feet	24/foot	9,600
Pumps (3 hp)	--	--	--
Instrumentation	--	--	--
Steel Riser (10")	--	--	--
Well House (10'x15')	8	4,000/each	32,000
Electrical (hook-up)	--	--	--
Piping (6"/PVC)	3,500 lin. ft.	7.86/lin. foot	27,500
Total			162,300
O&M			
Maintenance (7% Capital)		Annual	11,361

* Wells 150 feet in depth; gravity injection.
** Assumes drilled same time as extraction wells.

TABLE A-7. CARBON USAGE RATE CALCULATIONS FOR REMOVAL OF VOCS AND AROMATICS FROM GROUNDWATER (3 YR. EXTRACTION)

Compound	Co (ug/l)	X/M (mg/gm)	Gc (lbs/MG)	Calculated Carbon Reqd. (lb/year)
Benzene	440	2.479237	1481.019	124,548
Xylene	39	45.89033	7.092016	596
Toluene	35	5.970771	48.91746	4,114
Tetrachloroethylene	710	41.93420	141.2915	11,882
Trichloroethylene	47	4.205897	93.25357	7,842
trans 1,2-Dichloroethylene	64	0.750674	711.4668	59,832
			Total:	208,814

Co = initial concentration; mg of constituent per liter of water

(X/M) @ Co = carbon capacity @ initial concentration; mg of constituent per gram of carbon

Gc = carbon requirement; pounds of carbon per million gallons of water

Water Flow Rates:

gallons per minute	160
gallons per day	230,400
gallons per year	84,096,000

Dobbs, R.A. and J.M. Cohen, Carbon Adsorption Isotherms for Toxic Organics, EPA-600/8-80-023, USEPA Municipal Environmental Research Laboratory, Cincinnati, OH 45268, April 1980.

Calgon Inc., Carbon Adsorption Isotherms, Prepared by Manufacturer.

TABLE A-8. CARBON USAGE RATE CALCULATIONS FOR REMOVAL OF VOCS AND AROMATICS FROM GROUNDWATER (6 YR. EXTRACTION)

Compound	Co (ug/l)	X/M (mg/gm)	Gc (lbs/MG)	Calculated Carbon Reqd. (lb/year)
Benzene	440	2.479237	1481.019	62,274
Xylene	39	45.89033	7.092016	298
Toluene	35	5.970771	48.91746	2,057
Tetrachloroethylene	710	41.93420	141.2915	5,941
Trichloroethylene	47	4.205897	93.25357	3,921
trans 1,2-Dichloroethylene	64	0.750674	711.4668	29,916
			Total:	104,407

Co = initial concentration; mg of constituent per liter of water

(X/M) @ Co = carbon capacity @ initial concentration; mg of constituent per gram of carbon

Gc = carbon requirement; pounds of carbon per million gallons of water

Water Flow Rates:	
gallons per minute	80
gallons per day	115,200
gallons per year	42,048,000

Dobbs, R.A. and J.M. Cohen, Carbon Adsorption Isotherms for Toxic Organics, EPA-600/8-80-023, USEPA Municipal Environmental Research Laboratory, Cincinnati, OH 45268, April 1980.

Calgon Inc., Carbon Adsorption Isotherms, Prepared by Manufacturer.

TABLE A-9. AIR STRIPPING DESIGN - INITIAL INPUT (3 YR. EXTRACTION)

Air Stripping Tower Design Calculations for Removal of Halogenated VOCs and Aromatics from Groundwater
Single air stripper with 3.5" Lantec Lanpac packing.
Calculation of packing height required to meet applicable standards

Ø stripping tower diameter (ft):	2.5
Packing type and size (diameter-in.):	Lanpac, 3.5"
Pressure Drop at liquid and gas loading rates (inches of w.c./ft of column):	0.5132

Water Flow Rate (gpm):	160	Air/Water Ratio (vol/vol):	100
Water Temperature (c)	11	Air Flow Rate (cfm):	2139
Water Viscosity (lb/hr-ft):	284	gas (air) loading rate (lb/hr-sf):	2027
Liquid (water) loading rate (gpm/sf):	32.6	Gas (air) Density (lb/cf):	0.0775
Liquid (water) loading rate (lb-hr/sf):	16291	Superficial Gas (air) velocity (ft/sec):	7.26

