BIG V SUPERMARKETS, INC.
Florida, New York

FEASIBILITY STUDY
Baldwin Place Mall
Somers, New York

June 1995

LMS
LAWLER, MATUSKY & SKELLY ENGINEERS
Environmental Science & Engineering Consultants
One Blue Hill Plaza • Pearl River, New York 10965

Lawler, Matusky & Skelly Engineers
Environmental Science & Engineering Consultants
One Blue Hill Plaza
Pearl River, New York 10965

LETTER OF TRANSMITTAL

Date 7/31/95	Job No. 100-233
Attention: Ms. O'Dell-Keller	
Re: Baldwin Place Mall	

TO:
NYSDEC Region III
21 South Putt Corners Rd.
New Paltz, NY 12561

AUG 1 1995

GENTLEMEN:

We are sending you X attached ___ under separate cover, via ___ the following items:

___ Shop drawings ___ Prints ___ Plans ___ Samples ___ Specifications ___ Copy of letter

___ Change order ___ Other ___

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If enclosures are not as noted, kindly notify us at once. Sara A. Handy
(Signed)

Copy to ___

Sara A. Handy
Project Engineer

3/30/88

360023

New York State Department of Environmental Conservation
21 South Putt Corners Road, New Paltz, NY 12561-1696
(914) 256-3154 FAX (914) 255-3414

December 26, 1995

Supervisor William Harding
Somers Town House
Routes 100 and 202
Somers, NY 10589

Dear Supervisor Harding:

Enclosed is a copy of the Record of Decision (ROD) for the Baldwin Place Shopping Center Inactive Hazardous Waste Site in Westchester County. The ROD represents the New York State Department of Environmental Conservation (DEC) approved remedial action chosen for the site. It documents the information and rationale used to arrive at the decision.

The ROD will be placed in the document repositories at the Somers Public Library and the DEC Region 3 office on, or about, December 29, 1995. At that time, DEC will issue a release to the news media, as well as a notice to the contact list, announcing availability of the ROD.

If you have questions or comments, contact me at the telephone number listed above.

Sincerely,

Theresa Ludanyi

Theresa Ludanyi
Citizen Participation Specialist

cc: Ramanand Pergadia

New York State Department of Environmental Conservation
21 South Putt Corners Road, New Paltz, NY 12561-1696
(914) 256-3154 FAX (914) 255-3414

December 26, 1995

Johanna DiDio
Big V Supermarkets
176 North Main Street
Florida, NY 10921

Dear Ms. DiDio:

Enclosed is a copy of the Record of Decision (ROD) for the Baldwin Place Shopping Center Inactive Hazardous Waste Site in Westchester County. The ROD represents the New York State Department of Environmental Conservation (DEC) approved remedial action chosen for the site. It documents the information and rationale used to arrive at the decision.

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New York State Department of Environmental Conservation
21 South Putt Corners Road, New Paltz, NY 12561-1696
(914) 256-3154 FAX (914) 255-3414

December 26, 1995

Maureen Schuck
Bureau of Environmental Exposure
NYS Dept. of Health
2 University Place
Albany, NY 12237

Dear Ms. Schuck:

Enclosed is a copy of the Record of Decision (ROD) for the Baldwin Place Shopping Center Inactive Hazardous Waste Site in Westchester County. The ROD represents the New York State Department of Environmental Conservation (DEC) approved remedial action chosen for the site. It documents the information and rationale used to arrive at the decision.

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New York State Department of Environmental Conservation
21 South Putt Corners Road, New Paltz, NY 12561-1696
(914) 256-3154 FAX (914) 255-3414

December 26, 1995

Elizabeth Hendricks
Westchester County Dept. of Health
19 Bradhurst Avenue
Hawthorne, NY 10532

Dear Ms. Hendricks:

Enclosed is a copy of the Record of Decision (ROD) for the Baldwin Place Shopping Center Inactive Hazardous Waste Site in Westchester County. The ROD represents the New York State Department of Environmental Conservation (DEC) approved remedial action chosen for the site. It documents the information and rationale used to arrive at the decision.

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cc: Ramanand Pergadia

New York State Department of Environmental Conservation
21 South Putt Corners Road, New Paltz, NY 12561-1696
(914) 256-3154 FAX (914) 255-3414

December 26, 1995

DEC Division of Environmental Enforcement
Eastern Field Unit
200 White Plains Road
Tarrytown, NY 10591-5805

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BIG V SUPERMARKETS, INC.
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FEASIBILITY STUDY

Baldwin Place Mall
Somers, New York

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LMSE-95/0231&100/233

LAWLER, MATUSKY & SKELLY ENGINEERS
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One Blue Hill Plaza
Pearl River, New York 10965

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CHAPTER 1

SUMMARY OF REMEDIAL INVESTIGATION

1.1 INTRODUCTION

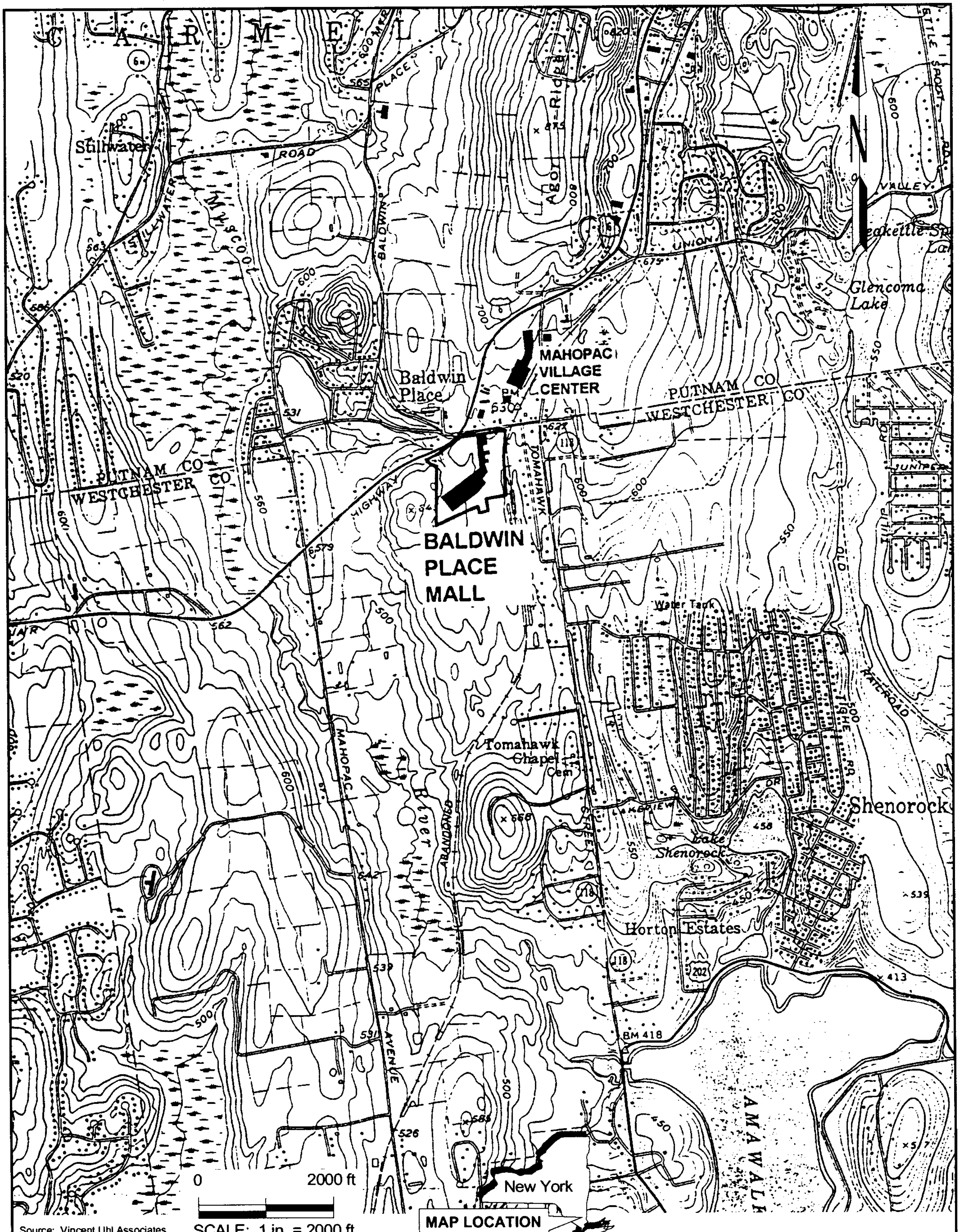
This report presents the feasibility study (FS) for the Baldwin Place Mall (BPM) site conducted by Lawler, Matusky & Skelly Engineers (LMS) with the technical assistance of Vincent Uhl Associates, Inc. (VUA). This FS was prepared as required by the Order on Consent for this site entered into by Big V Supermarkets, Inc. and the New York State Department of Environmental Conservation (NYSDEC) on 4 August 1992 and was conducted in accordance with the U.S. Environmental Protection Agency (EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988).

The FS is based on the results of the remedial investigation (RI) conducted by VUA (VUA 1994). Chapter 1 includes a brief summary of the RI, including the baseline risk assessment and the fish and wildlife impact analysis performed by Environmental Standards, Inc., and Jay Fain & Associates, respectively.

1.2 SITE DESCRIPTION

The BPM is located due south of the Route 6, Route 118, and Baldwin Place Road intersection at the northern edge of the Town of Somers, New York, in northern Westchester County (Figure 1-1). The approximately 28-acre site is bounded on the northwest by U.S. Route 6; on the west and south by undeveloped property; on the east by an abandoned railroad embankment; and on the north by a short east-west oriented section of Route 118 which represents the Putnam-Westchester County line (Plate 1-1, at the back of this report). Land use to the east of the site is residential (Meadow Park Road [MPR]); to the north and northwest commercial (Route 118 and Route 6), and to the west and south undeveloped.

The BPM was constructed in 1965. Prior to the mall, an orchard had been maintained on the property. Big V Supermarkets, Inc. purchased the BPM in July 1986. Most of the mall space is currently vacant and in need of renovation before it can be utilized. In addition to the mall buildings, a McDonalds restaurant and an Exxon service station (formerly a Mobil) are located along Route 6 on the northwest part of the property. Two residences are situated in the northeast corner of the property; one residence is tenanted and the other is unoccupied.



Source: Vincent Uhl Associates

SCALE: 1 in. = 2000 ft

LMS Lawler, Matusky & Skelly Engineers
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Location Map

BALDWIN PLACE MALL

Figure 1-1

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Investigation of the dry cleaners at the mall by the Westchester County Department of Health (WCDOH) began in the late 1970s as a result of the discovery of dry cleaning chemicals (tetrachloroethylene [PCE] and trichloroethylene [TCE]) in the mall water supply. Mall tenant records indicated that "there always has been a dry cleaner on the premises" (J. Robert Folchetti & Associates [JRFA] 1989). Until November 1991, dry cleaning processing was performed on the BPM property. After that time, the dry cleaners' processing was performed off site.

The mall water supply is comprised of two production wells located in a fenced area on the southern part of the property. These wells are 260 ft deep (production well PW-1) and 400 ft deep (production well PW-2), and can reportedly provide a combined capacity of 115 gallons per minute (gpm). The water supply is treated by a granular activated carbon (GAC) filter system that was installed in April 1989 (JRFA 1989). The filter system is designed for 60 gpm; current BPM water usage is on the order of 3.8 gpm. The filter system has been effective in removing PCE and TCE from the BPM production well flows. The two on-site residences are also connected to the mall water-supply system.

Sanitary wastewater from the mall is handled by an on-site treatment plant also located in the fenced area on the southeast part of the property. The treatment plant effluent is routed through two subsurface sand filters, collected by an underdrain assembly, chlorinated and re-aerated before discharge to the unnamed stream bordering the eastern edge of the property (State Pollutant Discharge Elimination System [SPDES] Permit No. 0067741).

The McDonalds restaurant well is reportedly 650 feet deep and cased to 31 feet below ground surface (bgs) (Technical Environmental Specialists [TES] Corporation 1991). This well was temporarily taken out of service in 1989 as a result of water quality problems; both methyl tert-butyl ether [MTBE] and PCE were detected. MTBE is a common gasoline additive; its presence at this location may be the result of the leakage of petroleum products from underground storage tanks at one or more of the four service stations located adjacent to the BPM site. This well is presently operating and is equipped with a GAC filter system maintained by Mobil Oil Corporation.

The residential and commercial establishments within a 1/2-mile radius of the site rely on groundwater for potable supply purposes. Available well records indicate that these residential and commercial wells are completed in bedrock. Most of the residences proximate to the site rely on individual wells for drinking water. These include the 19 homes in the MPR community (on Meadow Park Road and Tomahawk Street) directly east of the BPM. In addition, approximately 32 homes on Lounsbury Drive and Cornelius Lane east of Tomahawk Street; and at least seven homes on Kennard Lane northwest of the BPM have individual potable water wells. Twelve of the homes in the MPR community currently have GAC filter systems for removal of PCE and TCE, and two of the homes on Kennard Lane have GAC filter systems for the removal of MTBE.

The nearest public water supply is the Lake Baldwin system located approximately 1,800 feet northwest of the western BPM site boundary which serves 165 residences in the Lake Baldwin community. This utility, which is owned and operated by the Town of Carmel, uses six wells and delivers an average of 32,000 gallons per day (gpd). No water treatment has been employed to date. The Lake Baldwin system wells are all completed in bedrock; range in depth from 220 to 950 feet bgs; and have reported yields from 8 to 30 gpm.

The Mahopac Village Center mall to the northeast of the site (Figure 1-1) utilizes three wells for supply purposes, with flow from one well treated using an air stripper for removal of MTBE. The smaller commercial establishments on Route 6 have individual wells. At least seven of the individual commercial wells are also equipped with treatment systems; four primarily for removal of PCE and TCE and three for removal of MTBE.

The major groundwater pumping systems in the area are the BPM, Mahopac Village Center mall, and the Lake Baldwin wells. Estimated average daily withdrawals for these three supply systems are 5,400 gpd for the BPM, 10,000 gpd for the Mahopac Village Center, and 32,000 gpd for the Lake Baldwin system. A residential development (Stephens Green) has been proposed for the area east of the site and Tomahawk Street (Route 118). The production wells for this property are located approximately 0.8 mile east of the BPM site, however, these wells are not currently being used for potable supply purposes.

The on-site Exxon (formerly Mobil) service station has an operating groundwater remediation system installed by TES for Mobil Oil Corporation. The remediation system consists of two recovery wells, one shallow and one bedrock well, to recover groundwater containing dissolved petroleum hydrocarbon compounds, including benzene, toluene, ethylbenzene, and xylenes (BTEX) and MTBE. The groundwater pumped from the recovery wells is treated by carbon filtration before discharge into the same stormwater system that drains the parking area in the western portion of the BPM (TES 1991). In addition, the Citgo and Texaco stations to the north of the site (intersection of Baldwin Place and Route 6) have active groundwater remediation systems. An investigation at the fourth service station (Shell) concluded that this facility has not been a source of gasoline constituents in the aquifer (International Technology Corporation 1990).

1.3 SITE HISTORY

The BPM water supply was initially sampled by the WCDOH in 1979 as part of a county-wide investigation of water supplies vulnerable to dry cleaning-related chemical contamination. In the initial March 1979 sample collected by WCDOH from the tap at the liquor store in the mall, PCE was detected at 37 μg/l (WCDOH 1994). Subsequently in 1979, site inspections by WCDOH and others did not note evidence of chemical dumping or spillage, or unacceptable disposal practices at the dry cleaners. The results of wastewater testing and soil and groundwater sampling adjacent to the sand filters indicated that the BPM wastewater system was not the apparent source of PCE and TCE in the groundwater, therefore, the source must be present at another location either on or off the BPM site.