Contaminant	Cont. Feed Conc. (ppb)	Cont. Effl. Limit (ppb)	Removal Efficiency (%)	HTU (ft)	NTU (d'less)	Total Packing Height (ft)	Total Tower Pressure Drop (in. w.c.)	Air Release Rate at Calculated Removal Efficiency (lb/hr)	(lb/day)	Effluent Air Concentration (mg/cu m)	(ppm)	Mol. Wt. (g/mol)
Enter	Enter	Enter	Calc	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Enter
benzene	440	0.1	99.977%	3.210	8.87	28.5	14.60	0.0352	0.8457	4.40	1.38	78.11
xylene	39	5	87.179%	3.862	2.13	8.2	4.23	0.0027	0.0654	0.34	0.08	106.16
toluene	35	5	85.714%	3.546	2.01	7.1	3.66	0.0024	0.0577	0.30	0.08	92.13
tetrachloroethylene	710	0.7	99.901%	4.852	6.99	33.9	17.40	0.0568	1.3637	7.09	1.05	166
trichloroethylene	47	5	89.362%	4.559	2.28	10.4	5.34	0.0034	0.0807	0.42	0.08	131
1,2-dichloroethene	64	5	92.188%	4.217	2.66	11.2	5.76	0.0047	0.1134	0.59	0.15	97

Dobbs, R.A. and J.M. Cohen, Carbon Adsorption Isotherms for Toxic Organics, EPA-600/8-80-023, USEPA Municipal Environmental Research Laboratory, Cincinnati, OH 45268, April 1980.

Calgon Inc., Carbon Adsorption Isotherms, Prepared by Manufacturer.

TABLE A-10 AIR STRIPPING DESIGN - FINAL OUTPUT (3 YR. EXTRACTION)

Air Stripping Tower Design Calculations for Removal of Halogenated VOCs and Aromatics from Groundwater
Single air stripper with 3.5" Lantec Lanpac packing.
Calculation of packing height required to meet applicable standards

@ stripping tower diameter (ft):	2.5
Packing type and size (diameter-in.):	Lanpac, 3.5"
Pressure Drop at liquid and gas loading rates (inches of w.c./ft of column):	0.5132

Water Flow Rate (gpm):	160	Air/Water Ratio (vol/vol):	100
Water Temperature (c)	11	Air Flow Rate (cfm):	2139
Water Viscosity (lb/hr-ft):	284	gas (air) loading rate (lb/hr-sf):	2027
Liquid (water) loading rate (gpm/sf):	32.6	Gas (air) Density (lb/cf):	0.0775
Liquid (water) loading rate (lb-hr/sf):	16291	Superficial Gas (air) velocity (ft/sec):	7.26

Contaminant	Cont. Feed Conc. (ppb)	Cont. Effl. Limit (ppb)	Removal Efficiency (%)	HTU (ft)	NTU (d'less)	Total Packing Height (ft)	Total Tower Pressure Drop (in. w.c.)	Air Release Rate at Calculated Removal Efficiency (lb/hr)	(lb/day)	Effluent Air Concentration (mg/cu m)	(ppm)	Mol. Wt. (g/mol)
Enter	Enter	Enter	Calc	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Enter
benzene	440	0.0203	99.995%	3.210	10.56	33.9	17.40	0.0352	0.8459	4.40	1.38	78.11
xylene	39	0.0093	99.976%	3.862	8.78	33.9	17.40	0.0031	0.0750	0.39	0.09	106.16
toluene	35	0.0038	99.989%	3.546	9.56	33.9	17.40	0.0028	0.0673	0.35	0.09	92.13
tetrachloroethylene	710	0.7	99.901%	4.852	6.99	33.9	17.40	0.0568	1.3637	7.09	1.05	166
trichloroethylene	47	0.033	99.930%	4.559	7.44	33.9	17.40	0.0038	0.0903	0.47	0.09	131
1,2-dichloroethene	64	0.0313	99.951%	4.217	8.05	33.9	17.41	0.0051	0.1230	0.64	0.16	97

Dobbs, R.A. and J.M. Cohen, Carbon Adsorption Isotherms for Toxic Organics, EPA-600/8-80-023, USEPA Municipal Environmental Research Laboratory, Cincinnati, OH 45268, April 1980.

Calgon Inc., Carbon Adsorption Isotherms, Prepared by Manufacturer.

TABLE A-11. AIR STRIPPING DESIGN - INITIAL INPUT (6 YR. EXTRACTION)

Air Stripping Tower Design Calculations for Removal of Halogenated VOCs and Aromatics from Groundwater
Single air stripper with 3.5" Lantec Lanpac packing.
Calculation of packing height required to meet applicable standards

Ø stripping tower diameter (ft):	2.5
Packing type and size (diameter-in.):	Lanpac, 3.5"
Pressure Drop at liquid and gas loading rates (inches of w.c./ft of column):	0.0858

Water Flow Rate (gpm):	80	Air/Water Ratio (vol/vol):	100
Water Temperature (c)	11	Air Flow Rate (cfm):	1069
Water Viscosity (lb/hr-ft):	3.28	gas (air) loading rate (lb/hr-sf):	1014
Liquid (water) loading rate (gpm/sf):	16.3	Gas (air) Density (lb/cf):	0.0775
Liquid (water) loading rate (lb-hr/sf):	8147	Superficial Gas (air) velocity (ft/sec):	3.63