In late 1988 through early 1989, many wells in the area were sampled by either WCDOH or by the Putnam County Health Department (PCHD) in conjunction with the NYSDEC as part of an investigation of the apparent gasoline spill in the area. In April 1989, the WCDOH issued an Interim Report on Groundwater Volatile Organic Chemical Contamination at and in the BPM proximity (WCDOH 1989). This report summarized the investigative efforts and findings, and recommended the evaluation of water treatment and/or supply alternatives for the area and continuation of a groundwater monitoring program. WCDOH also forwarded their findings to the NYSDEC for consideration in a remedial action program. NYSDEC notified Big V Supermarkets, Inc. of the inclusion of the BPM in the Registry of Inactive Hazardous Waste Disposal Sites (Site Classification 2) in a letter dated 31 October 1989. The Inactive Hazardous Waste Disposal Report enclosed with the notification letter indicated that the NYSDEC viewed the WCDOH interim report as equivalent to a Phase I investigation, and that PCE in the BPM production wells and four residential wells in the area appeared to originate from the dry cleaners in the mall (NYSDEC 1989).

An Order on Consent concerning the performance of a limited soil gas and soil sampling investigation was entered into by Big V Supermarkets, Inc. and NYSDEC on 3 June 1991 (NYSDEC 1991a). The soil gas investigation was performed by Tracer Research Corporation under subcontract to Malcolm Pirnie, Inc. on 4 June 1991. An elevated PCE concentration of 94 ppm was detected at a location directly behind the dry cleaners, approximately 5 ft from the building (Malcolm Pirnie 1992). The soil gas investigation was followed by a limited soil boring program in July 1991. Low levels of PCE (1.6 to 1.7 mg/kg) were detected in the unsaturated soil from the boring directly behind the dry cleaners (Malcolm Pirnie 1992).

A second Order on Consent concerning Interim Remedial Measures (IRMs) was entered into by Big V Supermarkets, Inc. and NYSDEC on 12 September 1991 (NYSDEC 1991b). In accordance with the provisions of this Order, Big V Supermarkets installed GAC filter/ultraviolet (UV) disinfection systems on the MPR residential wells that exhibited PCE concentrations of greater than 5 μg/l and implemented a quarterly monitoring program for PCE and its breakdown products (TCE and 1,2-dichloroethylene [1,2-DCE]) that included all 18 residential wells which serve 19 residences on Meadow Park Road.

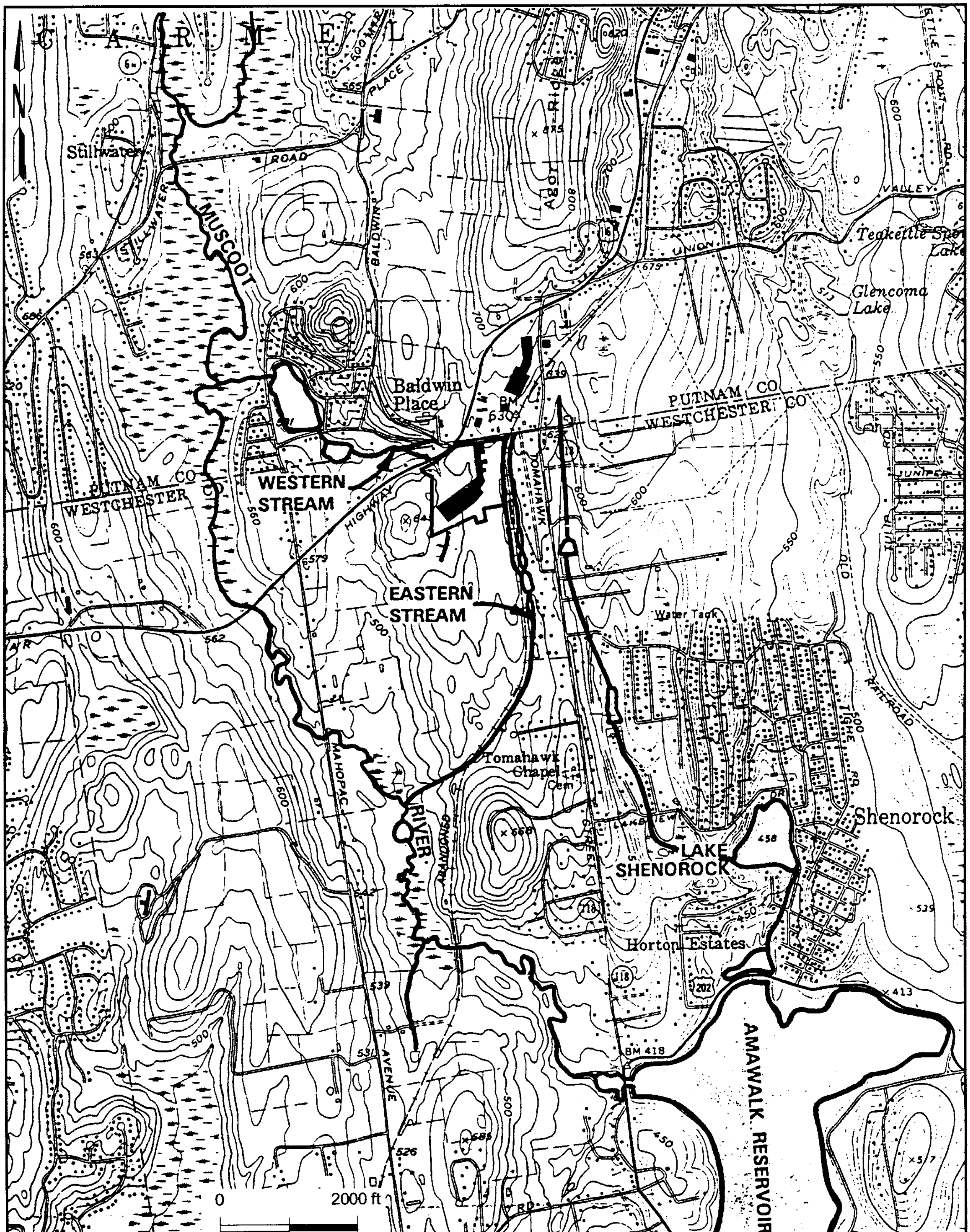
A third Order on Consent concerning the implementation of an RI/FS at the BPM site was entered into by Big V Supermarkets, Inc. and NYSDEC on 4 August 1992 (NYSDEC 1992a), as discussed below.

1.4 HYDROGEOLOGIC CONDITIONS

The BPM site is located at a relative topographic high and drainage is to the southeast and northwest. Drainage over the eastern and southeastern portions of the site is to an unnamed north-to-south flowing stream (eastern stream) that is tributary to the Muscoot River (Figure 1-2). Its confluence with the river lies approximately one mile south of the site. This eastern stream begins just north of Route 118 and flows south parallel to the eastern site boundary between the site and the MPR residential community. The eastern stream is divided into two separate channels by the railroad embankment; the eastern channel is routed through a series of man-made ponds and has a fairly gentle gradient. A parallel stream drainage system is present to the east of Tomahawk Street; this stream system drains to Lake Shenorock to the southeast.

Drainage over the western portion of the site is to an unnamed south-to-north flowing stream (western stream) that begins just south of the mall, is diverted under the mall and parking lot, and then empties into a relatively steep ravine and valley immediately north of Route 6 near McDonalds and the Exxon service station. This western stream flows in a northwesterly direction through two ponds (an unnamed pond and Kennard Pond) and Lake Baldwin prior to its confluence with the Muscoot river approximately 3,500 feet from the site (Figure 1-2). The western stream valley north of Route 6 is 30 to 50 feet lower in elevation than the BPM site and is bounded by hills to the north and west (ridge on Mahopac Avenue). This western stream valley comprises the most significant topographic feature in the study area. In contrast, the eastern stream topography is relatively featureless.

The BPM site and vicinity are underlain by glacial till, weathered bedrock, and bedrock. The glacial till comprises the uppermost geologic and water-bearing unit. The till is very thin near the western and northwestern site boundaries and thickens to the south/southeast. The saturated



Source: Vincent Uhl Associates

SCALE: 1 in. = 2000 ft

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Surface Water Features in the BPM Area

BALDWIN PLACE MALL

Figure 1-2

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glacial till materials range in thickness from less than 1 ft in the northwest to as much as 80 ft in the southeastern part of the site.

The glacial till is directly underlain by weathered bedrock. The weathered bedrock is approximately 20 ft thick with a gradation from highly weathered (decomposed) bedrock to competent bedrock. Groundwater circulation appears to be significant in the weathered and partially weathered bedrock horizon. The depth to competent bedrock (biotite gneiss) ranges from 22 ft bgs in the western part of the site to about 100 ft bgs in the east/southeast. The weathered bedrock/bedrock system is unconfined over the extreme western and northwestern portion of the site. Over the main body of the site, the weathered bedrock/bedrock system is overlain/confined by the glacial till water-bearing unit.

Water level measurements indicate the presence of an on-site groundwater divide oriented in a southwest to northeast direction in the vicinity of the main mall building (and dry cleaners). This shallow divide is evident under normal BPM production well pumping conditions (average of 3.8 gpm), and also when the mall wells have been shut down for a period of two weeks. Groundwater flow from the divide is to the southeast and to the west/northwest.

The regional water level contour map for the bedrock system confirms the presence of a similar deeper groundwater divide on site with flow components to the southeast and west/northwest when the BPM production wells are not pumping. Under present BPM pumping conditions, the mall production wells are capturing groundwater over a portion of the site with a component of groundwater flow off site to the southeast.

1.5 CONTAMINANT TRANSPORT

In the alleyway immediately behind the dry cleaners, PCE used in dry cleaning has entered the subsurface environment. High PCE soil concentrations (up to 1,200 mg/kg) are present in a limited area (approximately 15 by 15 ft) in the unsaturated zone. The water table in this area is approximately 3 ft bgs. PCE breakdown products (TCE and 1,2-DCE) are also in evidence at lower concentrations (i.e., up to 0.26 mg/kg TCE and 0.007 mg/kg 1,2-DCE) in this area.

PCE has migrated vertically through the unsaturated zone into the saturated soil beneath the water table. PCE concentrations within the saturated zone approximately 5 ft from the backdoor of the dry cleaners (at the TB-1/TB-16 location) ranged from 130 mg/kg to 4,500 mg/kg. The area of high PCE concentrations in the saturated zone extends approximately 5 to 10 ft further east than in the unsaturated zone and to a maximum depth of 15 ft bgs; below 15 ft, PCE was detected at trace or very low concentrations. The unconsolidated materials within the source area consist of till materials comprised of loose to moderately dense silty sand and clay with fine to medium rounded gravel to a depth of approximately 6 to 8 ft bgs. Below this depth the till materials attain a much greater density and are more compact.

The local stratigraphy, adsorption, and groundwater flow system are all factors governing the rate and direction of dissolved PCE migration in the saturated zone. The groundwater within the source area exhibits 24,000 μg/l PCE concentration at a depth of 4 to 14 ft bgs and 3,200 μg/l at a depth of 22 to 32 ft bgs. As a result of the groundwater divide, PCE is migrating in the groundwater in both the south/southeasterly and westerly directions (Plate 1-2 at the back of this report).

With distance from the source, the contaminant concentrations (PCE, TCE, and 1,2-DCE) markedly diminish (dilute), primarily due to hydrodynamic dispersion, which in turn is dependent on permeability, fracture widths, and direction of groundwater flow (which is governed by recharge/discharge dynamics) as well as fracture geometry. The PCE concentration is on the order of 900 μg/l in monitoring well MW-5D approximately 90 ft downgradient (southeast) of the source area, and off-site PCE concentrations are trace (below 1 μg/l) to about 300 μg/l. Due to dispersion, the plume tends to widen with distance from the source area.

Over the southeast portion of the site, the glacial till materials are 45 to 80 ft thick. In this area, water level elevations in shallow monitoring wells completed in the glacial till are approximately 10 to 12 ft higher than water level elevations in deeper wells completed in weathered and competent bedrock. As a result, there is a substantial downward vertical component to groundwater flow while the lateral extent of contaminant migration in the shallow glacial till materials appears to be somewhat limited. The contaminants are therefore moving into the weathered bedrock horizon within a very short distance from the source area. As such, the principal migration pathway to the south/southeast is in the weathered bedrock/bedrock system.

The operation of the BPM production wells influences the deeper (weathered bedrock/bedrock) groundwater flow conditions. At current pumping rates (average of 3.8 gpm), the BPM wells capture a portion of the contaminated groundwater emanating from the source area as indicated by samples of untreated groundwater from these wells. PCE concentrations typically range from 50 to 100 μg/l, TCE from 2 to 10 μg/l, and 1,2-DCE below 1 μg/l in the BPM production well samples.

There is also a deeper component of groundwater flow in a southeast direction from the source area that has reached the MPR community area. The MPR area impacted by PCE, TCE and 1,2-DCE extends approximately 1,200 ft, from southeast of the dry cleaners to the southern intersection of Meadow Park Road and Tomahawk Street. Eleven residential wells in the MPR community have detectable concentrations of PCE ranging from less than 1.3 to 300 μg/l, TCE ranging from nondetectable to 10 μg/l, and 1,2-DCE from nondetectable to 0.5 μg/l. In nine of these wells, PCE concentrations consistently or intermittently exceed the 5 μg/l Class GA groundwater standard for PCE in the quarterly samples. Quarterly sampling results from late 1988 through late 1993 show gradually increasing PCE concentrations in the MPR area, except in the first two quarters of 1994 when a more marked increase was observed in the four northernmost impacted residential wells within this area.

On the western portion of the site, the glacial till materials become thinner and over the far western/northwestern parts of the site, the glacial till materials lie at or near the top of the zone of saturation (water table). Therefore, the shallow groundwater system proximate to the source area is in glacial till while farther west, as the saturated glacial materials thin (to less than 1 ft), the shallow groundwater system is comprised of weathered bedrock. In contrast to the eastern portion of the site, water level elevations in the western shallow monitoring wells (glacial till and weathered bedrock) are only slightly higher than water level elevations in coupled deeper bedrock monitoring wells. As such, there is less of a downward component to groundwater flow in the western portion of the site and contaminant migration occurs in the shallow as well as the deeper aquifer systems.

The shallow groundwater flow component from the source area is toward the MW-9 cluster. PCE concentrations were detected in shallow and deeper wells MW-9S and MW-9D at 850 and 300 μg/l, respectively. As a result of hydrodynamic dispersion, lower concentrations were detected in the MW-1 cluster to the north and in the MW-10 cluster to the south. The regional flow conditions point to the presence of a deeper groundwater divide on site and a deeper component of groundwater flow in a westerly direction when the BPM production wells are not pumping.

Groundwater flow from the western site boundary is in a northwesterly direction toward Route 6 and the western stream. Along Route 6, there is a sharply delineated area of impact. The impacted area extends along Route 6 approximately 1,200 ft, begins west of where the western stream crosses under Route 6, and does not extend to where the ground surface begins to rise markedly toward Mahopac Avenue. Four commercial wells (CW-20 through CW-23) lie within the groundwater flow path of the on-site source; it is uncertain if a fifth well (CW-24) is within the flow path. In the two commercial wells routinely monitored by Big V Supermarkets, PCE concentrations up to 80 μg/l; TCE up to 4.0 μg/l; and 1,2-DCE up to 1.4 μg/l (as of May 1994) have been detected. Wells both east and west (CW-19 to the east and CW-25 to the west) of these impacted wells have no detectable PCE or TCE concentrations.

Residential wells (RW-40, RW-41, RW-42 and RW-43) and the Lake Baldwin public supply wells (PW-44) north of the western stream have not shown the presence of site-related constituents, with the exception of a single occurrence of 1 μg/l PCE in RW-41 in August 1992. Well RW-41 is located within a few feet of the western stream.

The area to the north of Route 118 is hydraulically upgradient of the site in both the shallow and deeper groundwater flow systems. PCE is not entering the site from the upgradient direction as evidenced by its absence in the three upgradient monitoring wells (MW-4S/4D and MW-8S) located at the northern site boundary. PCE is also absent in commercial and residential wells to the north and northeast of the site along Tomahawk Street (Route 118).

Surface water and sediments in the eastern stream did not contain site-related constituents. The western stream serves as a discharge point for groundwater emanating from the western portion of the site and has been impacted to a very limited degree (i.e., PCE concentrations in surface water and sediments of up to 2 μg/l and 4 μg/kg, respectively) by the site-related constituents. Low levels of PCE (i.e., 1 μg/l in surface water and 4 μg/kg in sediment) were detected in a small drainage ditch on the south side of Route 6 that is tributary to the western stream.

The area that has been apparently impacted by fuel spills from the service stations in the vicinity of the Baldwin Place intersection (Exxon (formerly Mobil), Texaco, Citgo) extends into the areas both immediately north and south of the western stream. The four Route 6 wells south of the western stream equipped with filter systems to remove PCE contamination also contain MTBE (from trace levels up to 53 μg/l). Four additional wells north of the western stream on Route 6 and Kennard Road are equipped with GAC filter systems to remove MTBE concentrations: two commercial establishment systems on Route 6 (CW-19 and CW-54) are maintained by NYSDEC, and two residential systems on Kennard Road (RW-40 and RW-41) are maintained by Spain Oil.

The McDonalds well at the northwest corner of the BPM site contains MTBE (as well as low-level PCE concentrations) and has been equipped with a GAC filter system maintained by Mobil Oil Corporation. MTBE from fuel spills at the service stations has apparently resulted in dispersion of this highly mobile compound at low concentrations (1 to 15 μg/l) over wide areas of the BPM property.

1.6 HYDRAULIC CHARACTERISTICS

A 48-hour constant-rate aquifer pumping test conducted during the RI on BPM production well PW-1 indicates that the weathered bedrock/bedrock aquifer underlying the site behaves as a leaky artesian system wherein the overlying glacial till materials serve as a leaky confining unit. Leakage through the glacial till is the principal source of recharge to the weathered bedrock/bedrock system.

The transmissivity of the weathered bedrock/bedrock aquifer ranges from 750 to 1,500 gpd/ft which is characteristic of a moderately permeable bedrock system. Storativity ranges from 1.7 x 10^{-4} to 2.5 x 10^{-3} and is reflective of leaky artesian conditions. The vertical permeability of the glacial till confining unit ranges from 0.043 to 0.050 gpd/ft^2.

The theoretical capture zone calculated for PW-1 pumping at 39 gpm (the maximum pump capacity) with a transmissivity of 1,500 gpd/ft is comparable with the field-determined capture zone based on water-level measurements made after 42 hours of pumping. Both the theoretical and field-based capture zones demonstrate that the sustained PW-1 pumping at 39 gpm effectively captures deeper groundwater on the site. The step-drawdown pumping test on BPM production well PW-1 indicates that this well can sustain a yield of 39 gpm with 30 to 40 feet of remaining available drawdown.

1.7 FISH AND WILDLIFE IMPACT ANALYSIS

The fish and wildlife impact analysis for the BPM was prepared by Jay Fain & Associates of Westport, Connecticut (VUA 1994, Appendix M). Step I of the study identified the fish and wildlife resources present in the vicinity of the site and provided a qualitative assessment of the value of these resources. The Step I study concluded that all surface water flow in the BPM area is within the Muscoot River sub-basin. The Muscoot River, including the Amawalk Reservoir, and its associated wetlands, open water, and riparian areas, is the most significant fish and wildlife resource, both within the 1/2 mile radius and within two miles downstream of the site. Correspondence with the New York Natural Heritage Program did not identify any resident endangered, threatened, or species of special concern within the boundaries of the study area. Two wetland communities were found at the BPM site; field investigation of these areas did not disclose the presence of any Federal- or State-listed rare or endangered plant species.

The ecological risk posed by the currently identified contaminant levels was examined in the baseline risk assessment, which concluded that chemicals present in surface water do not pose a risk to the freshwater aquatic life or its uses in the tributaries to the Muscoot River. Results of the ecological analysis of sediment also demonstrated no environmental risk. Based on the finding of no impact to fish and wildlife resources in the pathway analysis, the fish and wildlife impact analysis concluded that further studies were not warranted.

1.8 BASELINE RISK ASSESSMENT

The baseline risk assessment for the BPM was prepared by Environmental Standards, Inc. of Valley Forge, Pennsylvania (VUA 1994, Appendix N). The risk assessment provided an analysis of potential risks to human health and the environment associated with exposures to site-related chemical constituents under current and potential future site use conditions based on the RI sampling data. These potential risks, as they relate to various site media, are discussed briefly in the following paragraphs.

1.8.1 Unsaturated Soil in the Source Area

Cancer risks posed to future construction workers in the area of soil contamination (source area) as a result of ingestion of, dermal contact with, and inhalation of PCE and TCE in soils is estimated to be 1×10^{-5}. Exposure of future office workers from infiltration of PCE and TCE vapors through the foundation of a potential future building constructed over the area of soil contamination (source area) are estimated to incur a combined cancer risk of 9×10^{-6}. Each of these cancer risk estimates are within EPA's acceptable target risk range of 1×10^{-4} to 1×10^{-6}. The combined PCE and TCE hazard indices for noncarcinogenic health effects based on the soil ingestion, dermal contact, and inhalation pathways are estimated to be 6.0 for the construction worker and 2.0 for the future office worker, which exceed the threshold benchmark of 1.0. The potential carcinogenic and noncarcinogenic risks in each case are primarily attributable to PCE.

1.8.2 Groundwater (Water Supply)

At this time, all residential and commercial water supplies analyzed during the RI are currently meeting the NYSDOH maximum contaminant levels (MCLs) for drinking water (by means of GAC treatment systems) and are, therefore, adequately protected. The combined PCE and TCE noncarcinogenic hazard index based on the groundwater ingestion, dermal contact, and inhalation pathways for this group of exposed individuals (current residents) is estimated to be 0.08, which is well below unity. Assuming a concentration of 5 μg/l for both PCE and TCE, the nearby residents (assuming a residence time of 30 years) are estimated to incur a combined cancer risk of about 4×10^{-6}, which is well within the EPA's acceptable risk range. Assuming the concentrations of both PCE and TCE are 5 μg/l for current residents is a conservative (i.e., over-estimation) assumption because the impacted wells are equipped with GAC filter systems and PCE and TCE have not been detected in the treated water.

Assuming exposure to the concentrations of constituents detected in the residential, commercial, and deep monitoring wells (i.e., treatment prior to use), a carcinogenic risk of 5×10^{-5} is estimated. This risk is within EPA's acceptable target risk range of 1×10^{-4} to 1×10^{-6}. The combined PCE and TCE noncarcinogenic hazard index for the groundwater ingestion, dermal contact, and inhalation pathways for future residents is estimated to be 1.0.

1.8.3 Combined Media (Children)

Children are estimated to incur a combined cancer risk of 5×10^{-7} from ingestion, dermal contact, and inhalation of PCE and TCE in soils, surface water, and sediments, which is below the de minimis benchmark level of 1×10^{-6}. The cancer risk to children results primarily from exposure to on-site soils, although such an exposure is theoretical and unlikely. The total combined noncarcinogenic hazard index based on the soil, surface water, and sediment exposure pathways for children is estimated to be 0.2, indicating that no adverse health effects are anticipated, even under reasonable maximum conditions of exposure, i.e., exposure to soil, sediment, and surface water. These results indicate that no remediation of these media is necessary under the scenarios developed to assess potential exposure by children.

1.9 INTERIM REMEDIAL MEASURE

On 12 September 1991, Big V Supermarkets, Inc. and NYSDEC entered into an Order On Consent Concerning Interim Remedial Measures for the MPR residential wells (NYSDEC 1991b). In accordance with the provisions of this Order, Big V Supermarkets, Inc. installed GAC filter/UV disinfection systems on the four MPR residential wells (RW-08, RW-09, RW-10 and RW-15) that exhibited PCE concentrations above the 5 μg/l MCL in samples collected by the New York State Department of Health (NYSDOH) in August 1991. Big V Supermarkets, Inc. also assumed maintenance and monitoring responsibilities for the filter at a fifth residence (RW-05) that was previously installed by the owner, and agreed to implement a quarterly monitoring program including sampling and analyses for PCE and its breakdown products at all 18 residential wells on Meadow Park Road.

The initial quarterly monitoring event under this program was conducted in late October/early November 1991. Split samples of water from points before and after treatment at selected residences were also collected by NYSDOH. All five GAC systems were found to be reducing contaminant concentrations to below detectable levels. During this sampling, a sixth residential well (RW-07) on Meadow Park Road exhibited a PCE concentration above 5 μg/l, and this residence was fitted with a GAC/UV system by Big V Supermarkets, Inc. in December 1991.

Thirteen MPR quarterly sampling events have been conducted from late October/November 1991 through November 1994. During this time, three additional MPR residential wells exhibited PCE concentrations above the 5 μg/l MCL and were fitted with GAC/UV systems by Big V Supermarkets, Inc. (RW-16 in March 1993; RW-11 and RW-17 in March 1994). In October 1994, Big V Supermarkets installed GAC/UV systems on the two other MPR residential wells (RW-12 and RW-14) that show measurable, but below the MCL, PCE concentrations.

Although the IRM mandated by the Order On Consent addressed only the MPR residential wells, Big V Supermarkets, Inc. also equipped two commercial wells (CW-20 and CW-21) on Route 6 with GAC/UV systems in April 1993 based on the March 1993 RI sampling results. The two other commercial wells (CW-22 and CW-23) known to be within the groundwater flow path from the BPM site had existing GAC filter systems installed by the owner. A fifth well (CW-24) which could not be sampled during the RI (access was not granted), and for which no historic data was available, lies between the westernmost known impacted well and wells further west which have historically shown no detectable concentrations of PCE.

Plate 1-3 at the back of this report shows the locations of the MPR residential wells and Route 6 commercial wells equipped with GAC/UV filter systems. The quarterly monitoring has indicated that these filter systems afford consistent protection and provide water supplies with no detectable concentrations of PCE and TCE.

CHAPTER 2

REMEDIAL ACTION OBJECTIVES AND QUANTITIES OF CONTAMINATED MEDIA

2.1 INTRODUCTION

The FS process involves identifying and screening potentially applicable remedial technologies, combining appropriate technologies into remedial alternatives for the site, and evaluating the alternatives based on their implementability, feasibility, and cost. The process of alternative development, screening, and evaluation is done in conjunction with the development of remedial action objectives for the site and the quantification of contaminated materials present. This chapter presents the remedial action objectives developed for the BPM site and the quantification of contaminated soils and groundwater requiring remediation. Applicable or relevant and appropriate requirements (ARARs) for the site are also identified in this chapter.

2.2 REMEDIAL ACTION OBJECTIVES

Remedial action objectives were developed for the BPM site based on the results of the RI and baseline risk assessment. The baseline risk assessment concluded that potential adverse health effects associated with the site are attributable to exposure to PCE and TCE. PCE and its breakdown products (TCE and 1,2-DCE) were therefore identified as the contaminants of concern for establishing site remedial action objectives. Vinyl chloride, also a breakdown product of PCE, was detected at a very low concentration in only one soil sample during the RI, therefore, it was not included as a contaminant of concern. Several other contaminants (e.g., benzene, toluene, MTBE) were detected at concentrations exceeding chemical-specific ARARs, however, the presence of these constituents is not wide-spread and was not attributed to site activities. Contaminants other than PCE and its breakdown products were therefore not included as contaminants of concern for the purpose of establishing remedial action objectives. However, the presence of these constituents at concentrations exceeding regulatory limits will be considered when selecting treatment and disposal options for site contaminated media.

The site remedial action objectives are as follows:

- Prevent exposure (inhalation, ingestion, and dermal) to soils containing unacceptable levels of PCE and its breakdown products.

- Prevent continued degradation of groundwater quality through migration of PCE and its breakdown products from soils to groundwater.

- Prevent exposure (inhalation, ingestion, and dermal) to groundwater contaminated at unacceptable levels with PCE and its breakdown products.

- Restore groundwater quality (impacted by PCE and its breakdown products) to acceptable levels within a reasonable time frame (i.e., shortest time frame feasible).

- Prevent migration and discharge of site contaminants in groundwater to adjacent surface water bodies.

Application of remedial action objectives at a site generally involves developing levels to which contaminant concentrations must be reduced to protect human health and the environment. The cleanup levels established for carcinogens should provide protection to prevent excess lifetime cancer risks of greater than 1×10^{-6} for Class A1 and B2 carcinogens and 1×10^{-5} for Class C3 carcinogens (NYSDEC 1994). PCE and TCE are currently being evaluated by EPA as to their potential carcinogenicity to humans; the 1×10^{-6} risk level was therefore conservatively assumed as the cleanup level for these compounds. Cleanup levels for noncarcinogens should be based on the reference doses (RfDs) for the compounds, i.e., the daily exposure levels to which individuals can be exposed over a lifetime without an appreciable risk of adverse health effects. Where available, the remedial goals may be set at the chemical-specific ARARs identified for the site if these levels are determined to meet the guidelines presented above for the protection of human health.

The first remedial action objective is addressed by the baseline risk assessment. This assessment concluded that the concentrations of PCE in site soils pose an increased cancer risk of greater than 10^{-6} and an increased risk of noncarcinogenic health effects for two potentially exposed populations: future construction workers and office workers in a future building constructed over the area of the soil contamination. Based on these exposure pathways, PCE concentrations in source area soils would need to be reduced to 21 mg/kg or less to reduce the potential health risks to acceptable levels (i.e., cancer risk of less that 10^{-6} and hazard index of less than 1.0). This site-specific risk-based concentration is slightly higher than the NYSDEC recommended health-based soil cleanup objective for PCE of 14 mg/kg (NYSDEC 1994). The second site remedial action objective requires preventing migration of contaminants to groundwater at concentrations that would result in continued degradation of groundwater quality. The NYSDEC has established a recommended soil cleanup objective for PCE of 1.4 mg/kg based on protection of groundwater quality (NYSDEC 1994) assuming a soil total organic carbon (TOC) content of 1.0%. Site-specific TOC data is not available at this time, therefore, a default value of 1.0% was assumed in accordance with NYSDEC guidance (NYSDEC 1994b). This cleanup objective (1.4 mg/kg) applies to unsaturated soils where existing contaminants may migrate to the underlying groundwater and is more stringent than the cleanup objective for protection of human health (14 mg/kg as applied by NYSDEC). The 1.4 mg/kg level for PCE was therefore selected as the cleanup goal for soils at the BPM site (Table 2-1).

Although the NYSDEC guidance document on recommended soil cleanup objectives (NYSDEC 1994) does not include cleanup objectives for saturated soils, restoration of groundwater quality within the source area requires that soil contamination present below the water table be addressed. It will be difficult in any event to distinguish between soil and groundwater contributions to total contaminant levels in saturated soil samples at the site. Therefore, achievement of the cleanup objective in saturated soils will be assessed based on achievement of groundwater cleanup objectives.

Groundwater cleanup objectives for the site are based on the NYSDEC Class GA groundwater standards for the contaminants of concern as summarized in Table 2-1. The Class GA standards apply to aquifers which are currently used or may be developed as a potable water supply; these standards are therefore equivalent to the New York State MCLs as required for drinking water supplies. The New York State MCLs are equivalent to or are more stringent than the Federal MCLs promulgated under the Safe Drinking Water Act (SDWA), as discussed in Section 2.4. The baseline risk assessment concluded that the New York State MCL for PCE of 5 μg/l is adequately protective of human health for potable water users. Achievement of the groundwater cleanup objectives within the on-site aquifer and at the point of use of the potable water supply will be used to assess compliance with the third and fourth remedial action objectives for the site.