Contaminant	Cont. Feed Conc. (ppb)	Cont. Effl. Limit (ppb)	Removal Efficiency (%)	HTU (ft)	NTU (d'less)	Total Packing Height (ft)	Total Tower Pressure Drop (in. w.c.)	Air Release Rate at Calculated Removal Efficiency (lb/hr)	(lb/day)	Effluent Air Concentration (mg/cu m)	(ppm)	Mol. Wt. (g/mol)
Enter	Enter	Enter	Calc	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Enter
benzene	440	0.1	99.977%	2.554	8.87	22.6	1.94	0.0176	0.4229	4.40	1.38	78.11
xylene	39	5	87.179%	3.073	2.13	6.6	0.56	0.0014	0.0327	0.34	0.08	106.16
toluene	35	5	85.714%	2.821	2.01	5.7	0.49	0.0012	0.0288	0.30	0.08	92.13
tetrachloroethylene	710	0.7	99.901%	3.860	6.99	27.0	2.32	0.0284	0.6818	7.09	1.05	166
trichloroethylene	47	5	89.362%	3.627	2.28	8.3	0.71	0.0017	0.0404	0.42	0.08	131
1,2-dichloroethene	64	5	92.188%	3.355	2.66	8.9	0.77	0.0024	0.0567	0.59	0.15	97

Dobbs, R.A. and J.M. Cohen, Carbon Adsorption Isotherms for Toxic Organics, EPA-600/8-80-023, USEPA Municipal Environmental Research Laboratory, Cincinnati, OH 45268, April 1980.

Calgon Inc., Carbon Adsorption Isotherms, Prepared by Manufacturer.

TABLE A-12. AIR STRIPPING DESIGN - FINAL OUTPUT
(6 YR. EXTRACTION)

Air Stripping Tower Design Calculations for Removal of Halogenated VOCs and Aromatics from Groundwater
Single air stripper with 3.5" Lantec Lanpac packing.
Calculation of packing height required to meet applicable standards

Ø stripping tower diameter (ft): 2.5
Packing type and size (diameter-in.): Lanpac, 3.5"
Pressure Drop at liquid and gas loading rates (inches of w.c./ft of column): 0.0858

Water Flow Rate (gpm):	80	Air/Water Ratio (vol/vol):	100
Water Temperature (c)	11	Air Flow Rate (cfm):	1069
Water Viscosity (lb/hr-ft):	3.28	gas (air) loading rate (lb/hr-sf):	1014
Liquid (water) loading rate (gpm/sf):	16.3	Gas (air) Density (lb/cf):	0.0775
Liquid (water) loading rate (lb-hr/sf):	8147	Superficial Gas (air) velocity (ft/sec):	3.63

Contaminant	Cont. Feed Conc. (ppb)	Cont. Effl. Limit (ppb)	Removal Efficiency (%)	HTU (ft)	NTU (d'less)	Total Packing Height (ft)	Total Tower Pressure Drop (in. w.c.)	Air Release Rate at Calculated Removal Efficiency (lb/hr)	(lb/day)	Effluent Air Concentration (mg/cu m)	(ppm)	Mol. Wt. (g/mol)
Enter	Enter	Enter	Calc	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Enter
benzene	440	0.0203	99.995%	2.553	10.56	27.0	2.31	0.0176	0.4229	4.40	1.38	78.11
xylene	39	0.0093	99.976%	3.072	8.78	27.0	2.31	0.0016	0.0375	0.39	0.09	106.16
toluene	35	0.0038	99.989%	2.820	9.56	27.0	2.31	0.0014	0.0336	0.35	0.09	92.13
tetrachloroethylene	710	0.7	99.901%	3.860	6.99	27.0	2.31	0.0284	0.6818	7.10	1.05	166
trichloroethylene	47	0.033	99.930%	3.626	7.44	27.0	2.31	0.0019	0.0451	0.47	0.09	131
1,2-dichloroethene	64	0.0313	99.951%	3.354	8.05	27.0	2.32	0.0026	0.0615	0.64	0.16	97

Dobbs, R.A. and J.M. Cohen, Carbon Adsorption Isotherms for Toxic Organics, EPA-600/8-80-023, USEPA Municipal Environmental Research Laboratory, Cincinnati, OH 45268, April 1980.

Calgon Inc., Carbon Adsorption Isotherms, Prepared by Manufacturer.

APPENDIX C

CONCEPTUAL DESIGN OF
THE PLANNED PONDS DEVELOPMENT

1952E