Existing surface water and sediment contaminant levels as evaluated in the baseline risk assessment did not pose an increased risk of adverse health effects to potentially exposed populations, therefore, cleanup levels were not established for these media. Preventing the migration of contaminated groundwater to nearby surface water bodies is included as the fifth site remedial action objective as appropriate in the absence of a need for active remediation.

2.3 QUANTITIES OF CONTAMINATED MEDIA

The remedial action objectives discussed in the previous section were used to estimate the quantities of contaminated media present at the site. The estimated quantities of contaminated media are used to evaluate potential remedial alternatives for the site including their cost-effectiveness. Table 2-1 presents a summary of the cleanup objectives for the site and the corresponding quantities of contaminated media, which were estimated as discussed below.

TABLE 2-1

SITE CLEANUP OBJECTIVES AND QUANTITIES OF CONTAMINATED MEDIA

Baldwin Place Mall

MEDIA	REMEDIAL ACTION OBJECTIVE [a]			APPROXIMATE QUANTITY
	PCE	TCE	1,2-DCE	
Soil (mg/kg):				
Unsaturated:	1.4	0.7	0.3 [b]	25 yd^3
Saturated	1.4[c]	0.7[c]	0.3 [b,c]	160 yd^3
Total:				185 yd^3
Groundwater (µg/l):	5	5	5	220 millon gal

a - Assumes a soil TOC content of 1% in absence of site-specific data in accordance with NYSDEC guidance (NYSDEC 1994).

b - NYSDEC recommended soil cleanup objective for trans-1,2-DCE (NYSDEC 1994).

c - Conditional cleanup objective-used to delineate area of elevated contamination only. Achievement of remedial action objectives for saturated soil will be evaluated based on achievement of groundwater cleanup objectives.

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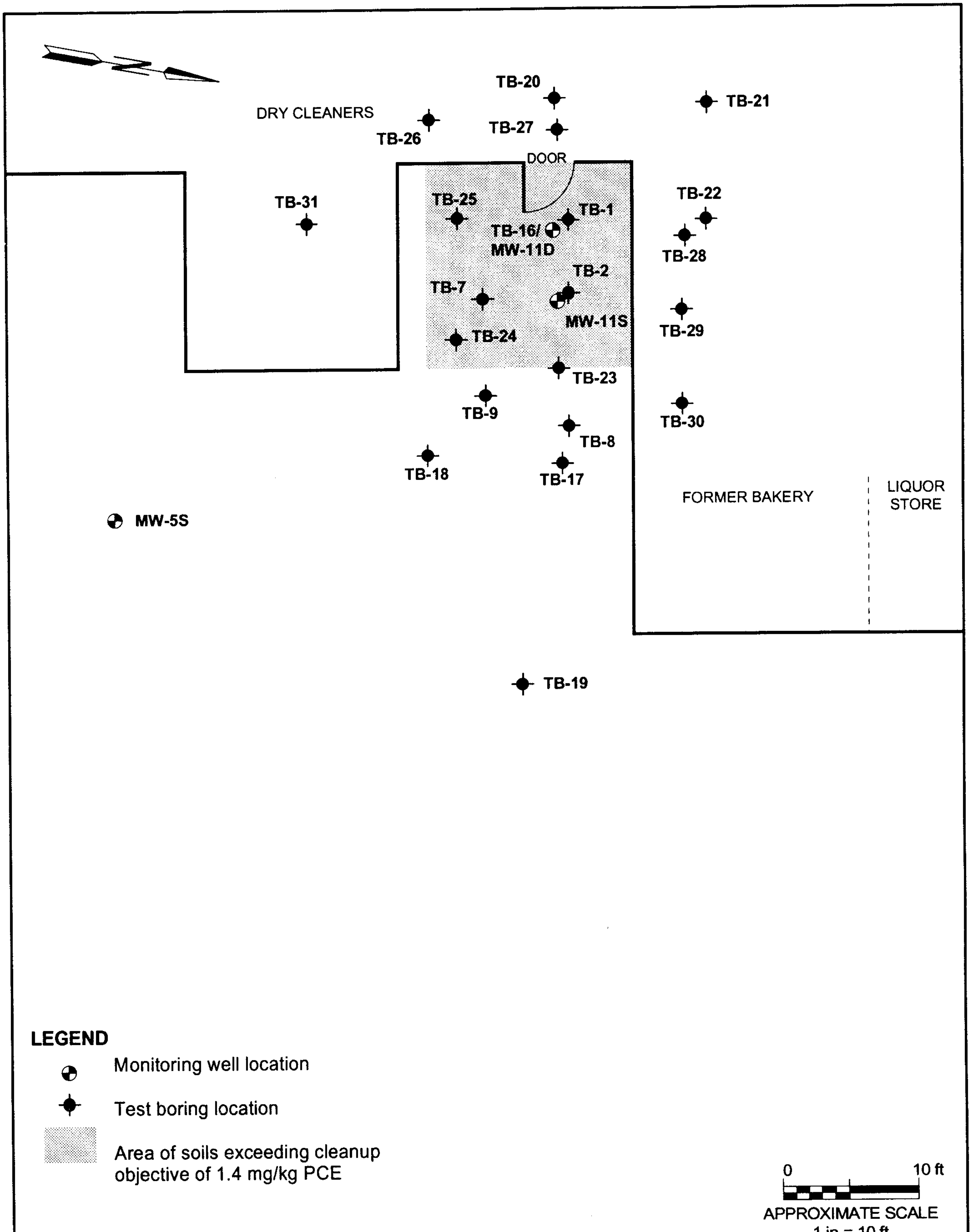
The area of unsaturated soils exceeding the cleanup objective of 1.4 mg/kg PCE is shown on Figure 2-1. This area is entirely within the alleyway behind the dry cleaners and is approximately 15 ft by 15 ft. The water table is approximately 3 ft bgs in this area; this corresponds to a volume of approximately 25 yd^3 of unsaturated zone soils. Saturated zone soils exceeding the conditional cleanup objective of 1.4 mg/kg PCE are shown on Figure 2-2. The areal extent of the elevated PCE concentrations in the saturated zone is approximately 310 ft^2. Elevated PCE concentrations are present in the saturated zone at depths of 15 ft to 20 ft bgs as shown on Figures 2-3 and 2-4. Assuming the depths of PCE concentrations exceeding 1.4 mg/kg as shown on these figures results in an estimated volume of 160 yd^3 of contaminated saturated zone soils.

To estimate the quantity of contaminated groundwater requiring remediation, the analytical data obtained during the RI were compared with the groundwater cleanup objective for the primary contaminant of concern at the site, PCE. The areal extent of the PCE contamination is depicted on Plate 2-1 at the back of this report. Wells containing other constituents (e.g., TCE and 1,2-DCE) exceeding cleanup objectives are within the PCE plume, therefore, remediation of the PCE contamination will also address other site contaminants. The saturated thickness of the aquifer was assumed to be 100 ft. A representative effective porosity value of 0.1 was used to calculate the volume of groundwater contained within the plume area. The in situ pore volume of contaminated groundwater based on these assumptions is approximately 220 million gal.

2.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

This section identifies the ARARs for the BPM site. Applicable requirements are defined as those promulgated Federal or state requirements (e.g., cleanup standards, standards of control) that specifically address a hazardous substance, pollutant, or contaminant found at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. Relevant and appropriate requirements are those promulgated Federal or state requirements that, while not applicable, address problems sufficiently similar to those encountered at CERCLA sites that their application is appropriate. In addition to ARARs, there are other Federal, state, and local criteria, advisories, or guidances that may also apply to the conditions found at the site and are referred to as to-be-considered (TBC) items. TBCs are not legally binding but may be useful within the context of assessing site risks and determining site cleanup goals.

ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific ARARs. Chemical-specific ARARs provide guidance on acceptable or permissible contaminant concentrations in soil, air, and water. Location-specific ARARs govern activities in critical environments such as floodplains, wetlands, endangered species habitats,



Map source: Vincent Uhl Associates

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One Blue Hill Plaza • Pearl River, New York 10965
ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS

Area of Unsaturated Soils Exceeding Cleanup Objective of 1.4 mg/kg PCE
BALDWIN PLACE MALL

Figure 2-1
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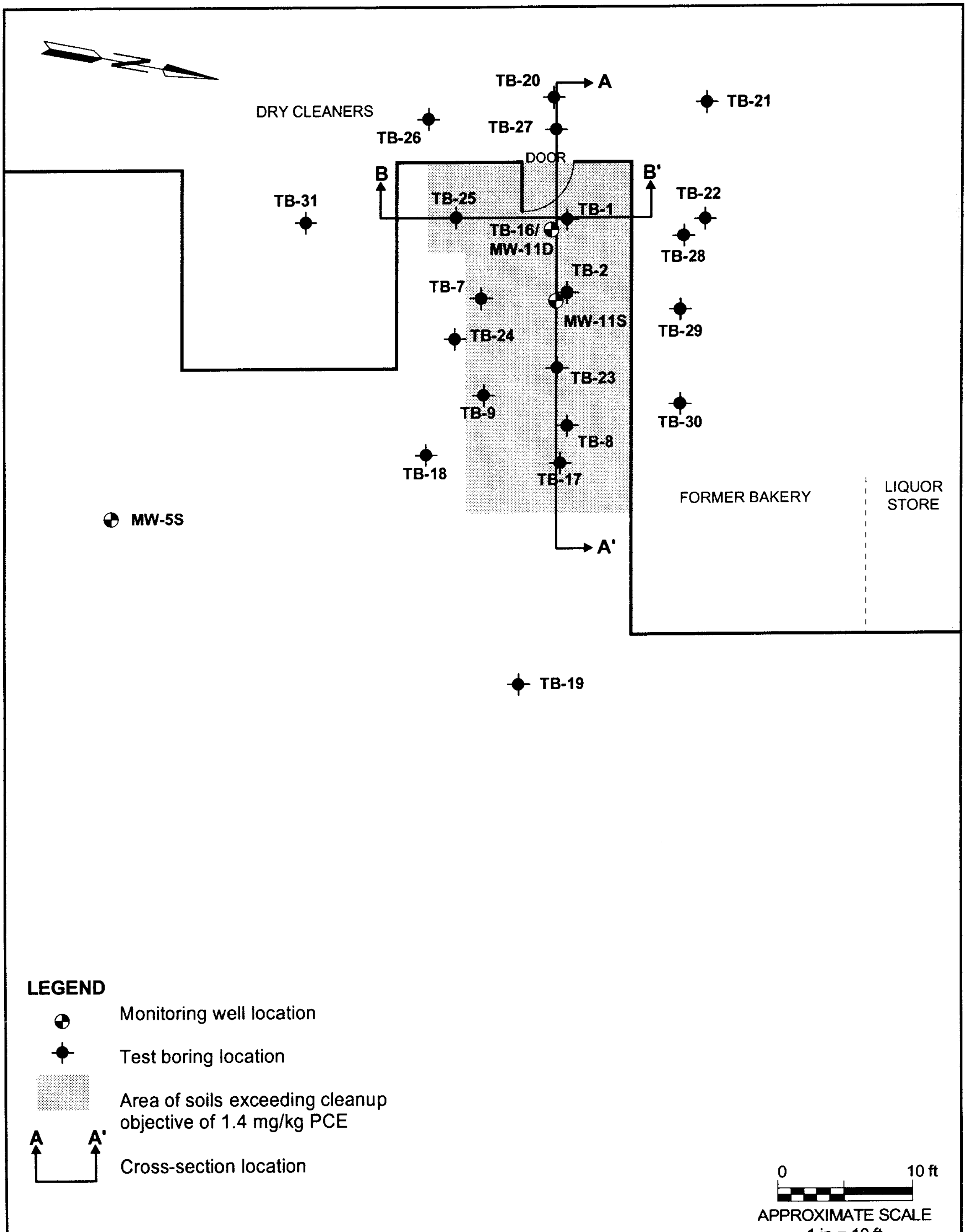
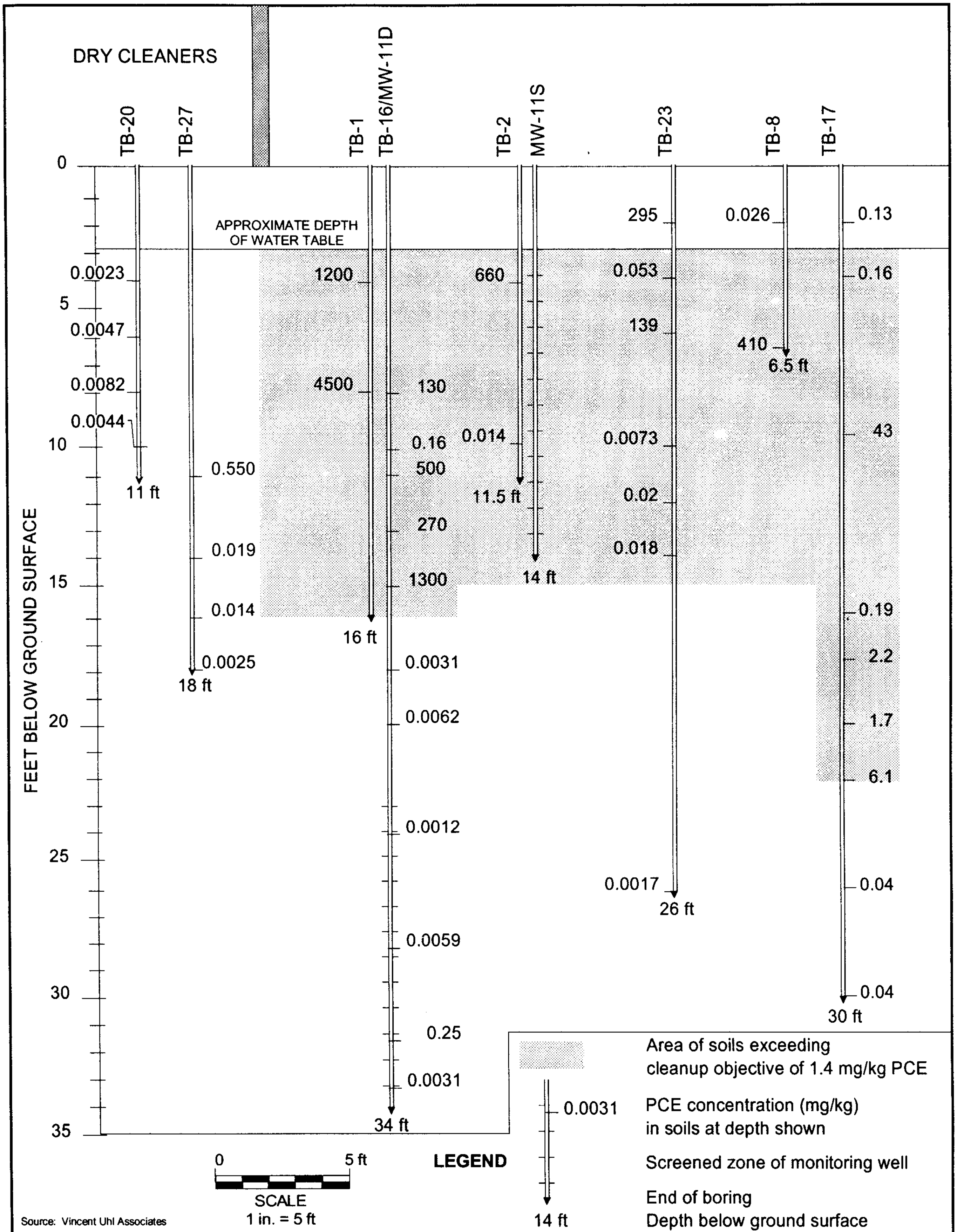


Map source: Vincent Uhl Associates

LMS Lawler, Matusky & Skelly Engineers One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Area of Saturated Soils Exceeding Cleanup Objective of 1.4 mg/kg PCE** **BALDWIN PLACE MALL**	**Figure 2-2** \100\233.ds4



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Cross Section A-A'

BALDWIN PLACE MALL

Figure 2-3

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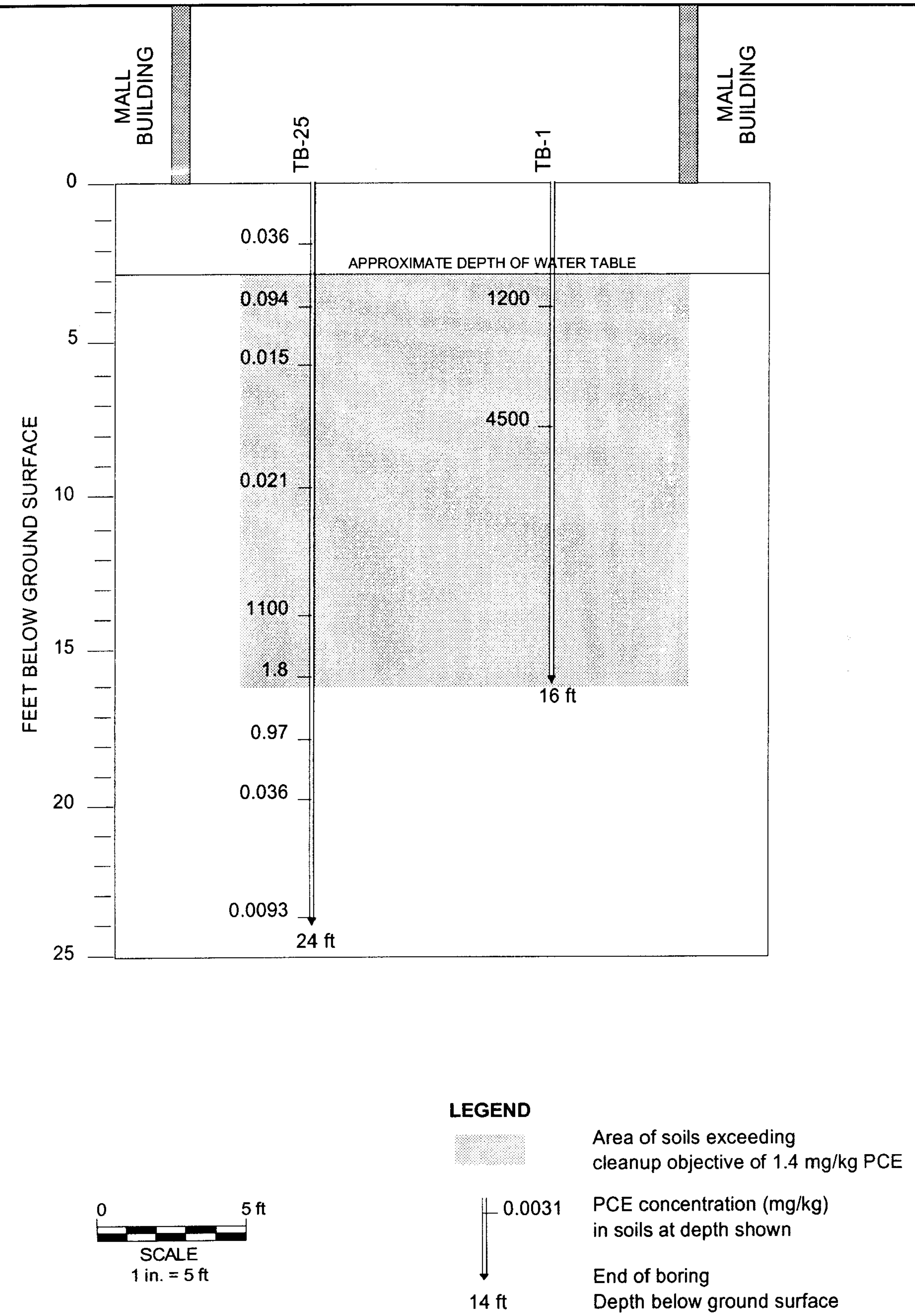

Source: Vincent Uhl Associates

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Cross Section B-B'

BALDWIN PLACE MALL

Figure 2-4

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or historically significant areas, while action-specific ARARs are technology- or activity-based requirements.

2.4.1 Chemical-Specific ARARs and TBCs

2.4.1.1 ***ARARs***. Chemical-specific ARARs for the contaminants of concern (i.e., PCE and its breakdown products) at the BPM site are summarized in Table 2-2. The origin and definition of each of the ARARs is presented below.

The Clean Air Act (CAA) passed in 1977 governs air emissions resulting from remedial actions at CERCLA sites. National Ambient Air Quality Standards (40 CFR Part 50) have been promulgated under the CAA for six criteria pollutants, including airborne particulates. No specific air quality standards for the contaminants of concern at this site have been promulgated, however.

The Safe Drinking Water Act (SDWA) promulgated National Primary Drinking Water Standards (40 CFR Part 141) for the regulation of contaminants in all surface or groundwaters utilized as potable water supplies. The primary standards include both MCLs and Maximum Contaminant Level Goals (MCLGs). MCLs are enforceable standards for specific contaminants based on human health factors as well as the technical and economic feasibility of removing the contaminants from the water supply. MCLGs are nonenforceable standards that do not consider the feasibility of contaminant removal. The SDWA also includes secondary MCLs (40 CFR Part 143) that are nonenforceable guidelines for those contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance.

New York State Groundwater Standards have been promulgated by NYSDEC and are legally enforceable. The aquifer underlying the site has been designated a Class GA groundwater, which is defined as follows: "The best usage of Class GA waters is as a source of potable water supply. Class GA waters are fresh groundwaters found in the saturated zone of unconsolidated deposits and consolidated rock or bedrock." Therefore, the Class GA groundwater standards are intended for protection of human health through use of the groundwater as a drinking water supply and, as such, are equivalent to the MCLs established by NYSDOH for public drinking water supplies. The New York State MCLs were promulgated in the New York Code of Rules and Regulations (NYCRR) Title 10 Chapter I (State Sanitary Code) Subpart 5-1. New York State MCLs are equivalent to or more stringent than the Federal MCLs.

TABLE 2-2

CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND OTHER FEDERAL AND STATE STANDARDS, CRITERIA, AND ADVISORIES

Baldwin Place Mall

ITEM	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS:				
National Ambient Air Quality Standards (mg/m^3)	NS	NS	NS	NS
Federal Drinking Water Standards - MCL/MCLG (µg/l)	5/0	5/0	70/70	100/100
NYS Class GA Groundwater Standards (µg/l)	5	5	NS	5
NYS Class B Surface Water Standards (µg/l)	1[a]	11[a]	NS	NS
OTHER FEDERAL AND STATE STANDARDS, CRITERIA, AND ADVISORIES:				
NYS Recommended Soil Cleanup Objectives (mg/kg)	1.4	0.7	NS	0.3
NYS Sediment Criteria[b] (µg/gOC)	0.8	2.0	NS	NS
Federal Ambient Water Quality Criteria, Human Health Only (µg/l)	0.8	2.7	NS	NS
EPA Drinking Water Health Advisory - DWEL (µg/l)	500	NS	NS	NS
NIOSH IDLH (ppm)	150	1,000	1,000[c]	1,000[c]
OSHA PEL - TWA (ppm)	100	100	200	200

a - Guidance value; based on protection of human health from consumption of fish.
b - Human Health Bioaccumulation Sediment Criteria from Technical Guidance for Screening Contaminated Sediments (NYSDEC 1993).
c - Criteria apply to total of cis- and trans-isomers of 1,2-DCE.
NS - No standard.

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New York State Surface Water Standards have been promulgated by NYSDEC for the protection of human health and/or aquatic life and are legally enforceable. The surface water standards are dependent on the state-assigned classification of the surface water body as well as the carbonate hardness of the surface water for inorganic constituents. Subtributaries of the Muscoot River, which include the eastern and western streams at the BPM site, have been identified as Class B surface water bodies by NYSDEC. Class B surface waters are defined as water bodies whose best usage is primary and secondary contact recreation and fishing. The water quality in Class B surface water bodies should be suitable for fish propagation and survival. Class B surface water standards for the contaminants of concern are included in Table 2-2 and are based on the protection of human health through consumption of fish.

2.4.1.2 ***TBCs***. Chemical-specific TBCs for the site are summarized in Table 2-2 and described below.

New York State Recommended Soil Cleanup Objectives have been prepared by NYSDEC in a revised Technical and Administrative Guidance Memorandum (TAGM) issued on 24 November 1994 (NYSDEC 1994). This TBC guidance outlines the basis and procedure for determining soil cleanup levels at state Superfund sites. Soil cleanup objectives are based on protection of human health and groundwater quality, and are dependent on soil TOC content for organic compounds. In the absence of site-specific TOC data, the TAGM recommends soil cleanup objectives based on a TOC value of 1%. These cleanup objectives are applicable for unsaturated zone soils as they are derived based on the leaching potential of contaminants in unsaturated soils to the underlying groundwater.

New York State Sediment Criteria have been developed by NYSDEC and are included in the Technical Guidance for Screening Contaminated Sediments (November 1993). The NYSDEC sediment criteria are intended for use in identifying areas of sediment contamination and evaluating the potential risks posed by the contamination. These criteria are not considered remediation goals, but may be used to develop remediation goals for the site. The sediment criteria for organic compounds included in Table 2-2 are human health-based values assuming contact with the contaminants through bioaccumulation in fish.

Federal Ambient Water Quality Criteria (AWQC) have been developed by EPA for 64 pollutants. AWQC are not legally enforceable, but may be referenced by states when developing enforceable water quality standards. AWQC are available for the protection of human health from exposure to contaminants in drinking water and for the protection of aquatic life. Only those standards applicable for the protection of human health have been included in Table 2-2.

Drinking Water Health Advisories are nonenforceable guidelines developed by EPA for chemicals that may be encountered in drinking water. EPA has prepared short-term (1- to 10-day) and long-term (several years to lifetime) health advisories for subchronic and chronic effects of contaminants. A drinking water equivalent level (DWEL) is calculated as a lifetime health advisory based on a 2-liter/day water consumption for a 70-kg adult. The DWEL is the most appropriate guideline for evaluation of contaminant levels in a potable water supply, and are included in Table 2-2 for the contaminants of concern at this site.

National Institute for Occupational Safety and Health (NIOSH) has developed concentrations of contaminants in air that are immediately dangerous to life or health (IDLH) for individuals in occupational settings. The IDLH is the maximum concentration, which, in the event of respirator failure, could be tolerated for 30 min without experiencing any escape-impairing or irreversible health effects. The IDLHs are appropriate only for subchronic exposures to noncarcinogenic compounds or effects of compounds in air. These values are not directly applicable to CERCLA sites; however, they may provide guidance concerning the upper bound of safe inhalation exposures to contaminants for on-site workers.

The Occupational Safety and Health Administration (OSHA) has promulgated permissible exposure limits (PELs) for a variety of contaminants in air (29 CFR 1910, Subpart Z). The PELs are based on time-weighted average (TWA) concentrations to which workers may be exposed over an 8-hr exposure period without adverse health effects. PEL-TWAs are intended for adult workers exposed in an occupational setting, and are not directly applicable to CERCLA sites. The PEL-TWAs may be used as guidance values to determine whether long-term exposures to contaminants in air may pose a human health risk.

2.4.2 Location-Specific ARARs

The BPM site is not a critical or significant habitat for any threatened or endangered species, and no threatened or endangered species were observed or are expected to be present within the study area as determined in the fish and wildlife impact analysis (VUA 1994, Appendix N). Two low-quality wetlands areas were identified on the site, however, no rare or endangered plant species were present within the wetlands. Previous construction activities at the site have adversely affected these areas, resulting in diminished function and value of the wetlands.

The site is located within the Amawalk Reservoir watershed, which includes all upstream tributaries of the reservoir. The Amawalk Reservoir is part of the New York City water supply system and is therefore protected by the New York City Department of Environmental Protection (NYCDEP). Remedial activities at the site may require approval by NYCDEP prior to implementation. All point discharges to water bodies within watersheds for potable water supply systems are also subject to regulation by NYSDEC.

2.4.3 Action-Specific ARARs

Action-specific ARARs for the site include compliance with Section 121, Subsections 104 and 106, of CERCLA which states that the selected remedial alternative must attain a cleanup level that is protective of human health and the environment. The extent to which each of the remedial alternatives for the site complies with this requirement will be assessed during the detailed evaluation of alternatives.

Treatment and disposal of all hazardous wastes from the site must be in accordance with the Federal hazardous waste regulations (40 CFR Part 260-268) promulgated under the Resource Conservation and Recovery Act (RCRA), as well as New York State hazardous waste regulations (6 NYCRR Parts 364 and 370-376). Determination of the presence and appropriate waste code for any hazardous wastes at the site will be made in accordance with 6 NYCRR Part 371 (Identification and Listing of Hazardous Wastes). It is anticipated the PCE-contaminated soils from the site will be assigned an F002 and/or a U210 waste classification. These waste classifications are defined as follows:

- F002 wastes are spent halogenated solvents (including PCE, TCE, methylene chloride, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, orthodichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane) or spent solvent mixtures containing (before use) ten percent or more of one of the above halogenated solvents. This waste category includes any contaminated soil, water, or other debris resulting from cleanup of a spill of an F002 waste. Therefore, soils and groundwater contaminated through spillage of used PCE or PCE-containing mixture would be considered an F002 waste.

- A U210 waste is waste PCE as an unused commercial chemical product or any soil, water, or other debris contaminated by spillage of the unused commercial chemical product. Soils or groundwater contaminated by a spill of unused commercial-grade PCE are therefore classified as U210 wastes.

Soils and groundwater at the BPM may be either an F002 or a U210 waste or both, depending on the type of product (currently unknown) released or spilled to the environment. In addition, even if the wastes are not listed wastes (i.e., an F or U waste), they may still be characteristic wastes. Groundwater or soils with PCE exceeding the toxicity characteristic concentration of 0.7 mg/l (determined using the toxicity characteristic leaching procedure [TCLP] for soils) are also regulated as hazardous wastes and are classified as D039 wastes.

Federal and state land disposal restrictions (LDRs) (40 CFR Part 268 and 6 NYCRR Part 376, respectively) prohibit the direct land disposal of wastes with any of the waste codes potentially applicable to site wastes (i.e., F002, U210, and D039 wastes). Treatment of the wastes is therefore required prior to land disposal. The Federal LDRs specify allowable residues in treated wastes which must be met prior to land disposal regardless of the applicable waste code (Universal Treatment Standards); the residual concentrations for the site contaminants of concern are as follows:

	WASTEWATER	NONWASTEWATER
PCE	0.056 mg/l	6.0 mg/kg
TCE	0.054 mg/l	6.0 mg/kg
1,2-DCE (trans)	0.054 mg/l	30 mg/kg

These Universal Treatment Standards were promulgated by EPA on 19 September 1994 and take effect on 19 December 1994. New York State currently has different treatment levels for some of these waste code, as follows:

WASTE CODE	CONSTITUENT	WASTEWATER	NONWASTEWATER
F002	PCE	0.079 mg/l	0.05 mg/l (TCLP)
	TCE	0.062 mg/l	0.091 mg/l (TCLP)
U210	PCE	0.056 mg/l	5.6 mg/kg

Under current state regulations, the treatment level for PCE in F002 nonwastewaters is based on achievement of a concentration of 0.05 mg/l in the TCLP extract of the sample, while PCE in U210 nonwastewaters is based on a total PCE concentration of 5.6 mg/kg.

Transportation of hazardous wastes must be conducted in accordance with all applicable regulations, including 40 CFR Part 263 and 6 NYCRR Part 372.3. Storage of hazardous wastes on site is allowable only as a temporary control measure; wastes may be stored on site in such a manner as to prevent release of contaminants to the surrounding environment (e.g., use of impervious liners for stockpiling excavated soils) for a maximum of 90 days in accordance with 40 CFR Part 268 Subpart E. The requirements promulgated in 40 CFR Part 264, Section 117, and 6 NYCRR Part 373.2 (post-closure care and use of property), which include long-term groundwater monitoring and maintenance of controls for any contaminants remaining at the site, are also relevant and appropriate for this site following completion of any remedial activities.

Construction and development of a distribution system to supply water to affected residents on MPR or businesses on Route 6 must comply with the requirements included in 10 NYCRR Chapter I Subpart 5-1 (Public Water Systems) and with the Great Lakes Upper Mississippi River Board Standards for Water Works (Ten States Standards). The Public Water System requirements include minimum treatment for groundwater supplies by disinfection (e.g., chlorination), distribution system requirements such as maintenance of a minimum pressure of 20 psi and cross-connection control requirements, and water quality monitoring and record-keeping requirements based on the size of the system. The Ten State Standards specify well construction, treatment, pumping, storage, and distribution system requirements, including provision of a minimum of two sources of groundwater supply (e.g., two separate production wells) and redundant treatment capacity (e.g., two treatment units each capable of handling the maximum design flow). In addition, local authorities including the WCDOH and the Town of Somers may have specific requirements for design of public water supply systems (e.g., minimum water main sizes, provision of fire protection) that must be met prior to approval of a system.

CHAPTER 3

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES

3.1 INTRODUCTION

The first step in developing a range of alternatives intended to achieve the remedial action objectives established for the site is to identify all potentially applicable remedial technologies. An initial screening is performed in which the applicability of the identified technologies to site conditions, contaminants, and contaminated media characteristics is evaluated. The most promising technologies are combined into site-wide remedial alternatives, which are then included in the detailed analysis of alternatives.

The remedial technologies identified for potential application to contaminated soils and groundwater at the BPM site are listed in Tables 3-1 and 3-2, respectively. The technologies have been grouped by general response actions. General response actions are categories of technologies which represent a particular approach to achieving the remedial action objectives, and include institutional measures, containment, in situ treatment, removal, treatment, and disposal. Technology types and process options have been identified within each general response action. Technology types are general categories of technologies, e.g., thermal treatment, while process options are specific processes within each technology type, e.g., incineration.

The screening of the technology types and process options is summarized in Tables 3-1 and 3-2 and is discussed below. This screening was based on the criteria of effectiveness for treating impacted soils and groundwater present at the site, implementability given site-specific constraints, and relative cost. Ability to reduce PCE concentrations to required remedial action objectives was the primary focus of the evaluation. Treatability studies and/or site demonstrations may be needed to determine the ultimate applicability of a particular technology.

3.2 SOIL CONTROLS

3.2.1 Institutional Measures

Institutional measures for soil contamination which may be applied at the BPM site include access restrictions (e.g., fencing), deed restrictions, and development or building restrictions. The purpose of the institutional measures is to reduce the possibility of human contact with any contaminants remaining at the site in the absence of active remedial measures or following any

TABLE 3-1 (Page 1 of 7)

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Institutional Measures	A. Access restrictions		
	1. Fencing	No	Not consistent with use of site as active shopping mall; does not prevent continued migration of contamination to and within groundwater.
	B. Deed restrictions	Maybe	May be used to prevent human contact with existing contaminants in absence of active remediation; will not prevent continued migration of contaminants to groundwater.
	C. Development restrictions	Maybe	Same as above.
Containment	A. Capping	No	Effective for prevention of human contact with contaminants and migration of contaminants from unsaturated soils to groundwater; will not prevent continued leaching of contaminants in saturated soils to groundwater. Would preclude development in this area of the site.
	1. Synthetic membrane	No	Best used as part of a multilayer cap to prevent escape of volatilized constituents to atmosphere.
	2. Clay	No	May shrink or crack due to freezing/thawing; best used as part of a multilayer cap.
	3. Asphalt/concrete	No	Would not prevent escape of volatilized constituents to atmosphere; would require long-term maintenance.
	4. Multilayer cap	No	Most reliable capping method; may need to include vapor collection and treatment.

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SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In Situ Treatment	A. Biological		
	1. Bioremediation	No	Would require flushing of nutrients through source area using injection/capture wells; would not be consistent with continued pumping of groundwater for potable use. Halogenated volatiles are not as readily biodegradable.
	2. Bioventing	No	Applicable only to unsaturated soils where the water table is not within several feet of the surface; halogenated volatiles are not as readily biodegradable.
	B. Thermal		
	1. Vitrification	No	Applicable to unsaturated soils only. Results in significant subsidence of treated soils; would preclude future construction in this area of the site. Off-gases must be controlled.
	2. Radio frequency/ microwave heating	No	Primarily applicable to the unsaturated zone; has not been widely applied at hazardous waste sites to date. Off-gases must be controlled.
	C. Physical/chemical		
	1. Solidification/ stabilization	No	Generally applied to soils with inorganic contamination; high levels of organics may cause interference in process. Volatile organics may be released to atmosphere during mixing.

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TABLE 3-1 (Page 3 of 7)

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In Situ Treatment (Continued)	2. Soil flushing	No	Would require flushing of wash solution through source area; may be difficult to recapture flushing solution and may not be compatible with continued pumping of groundwater as potable water source. Not as effective on lower-permeability soils.
	3. Chemical degradation/ detoxification	No	No field demonstration for in situ treatment to date. Requires injection of potentially hazardous agents (e.g., hydrogen peroxide, hypochlorites) into subsurface; may not be compatible with continued pumping of groundwater as potable water source.
	4. Photolysis	No	Application limited to surface soils; no data available on the rate of PCE degradation through photolysis.
	5. Dilution	No	Mixing of clean soils with contaminated soils to reduce concentrations to acceptable levels is limited by volume of clean soils required and depth of contamination. Generally not acceptable to regulatory agencies.
	6. Soil vapor extraction	Maybe	Effective for removal of volatile organics from unsaturated zone; may be combined with another technology that addresses saturated zone. Off-gases must be controlled.
	7. Air sparging/soil vapor extraction	Yes	Compressed air forced into subsurface by injection wells removes volatile organics from saturated zone (soils and groundwater). Vapor extraction system used to capture volatilized constituents in the unsaturated zone.

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In Situ Treatment (Continued)	8. Thermally enhanced soil vapor extraction	No	Use of injected steam or hot air to increase volatilization of constituents from the subsurface not necessary for site contaminants (PCE, TCE). Not widely applied at hazardous waste sites to date.
	9. Pneumatic fracturing	No	Used primarily in bedrock and fine-grained soils to increase subsurface permeability for application of other in situ technologies. May adversely impact nearby utilities or structures and may open up new pathways for contaminant migration. Not widely applied at hazardous waste sites to date.
Removal	A. Excavation		
	1. Unsaturated soils	Yes	Can easily be accomplished using standard mechanical equipment (e.g., backhoes, scrapers).
	2. Saturated soils	Maybe	More difficult to accomplish due to need for dewatering, shoring of the excavation, etc.
On-SiteTreatment	A. Biological		
	1. Slurry phase biodegradation	Maybe	Degradation of PCE requires anaerobic conditions. May not be cost-effective for relatively small volume of soils to be treated and may require a longer time frame to complete treatment than with other technologies.

TABLE 3-1 (Page 5 of 7)

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
On-Site Treatment (Continued)	2. Solid phase biodegradation	Maybe	Easier process to control than slurry phase treatment but requires large area for treatment. May not be as effective for treatment of chlorinated volatile organics (e.g., PCE).
	3. Landfarming	No	Requires large area at site for treatment. PCE generally not degraded under aerobic conditions.
	B. Thermal		
	1. Low-temperature thermal desorption	Yes	Effective for the removal of volatile organic constituents from excavated soils. Soils may require dewatering prior to treatment; off-gases may also require treatment.
	2. High-temperature thermal desorption	No	More expensive than low-temperature desorption; volatiles are adequately removed using lower temperatures.
	3. Vitrification	No	Expensive, energy-intensive process. Off-gases need to be treated.
	4. Incineration	No	May not be cost-effective for treatment of relatively small volume of soils on site. Off-gases need to be controlled. May meet with public opposition.
	5. Pyrolysis	No	May not be as effective as other technologies for treatment of halogenated volatiles (PCE, TCE). May require dewatering of soils prior to treatment. Not widely applied at hazardous waste sites to date.

TABLE 3-1 (Page 6 of 7)

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
On-Site Treatment (Continued)	C. Physical/chemical		
	1. Solidification/ stabilization	No	May not be effective for immobilizing PCE. High levels of organics may interfere with process.
	2. Soil washing	No	Generally more effective on coarser-grained soils and for semivolatile and inorganic contaminants. Soil contaminants may volatilize to atmosphere during washing process.
	3. Dehalogenation (glycolate or base-catalyzed)	No	May require dewatering of soils prior to treatment. Generally more effective for halogenated semivolatile contaminants. High concentrations of organics may require large volumes of reagent thereby substantially increasing costs.
	4. Solvent extraction	No	Generally more effective for semivolatile contaminants. High water content of soils may adversely affect process. Extracted solvent requires subsequent treatment.
	5. Chemical reduction/ oxidation	No	No proven effectiveness for treatment of halogenated volatile organics. Not cost-effective for treatment of soils with high contaminant concentrations.
	6. Soil vapor extraction	Maybe	Excavation of soils prior to application of this technology increases cost over in situ treatment. May not be cost-effective for small volume of soils. Off-gases must be collected and treated.

TABLE 3-1 (Page 7 of 7)

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Disposal	A. On-site landfill	No	Excavated wastes require incineration prior to landfilling in accordance with LDRs. Construction of an on-site landfill is not compatible with development and use of the site as an active mall. Shallow depth to groundwater and location of NYCDEP watershed also pose constraints to landfill siting on site.
	B. Off-site landfill	No	Wastes with halogenated organic contamination exceeding LDR levels require treatment by incineration. Residue from incinerator may then be landfilled in a secure landfill.
	C. Off-site incineration	Yes	Excavated wastes may be transported to a permitted TSDF for incineration and disposal.

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Institutional Measures	A. Access restrictions		
	1. Groundwater use restrictions	Yes	May be used to prevent additional development of aquifer as potable water supply; may be applied to existing affected supply wells if alternate water supply provided.
	B. Alternate water supply		
	1. Point-of-use (POU) treatment units	Yes	POU units are currently effective for removing contaminants from pumped water at affected MPR homes and Route 6 businesses. May be acceptable for continued use.
	2. Bottled water	No	Affected residents currently have POU treatments units; bottled water is more costly and less reliable and is generally only used as a short-term action.
	3. Connection to existing water district	No	Only water district within a reasonable distance of site (ASWD) does not have adequate additional supply to provide water to affected residents.
	4. New community well	No	Pumping of a new community well in vicinity of site may adversely impact site groundwater flow regime. Status of Stephens Green development is currently unknown.
	5. Use of treated water from BPM production wells as potable supply	Yes	Most readily implementable water supply option; will require approval by state and local agencies.

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Containment	A. Capping (See Source Area Controls for process options)	No	Prevents migration of contaminants from unsaturated soils to groundwater; majority of highly contaminated soils at site are already within saturated zone. Would preclude development in the source area at the site.
	B. Vertical barriers	No	Contact with subsurface contaminants may result in chemical degradation. Not effective for preventing migration of contaminants from soils/overburden aquifer downward into bedrock aquifer unless keyed into horizontal barrier. Would preclude development of source area at site.
	1. Soil/bentonite slurry wall	No	Contact with subsurface contaminants may result in degradation. Construction of wall requires large working area.
	2. Cement/bentonite slurry wall	No	Although cement gives wall more strength, it increases wall permeability.
	3. Grout curtains	No	Grout can be mixed to set up quickly but is more expensive.
	4. Sheet piling	No	May be difficult to install due to tightness of fill material; not generally used as a long-term remedial technology.
	C. Horizontal barriers	No	May be difficult to ensure installation of continuous horizontal barrier, especially in low permeability till materials in source area.

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SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In Situ Treatment	A. Biological		
	1. Bioremediation	No	PCE degradation rates are relatively slow; partial degradation may result in presence of more toxic contaminants (e.g., vinyl chloride) in aquifer. Requires injection of nutrients into subsurface; may be difficult to recapture injection solution due to downward gradient and underlying fractured bedrock. Not consistent with continued pumping of aquifer as potable water supply.
	2. Oxygen enhancement with hydrogen peroxide	No	PCE generally not degraded under aerobic conditions; increasing oxygen content in aquifer not expected to increase rate of PCE degradation. Injection of hydrogen peroxide into subsurface is not consistent with continued use of aquifer as potable water supply.
	3. Nitrate enhancement	No	Has been demonstrated effective only on gasoline constituents to date; not expected to be effective for halogenated volatiles. Injection of nitrates into subsurface not consistent with continued use of aquifer as potable water supply.
	B. Physical/chemical		
	1. Passive treatment walls	No	Effective only for relatively shallow aquifers as trench must be tied into underlying impermeable layer; no such layer exists at site. Downward groundwater gradient in source area and large areal extent of contaminant plume would preclude use. Not widely applied at hazardous waste sites to date.

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SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In Situ Treatment (Continued)	2. Free product recovery	No	Presence of free product phase has not been detected at site.
	3. Hydrofracturing	No	Used to increase permeability of subsurface environment for subsequent in situ treatment or groundwater extraction; RI pump test indicated aquifer has sufficient permeability for groundwater extraction. Not widely applied at hazardous waste sites to date.
	4. Air sparging	Maybe	May be effective for volatilizing contaminants from aquifer (saturated soils and groundwater) through injection of air into subsurface. Generally implemented in conjunction with a soil vapor extraction system to collect volatilized contaminants.
	5. Hot water or steam stripping	No	Hot water or steam is injected into subsurface to volatilize contaminants which are captured by a vacuum extraction system. Generally applied to sites with semivolative organic contaminants since volatiles such as PCE are readily removed using air stripping. Not widely applied at hazardous waste sites to date.
Collection	A. Extraction wells		
	1. Shallow wells	Yes	May be used to capture contaminated groundwater in shallow till/weathered bedrock. Effectiveness is dependent on aquifer characteristics; moderate aquifer transmissivities are desirable.
	2. Deep wells	Yes	May be used to capture contaminated groundwater in fractured bedrock. Effectiveness is dependent on aquifer characteristics; RI pump test indicated adequate aquifer permeability for groundwater control/collection.

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER
Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Collection (Continued)	B. Injection wells	No	Injection of clean or treated water into aquifer to flush contaminants towards extraction wells; may not be cost-effective if extensive treatment is required to meet drinking water standards prior to reinjection and may not be technically feasible given site-specific aquifer characteristics.
	C. Subsurface drains		
	1. Interceptor trenches	No	Perforated pipe in trenches filled with porous media to collect contaminated groundwater. Applicable for collection of shallow groundwater only; not applicable to site due to downward gradient in source area and large areal extent of contaminant plume.
On-Site Treatment	A. Biological		
	1. Aerobic bioreactor	No	PCE not degraded under aerobic conditions.
	2. Anaerobic bioreactor	No	Generally not as effective on halogenated organics. Requires skilled operators to monitor process. Residuals may require additional treatment prior to disposal.
	B. Thermal		
	1. Incineration (rotary kiln, fluidized bed, liquid injection; or infrared)	No	Generally not cost-effective for wastes with ppm concentrations of contaminants. Off-gases must be controlled. May meet with public opposition.
	2. Wet-air oxidation	No	Generally used as an alternative to biological treatment for organic contaminants in highly concentrated wastewaters; not as cost-effective for waste streams with ppm contaminant concentrations.

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SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
On-Site Treatment (Continued)	3. Molten salt/plasma arc	No	Innovative technologies; application to hazardous waste sites has not yet been commercially demonstrated.
	C. Physical/chemical		
	1. Precipitation	No	Generally applicable for removal of inorganic contaminants only.
	2. Air stripping	Yes	Effective for removal of VOCs from wastewater. Off-gases must be controlled.
	3. Carbon adsorption	Yes	Proven effectiveness for removal of contaminants from site groundwater. Contaminant concentrations higher than those currently being treated may require increased carbon dosages.
	4. UV oxidation	Maybe	Generally effective for destruction of halogenated volatiles in wastewater; need to determine effectiveness for contaminants of concern (PCE, TCE). May also be used as an alternative to chlorination for disinfection of water to be subsequently used as a potable supply.
	5. Reverse osmosis	No	Expensive process in comparison with other suitable technologies. Membrane subject to chemical attack, fouling, and plugging.
	6. Ion exchange	No	Generally applicable for removal of inorganic contaminants only.
	7. Flocculation/coagulation	No	Effective for removal of particulate-phase contaminants only; not likely to be effective on dissolved-phase contaminants such as PCE in site groundwater.

SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
On-Site Treatment (Continued)	8. Oxidation (hydrogen peroxide, chlorine dioxide, or photo-catalytic)	No	May be effective for removal of halogenated volatiles from wastewaters. Incomplete oxidation may result in presence of more toxic constituents (e.g., vinyl chloride).
	9. Sedimentation	No	Effective on particulate-phase contaminants only; would require relatively large area at site.
	10. Chlorination	Yes	Not effective for removal of organic constituents, but may be required following other treatment processes for disinfection of water to be used as a potable water supply.
	11. Neutralization (pH adjustment)	No	Not effective for removal of volatile contaminants.
	12. Liquid-liquid extraction	No	Expensive process for removal of contaminants from wastewater streams in comparison with other suitable methods.
	13. Oil-water separator	No	Effective for removal of free product from wastewater streams; presence of free product has not been detected at site.
	14. Filtration	No	Effective for removal of suspended particulates only; not effective for dissolved constituents.
Disposal	A. On-site discharge		
	1. Discharge to stream	Yes	Discharge must meet applicable water quality standards for receiving waters.

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SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/ PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Disposal (Continued)	2. Seepage basins	No	Used to recharge treated groundwater to subsurface. Requires a fairly large area; would not be consistent with future development of site.
	3. Well injection	No	Would require drinking water quality effluent prior to injection; may not be technically feasible given site-specific aquifer characteristics.
	B. Off-site disposal		
	1. Publicly owned treatment works (POTW)	No	No available facility or sanitary sewer system in site vicinity.
	2. Treatment, storage, and disposal facility (TSDF)	Maybe	May be feasible for relatively small volumes of wastewater for disposal; not appropriate for long-term disposal of large volumes of wastewater.

remedial activities. Fencing may deter unauthorized access to contaminated areas of the site, however, restriction of property access is not consistent with future redevelopment of the mall. Deed restrictions limit or prohibit certain uses or development of the site in the event of transfer of the property to other ownership, and serve to notify prospective owners of the existence of remaining contamination at the site. Development or building restrictions serve similar purposes as deed restrictions, however, they apply to any new construction initiated by the current property owners. Both deed and development restrictions may be incorporated into the future development plans for the site and therefore reduce the possibility of human contact but will not prevent continued migration of contaminants to and within the groundwater.

3.2.2 Containment

Containment of contaminated soils in place may be accomplished through capping. A variety of capping materials are available, including synthetic membranes, clay, asphalt, and concrete. Synthetic membranes are generally constructed of polyvinyl chloride (PVC), chlorinated polyethylene (CPE), or synthetic rubbers, and are highly impermeable to liquids as well as vapors. Synthetic liners are generally more expensive than other capping materials and require special field installation including an underlying smooth subbase, therefore, synthetic membranes are best used as part of a multi-layer cap. Clay may form an effective cap, however, natural clays may shrink or crack due to repeated freezing or thawing of the ground. As with synthetic membranes, clay is most effective when incorporated into a multilayer cap. Asphalt or concrete may be used as single-layer capping materials. Maintenance of the asphalt/concrete areas is required to ensure the integrity of the cap over time. Clay, asphalt, and concrete are not effective in preventing the migration of vapors from contaminated soil areas, therefore, use of a multilayer cap including a synthetic membrane to control vapor emissions would be the most appropriate for this site because of the presence of volatile organics. Typical multilayer cap designs consist of a clay layer overlain by a synthetic membrane, with a sand or gravel layer for collection of volatilized constituents and appropriate vapor treatment, if necessary.

Capping may prevent human contact with contaminated soils as well as reduce infiltration of surface water which may mobilize contaminants in the unsaturated zone and transport them to the underlying groundwater. Contaminated soils are also present below the water table at this site, therefore, capping will not prevent the continued leaching of these constituents to the groundwater. In addition, capped areas would require long-term maintenance to ensure cap integrity and would preclude building construction in those areas of the site.

3.2.3 In Situ Treatment

In situ soil treatment technologies potentially applicable to this site include biological, thermal, and physical/chemical treatment processes. Many of these processes are innovative technologies, with limited commercial demonstration at hazardous wastes sites, therefore, their applicability to the site and feasibility may require further evaluation in treatability or pilot-scale studies.

Biological treatment technologies include bioremediation and bioventing. Bioremediation is the in situ biodegradation of contaminants, which generally requires flushing of nutrients for biological growth throughout the treatment zone using injection/capture wells. Installation of a bioremediation system would not be consistent with the continued pumping of site groundwater for use as a potable water source as the injected nutrients and microbial populations may be drawn down into the bedrock aquifer and captured by the production wells. Halogenated volatile organics such as PCE are also not as readily degradable as nonhalogenated organics; therefore the design of an appropriate system as well as the required time frame for remediation are more uncertain. Bioventing involves the injection of oxygen into the subsurface to increase degradation rates, however, this technology is also less effective for halogenated volatiles. In addition, bioventing is applicable only to the unsaturated zone; the small volume of contaminated unsaturated zone soils at the site would not make this technology cost-effective.

Thermal treatment processes for decontamination of soils include vitrification and radio frequency/microwave heating. In situ vitrification turns treated soils into a nonleachable obsidian-like glass by sending a current through the subsurface between two probes inserted in the ground. Volatile contaminants are vaporized during treatment, requiring capture and treatment of the off-gases. Vitrification results in significant subsidence of the treated soils and would preclude future construction in or near treated areas. In addition, this technology is primarily applied to unsaturated zone soils as treatment of saturated soils requires substantially increased energy inputs to vaporize any water present prior to vitrification of the soils. Radio frequency or microwave heating generates superheated steam from the groundwater to vaporize organic constituents present in the unsaturated zone, however, contaminants in saturated zone soils at depths of more than one to two ft below the water table are not removed. Furthermore, the small volume of contamination present in the unsaturated zone at this site would not make application of either technology cost-effective.

A wide variety of physical/chemical treatment technologies are available for application to in situ soils, including solidification/stabilization, soil flushing, chemical degradation/detoxification, photolysis, dilution, soil vapor extraction (including thermally-enhanced soil vapor extraction and air sparging in combination with soil vapor extraction), and pneumatic fracturing. Solidification/stabilization is the in-place mixing of soils with chemical reagents to prevent leaching of contaminants from the treated soils. High levels of organics such as are present in the BPM source area soils may interfere with the solidification process; this technology is also generally not as effective for treatment of volatile organics as compared to semivolatile and inorganic contaminants. Soil flushing involves circulating water or a flushing solution through contaminated soils to increase the leaching of contaminants from soils and to extract the contaminants from the subsurface. The treatment system must be designed to ensure that the flushing solution and leached contaminants are captured by the extraction system; use of a soil flushing system with groundwater injection/extraction wells would therefore not be compatible with continued pumping of site groundwater as a potable water source. In addition, soil flushing is more difficult to apply to lower permeability soils such as those found at the site.

Soil contaminants may be degraded in situ through introduction of detoxification agents (e.g., hydrogen peroxide, hypochlorites, etc.) into the subsurface, however, complete reaction may be difficult to ensure. In situ detoxification is not applicable to the BPM site as the majority of the contaminated soils are present below the water table, and injection of potentially hazardous reagents into the groundwater is not compatible with the use of the groundwater for potable water supply. Photolysis is the destruction of organic contaminants by exposure to light (e.g., sunlight); this technology is therefore limited to surface soils. Data on the extent of photolytic degradation for PCE is not available to determine if this process would be effective. Dilution involves mixing contaminated soils with clean soils to reduce overall contaminant concentrations to acceptable levels. This option is generally not acceptable to regulatory agencies and may be difficult to implement due to the volume of clean soil required and the identified depth of contamination at the site.

Soil vapor extraction involves application of a vacuum to extraction wells installed in the soil which creates a pressure gradient that induces volatilized contaminants to diffuse through the soils to the extraction wells for removal. A system for handling the off-gases must be included in the process. This technology is applicable to unsaturated zone soils only, however, it may be implemented in conjunction with other technologies that address the saturated zone, such as air sparging. Air sparging uses compressed air forced into the subsurface through injection wells to volatilize contaminants below the water table (i.e., both dissolved contaminants and contaminants adsorbed to soil particles). The volatilized constituents are then captured using a soil vapor extraction system installed above the water table. The combined air sparging/soil vapor extraction system may be appropriate for remediation of the source area at this site as the majority of the highly contaminated soils are present below the water table. Thermally enhanced soil vapor extraction is the use of injected steam or hot air to increase the volatilization of subsurface contaminants. This technology is primarily applied at sites with semivolatile organic contamination; the contaminants present at this site (PCE, TCE) are readily removed using conventional vapor extraction.

Pneumatic fracturing, the injection of pressurized air into the subsurface to develop cracks in low permeability formations, may be applied at a site to increase the permeability of the subsurface environment to allow for more effective implementation of other in situ treatment technologies. Disadvantages of this technology include potential damage to subsurface utilities and structures and the potential for creating new contaminant migration pathways. Pneumatic fracturing is used primarily to fracture bedrock and clay formations and has not been widely applied at hazardous waste sites to date.

3.2.4 Removal

Excavation may be the most cost-effective method for removing soil contaminants, depending on site conditions. The contaminants are permanently removed from the site, although appropriate treatment and/or disposal of the excavated materials is required. Shallow soils may be readily removed using conventional earthmoving equipment, while excavation of soils below the water table will require the use of appropriate dewatering methods (e.g., use of sheet piling and/or groundwater pumping). Volatile emissions may require control during the excavation.

3.2.5 On-Site Treatment

3.2.5.1 ***Biological Treatment***. Biological treatment options for excavated soils include slurry phase biodegradation, solid phase biodegradation, and landfarming. Biodegradation of halogenated organics such as PCE is generally not as effective as treatment of nonhalogenated compounds; the time frame for biological treatment may be relatively long as compared to other treatment technologies. Solid phase biodegradation is an easier process to control than slurry phase biodegradation but requires a large area for treatment. Both processes may not be cost-effective for the relatively small quantity of soils to be treated from this site. Landfarming involves spreading the contaminated soils over the ground surface and aerating the soils by turning them over periodically. As this technology requires a large area, on-site landfarming would not be compatible with continued active use of the site as a mall.

3.2.5.2 ***Thermal Treatment***. Low-temperature and high-temperature thermal desorption, vitrification, incineration, and pyrolysis are thermal treatment technologies that may be applied to excavated site soils. Mobile treatment units are currently available for each of these technologies, with the exception of pyrolysis, which has been tested at pilot-scale only to date.

Low-temperature thermal desorption involves heating wastes to 200-600°F to volatilize water and any organic contaminants present. The low temperatures do not oxidize (i.e., destroy) the volatilized constituents, so off-gas collection and treatment is required. In addition, saturated soils may require dewatering prior to treatment. High-temperature thermal desorption heats the excavated soils to 600-1,000°F for volatilization of the contaminants present. As with low-temperature treatment, the volatilized constituents will not be destroyed, but will require collection and treatment. This technology is generally applied for the removal of semivolatile constituents from soils as lower temperatures are not sufficient for their removal. Low-temperature thermal desorption is expected to be adequate for removal of the volatile organics present in site soils.

Vitrification involves melting contaminated soils at high temperatures to form a crystalline structure with low leaching characteristics. Volatile organics may be driven off during the process, requiring collection and treatment of off-gases. Vitrification is an expensive, energy-intensive process that has not been widely applied at hazardous waste sites to date. Incineration uses high temperatures (1,600-2,200°F) to volatilize and combust any organic contaminants present. On-site incineration may not be cost-effective for the relatively small quantity of soils to be treated; in addition, public opposition may limit the application of this technology. Pyrolysis induces chemical decomposition of organic contaminants using heat in the absence of oxygen. This technology is generally not as effective for halogenated volatiles (e.g., PCE and TCE) as for semivolatile organics and may require dewatering of soils prior to treatment. Pyrolysis has also not been widely applied at hazardous waste sites to date.

3.2.5.3 ***Physical/Chemical Treatment.*** Physical or chemical treatment technologies for excavated soils include solidification/stabilization, soil washing, glycolate or base-catalyzed dehalogenation, solvent extraction, chemical reduction/oxidation, and soil vapor extraction. Solidification/stabilization is generally applied to immobilize inorganic contaminants; demonstration of its effectiveness on volatile organic constituents is limited. In addition, high concentrations of organics are known to interfere with the treatment process. In soil washing, contaminants sorbed onto soil particles are separated from the soils using a washing fluid. In addition, more highly contaminated fines are separated from larger, generally less-contaminated particles. This technology is more frequently applied for removal of semivolatile and inorganic rather than volatile constituents and is also more effective on coarser-grained soils than those present at the BPM site.

Dehalogenation using polyethylene glycolate (APEG) or a base catalyst may be used to reduce the toxicity of the halogenated volatile constituents present. This process is accomplished through mixing of the soils with the dehalogenation reagents in a reactor vessel that is heated to increase the reaction rate. Dehalogenation may require dewatering of the soils prior to treatment and is generally more effective on semivolatile rather than volatile contaminants. In addition, high concentrations of organics may require very large volumes of reagents for effective treatment. Solvent extraction is also more effective for semivolatile rather than volatile contaminants; this technology involves mixing an extraction solvent with the soils to desorb contaminants. The organics and solvent mixture is then treated to separate the solvent for recycling; the waste organic stream requires appropriate treatment and/or disposal. Chemical reduction/oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds though addition of ozone, hydrogen peroxide, hypochlorites, chlorine, or chlorine dioxide. This technology has not been demonstrated to be effective for the treatment of volatile organic contaminants.

Soil vapor extraction may be applied to excavated soils. This technology is essentially the same as in situ soil vapor extraction; a vacuum is applied to a network of piping installed in the excavated soil pile to encourage volatilization of organics. The process requires a system for handling the off-gases. Excavation of the soils prior to treatment increases the cost of this technology over in situ treatment.

3.2.6 **Disposal**

Disposal options for soils excavated from the BPM site include on-site landfilling, off-site landfilling, or off-site incineration. Construction of a hazardous waste landfill on the site has a number of constraints to its implementation, including shallow depth to groundwater, location within a NYCDEP watershed, and incompatibility with future development of the site. In addition, soils contaminated with a listed hazardous waste (i.e., F002 or U210 wastes) or containing halogenated organic constituents at concentrations exceeding the LDR treatment standards are banned from land disposal without prior treatment. Incineration is the preferred treatment technology for solvent-contaminated soils. Therefore, on- or off-site landfilling of the excavated soils in a hazardous waste landfill is not an acceptable option without prior treatment. Untreated excavated wastes may be transported to an approved treatment, storage, and disposal facility (TSDF) for incineration (or other comparable treatment). The incinerator ash may then be disposed of in a secure landfill depending upon the chemical characteristics of the ash. Soils treated on site may be replaced on site if regulatory criteria are met or the soils may be transported off site for disposal in a hazardous or nonhazardous waste landfill, depending on remaining contaminant concentrations.

3.3 GROUNDWATER CONTROLS

3.3.1 Institutional Measures

Groundwater use restrictions are a groundwater-specific institutional measure that may be applicable to the BPM site to prevent the additional development of contaminated or potentially contaminated portions of the aquifer as a potable water source. If an alternate source of water supply is provided to affected residents or businesses, groundwater use restrictions may be applied to existing individual potable supply wells to prohibit future use of these wells.

Provision of an alternate water supply for affected residents on Meadow Park Road and businesses on Route 6 also constitutes an institutional measure for prevention of human contact with contaminated groundwater. Alternate water supply options include POU treatment units, bottled water, connection to an existing water district, use of treated water from the BPM production wells as a potable supply, and pumping of a new or existing community water supply well.

While the affected homeowners may oppose the continued use of POU treatment units, they have been shown to be technically effective in providing potable water that meets Federal and state standards. Therefore, this technology is retained for further consideration both alone and in conjunction with other soil and groundwater remediation technologies. Bottled water was eliminated as a potential water supply option because affected residents and businesses currently have POU treatment units for removal of the contaminants of concern. Provision of bottled water is a more costly and less reliable option that POU units, and is generally only used as a temporary action.

Potential off-site sources for potable water supply to the homes on MPR that were identified include the Amawalk/Shenorock Water District (ASWD), the Westchester County Water District (WCWD) No. 2, and the Lake Baldwin Water District.

The Lake Baldwin Water District does not have adequate additional supply for serving the MPR area; in addition, the site is in Westchester County while the Lake Baldwin Water District is in Putnam County, creating additional administrative difficulties. This source was therefore eliminated as a potential water supply option for the MPR homes.

The nearest water main in WCWD No. 2 for tie-in by a distribution system from the MPR area is located at the junction of Routes 35 and 118 in Westchester County, a distance of approximately 5 miles from the site. This alternative is therefore not considered to be technically feasible for implementation (L. Doyle, WCDOH 1994, pers. commun.).

The ASWD is within a reasonable distance of the site (approximately half a mile), but does not currently have sufficient treatment capacity for supply of the MPR area (A. Smith, ASWD 1994, pers. commun.). The ASWD has submitted proposed plans to NYSDOH for construction of a new surface water filtration plant to augment their current treatment capacity. Due to the high cost of construction of the new treatment facility, the State has requested that ASWD perform a feasibility study to evaluate connection with WCWD No. 2 as an alternative to construction of the new plant. If this option were implemented, the ASWD would then have adequate yield to supply the MPR homes. This option is currently under consideration by ASWD as well as by the WCDOH and the Town of Somers to determine if the County does indeed have adequate additional yield. Implementation of this alternative would require that both the ASWD and the MPR area be incorporated into WCWD No. 2; the Somers Town Board must vote for incorporation, with approval by the State Legislature. Due to the administrative complexities involved, a time frame of two to five years is estimated for implementation of this option, however, no current conclusions can be made regarding the likelihood of connection of the ASWD to WCWD No. 2, allowing for potential supply to the MPR area.

Stephens Green is a proposed 200-home development on the east side of Route 118 across from MPR. Existing production wells at Stephens Green have sufficient capacity for the proposed homes with an excess supply. This supply is not considered a potential potable water source for the MPR homes at this time as no water district currently exists for distribution of the supply, the wells are not currently being used as a potable supply, and the potential for approval of use of the wells as a potable water supply by the Planning Board is currently unknown. The ASWD has indicated an interest in future incorporation of the Stephens Green area into their water district for use as an additional supply source. However, the Town of Somers has indicated that they may not approve such an option due to the location of the wells with respect to the BPM site; they are concerned that pumping of these production wells may impact groundwater flow patterns in the vicinity of the BPM site (G. Gagner, Town of Somers 1994, pers. commun.). Similarly, installation of new production wells in the vicinity of BPM to provide a potable supply source for the MPR homes may also adversely impact groundwater flow patterns and was eliminated from further consideration.

The final water supply option, installation of a distribution system to convey treated water from the BPM production wells to the MPR homes, appears to be the most readily implementable. Both the WCDOH and the Town of Somers have indicated that they would be willing to approve such a system given the lack of other readily implementable options. This alternative would require either the creation of a new water district by Big V Supermarkets for supply of the MPR homes, or the MPR area could be administratively included within the ASWD, although the MPR and ASWD distribution systems would not be physically connected. The two systems could then be connected at some point in the future if and when the ASWD is connected to WCWD No. 2.

3.3.2 Containment

Capping or surface sealing may be used to prevent migration of contaminants from the unsaturated zone to underlying groundwater through prevention of surface water infiltration. This technology is not applicable to the BPM site as a substantial portion of the highly-contaminated source area soils are present below the water table. In addition, capping of the source area would preclude future building construction on this portion of the site.

Vertical or horizontal barriers are another technology for the containment of contaminated groundwater. Their applicability to a site is dependent on site-specific geologic conditions. A number of different subsurface barrier options are available for containment of groundwater, including barrier placement options and construction materials. Barriers may be placed upgradient from the source area to decrease or prevent the flow of uncontaminated groundwater into the source area, while downgradient barriers may be used to prevent the migration of contaminated groundwater to uncontaminated areas. The most effective method of barrier wall placement is to completely encircle the contaminant plume, thereby isolating the source area. Horizontal barriers, i.e., bottom sealing, may be used to form a "floor" beneath the source area.

Potential materials for construction for groundwater barriers include soil/bentonite, cement/bentonite, grout, and sheet piling. A soil/bentonite slurry trench may be constructed at the site, however, contact with certain contaminants in the subsurface may result in deterioration of the slurry trench. Cement/bentonite slurry as a barrier construction material is stronger than soil/bentonite, but is generally more permeable. Grout, injected into the subsurface in formations known as curtains, is easier to install than slurry walls and sets up more quickly, but is more expensive and may also be subject to chemical degradation. Driving sheet piling to form an impermeable barrier may be difficult in the densely compacted till materials present in the source area. Due to the high cost and unpredictability of the wall integrity, sheet piling is generally used only for temporary dewatering.

The geology of the BPM site may limit the effectiveness of vertical barriers because there is no shallow continuous impermeable layer into which the barriers can be tied; vertical groundwater gradients in the source area result in direct migration of contaminants from the glacial till to the underlying weathered and competent bedrock. Groundwater flow within the bedrock system would then transport the contaminants beneath any vertical barriers installed in the till. Formation of an impermeable bottom seal through injection of grout beneath the source area would be difficult due to the low permeability of the till materials. Use of subsurface barriers for groundwater control was therefore eliminated from further consideration.

3.3.3 In Situ Treatment

In situ treatment technologies address contaminated groundwater in place without the need for collection/extraction of the groundwater. These techniques are most effective where the contaminant plume is well defined, homogenous, shallow in depth, and small in areal extent. Potential in situ treatment technologies for groundwater include biological and physical/chemical processes.

Bioremediation, or enhanced biodegradation, uses indigenous or introduced bacteria to biodegrade organic compounds under favorable soil conditions by optimizing such factors as oxygen content, pH, and temperature of the groundwater. The primary contaminant of concern at the site, PCE does not degrade under aerobic conditions and although degradation does occur under anaerobic conditions, the process is relatively slow. This technology requires injection of nutrients into the subsurface; recapture of the injection solution may be difficult due to the downward groundwater gradient in the source area and the underlying fractured bedrock. Incomplete degradation of PCE may result in the presence of more toxic breakdown products (i.e., vinyl chloride) in the aquifer.

Oxygen enhancement with hydrogen peroxide and nitrate enhancement are process options intended to increase the rate of in situ biodegradation. As discussed above, PCE does not degrade under aerobic conditions, therefore, increasing the oxygen content in the subsurface through injection of hydrogen peroxide will not increase the rate of PCE degradation. Nitrate enhancement has also not been demonstrated to be effective for treatment of halogenated volatile organics such as PCE. In addition, injection of potentially toxic constituents such as hydrogen peroxide or nitrate into the subsurface is not consistent with continued pumping of the aquifer as a potable water supply.

Passive treatment walls or beds are an innovative technology for the removal of contaminants from groundwater by subsurface beds filled with adsorptive media (e.g., ion-exchange resins or limestone) through which contaminated groundwater flows. Treatment walls are effective for removal of contamination present at relatively shallow depths (i.e., the depth to which a treatment wall can feasibly be installed) in the aquifer. Vertical groundwater gradients such as are present in the source area would result in groundwater flow beneath the treatment wall limiting their effectiveness for this site. In addition, this technology could feasibly be applied only to the source area due to the large areal extent of the contaminant plume.

Free product may be removed from the subsurface through pumping or passive collection techniques (e.g., subsurface trenches), however, free product was not detected at the site during any of the field investigation activities.

Hydrofracturing is an innovative technology used to increase the permeability of the subsurface environment to enhance the effectiveness of other in situ treatment or collection technologies. Pressurized water is injected into the subsurface to produce cracks in low permeability formations. This technology may result in increased migration of contaminants through creation of new contaminant pathways and may also adversely impact nearby underground utilities or structures. The aquifer pump test conducted during the RI indicated that the aquifer has adequate permeability for groundwater collection, therefore, this technology does not appear to be applicable to this site.

Air sparging is an in situ groundwater treatment technology applicable for the removal of volatile organic compounds which uses compressed air forced into the subsurface to volatilize the contaminants present. Air emissions generated must be monitoring and treated appropriately. Hot water or steam may be used in place of compressed air to increase the volatilization of subsurface constituents, however, the contaminants of concern at this site (PCE and its breakdown products) are readily removed using air stripping alone. This technology is often used in conjunction with soil vapor extraction for removal of volatilized organics in the unsaturated zone (Section 3.2.3). This technology is best suited for sites with coarse-grained materials (e.g., sand); the relatively low permeability of the till materials in the source area may inhibit air flow through the subsurface. This technology was retained for further evaluation of its implementability and feasibility.

3.3.4 **Collection**

Groundwater pumping is the most common collection method and may be used to extract contaminated groundwater for subsequent treatment and disposal. Extraction wells are used for groundwater and contaminant plume control. Application of this technology is dependent on aquifer characteristics and plume dimensions, as well as the extracted groundwater treatment and disposal options. Moderate aquifer transmissivities are desirable; the pump test conducted during the RI indicated that aquifer permeabilities are adequate for effective groundwater capture and extraction. Shallow wells may be used for extraction of groundwater in the shallow till or weathered bedrock environments, while deep wells will be required for extraction of groundwater from the bedrock. Clean or treated water may be injected into the aquifer to flush contaminants toward the extraction wells, however, injection of pumped groundwater may not be practical or cost-effective given (1) the shallow depth to groundwater at the site; (2) the relatively low to moderate permeability of the bedrock aquifer; and (3) the possible need for extensive pretreatment to meet drinking water standards as required prior to injection.

Subsurface drains (e.g., interceptor trenches) may also be used for groundwater control or collection. Interceptor trenches consist of perforated pipe installed in trenches filled with porous media to capture contaminated groundwater at or just below the water table surface in unconsolidated deposits. Collection of groundwater in weathered bedrock or bedrock environments is therefore not feasible using interceptor trenches. This technology is not applicable to the BPM site due to the depth of identified groundwater contamination and the large areal extent of the contaminant plume.

3.3.5 On-Site Treatment

A wide variety of technologies are available for the treatment of collected groundwater, including biological, thermal, and physical/chemical methods. The choice of an appropriate treatment technology is dependent on the nature and concentration of the contaminants present as well as the relative costs and effectiveness of each of the technologies. The presence of more than one type of contaminant in the extracted groundwater may dictate the use of more than one process option in a treatment train. A brief discussion of the available process options for treatment of contaminated groundwater within each of the three treatment technology categories is presented below.

3.3.5.1 ***Biological Treatment***. Biological treatment technologies include aerobic and anaerobic bioreactors. As discussed previously, PCE is not biodegraded under aerobic conditions. Anaerobic treatment may be used to remove PCE from extracted groundwater, however, the rate of degradation is relatively slow and would therefore require relatively large reactors to achieve the necessary retention time. Skilled operators are required to monitor the treatment process and maintain optimum conditions, and subsequent treatment to separate out the biological solids prior to disposal is needed. Biological treatment was not retained for further consideration due to the availability of other, more effective treatment technologies.

3.3.5.2 ***Thermal Treatment.*** Thermal treatment technologies may be effective for the removal of organic constituents from water. Appropriate treatment of air emissions is required to remove any volatilized constituents prior to release to the atmosphere. Thermal treatment units that have the potential to handle liquids include incinerators (rotary kiln, fluidized or circulating bed, liquid injection, or infrared), wet-air oxidation, and molten salt/plasma arc units. Wet-air oxidation and molten salt/plasma arc are both innovative treatment technologies that have not yet been commercially demonstrated at hazardous waste sites, therefore, their reliability and effectiveness are unknown. Incineration is an energy-intensive process and is not generally effective for liquid streams with part per million (ppm) contaminant concentrations. Administrative difficulties, including air permitting requirements and potential public opposition, make thermal treatment less implementable than other comparable treatment technologies, therefore, thermal treatment was eliminated from further consideration.

3.3.5.3 ***Physical/Chemical Treatment.*** Physical/chemical treatment technologies that may be applicable for the extracted groundwater flow include precipitation, air stripping, carbon adsorption, UV oxidation, reverse osmosis, ion exchange, flocculation/coagulation, oxidation, chlorination, neutralization, liquid-liquid extraction, oil-water separation, and filtration. A number of these technologies are not applicable for removal of the contaminants of concern (PCE and its breakdown products) from water streams: precipitation, ion exchange, and neutralization are generally employed for the removal of inorganic contaminants only, while flocculation/coagulation, sedimentation, and filtration are effective for removal of particulate-phase as opposed to dissolved-phase constituents.

Both air stripping and carbon adsorption have been proven effective in removing volatile organic compounds from waters; carbon adsorption is currently applied at the site for the removal of PCE and its breakdown products from extracted groundwater. Periodic regeneration of the activated carbon in the carbon adsorption units is required to prevent break-through of contaminants. Air stripping requires emission controls to handle volatilized constituents. Both technologies are also effective for the removal of gasoline constituents (BTEX and MTBE) from water.

Oxidation using hydrogen peroxide, chlorine dioxide, or photocatalysts may be used to destroy volatile organics in water, however, incomplete oxidation may result in the presence of more toxic constituents (e.g., vinyl chloride) in the treated stream. UV oxidation may also be used to destroy volatile organics, or may be used as an alternative to chlorination for disinfection of treated water supplies intended for potable use. Chlorination is not generally used for removal of organic constituents, but may be required for disinfection of the treated water, depending on the ultimate disposal or use of the water.

Reverse osmosis and liquid-liquid extraction have been demonstrated effective for removal of organic contaminants from water, however, these technologies are more expensive in comparison with other, equally effective, technologies. In addition, the membranes used for reverse osmosis are subject to chemical degradation and fouling. Oil-water separation may be used for removal of a free product phase from extracted groundwater, however, no free product has been detected at the site.

3.3.6 **Disposal**

Disposal options for collected groundwater from the site are dependent on the volume of water, pretreatment/treatment requirements, and regulatory considerations. Site groundwater may be discharged to a local publicly owned treatment works (POTW), however, no such facility is present in the vicinity of the site. Untreated groundwater may also be transported to a TSDF for treatment and disposal, however, this alternative is not cost-effective for large volumes of water and/or continuing discharges.

Discharge to a nearby surface water body (e.g., the eastern stream) is feasible, however, the discharge will require treatment to meet applicable surface water quality standards and otherwise meet the performance standards necessary to obtain a SPDES permit for the discharge. Seepage basins are used to recharge treated groundwater/surface water to the subsurface, however, they require a fairly large area and would therefore be restricted by available space at the site. Reinjection of extracted groundwater to the upper glacial aquifer is not technically feasible given the shallow depths to groundwater and low permeability of the glacial materials.

CHAPTER 4

SCREENING OF PRELIMINARY REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

The first step in developing a range of alternatives intended to achieve the remedial action objectives for the site is to identify potentially applicable remedial technologies, as discussed in the previous chapter. The most promising technologies are then combined into preliminary remedial alternatives, which are screened based on their effectiveness, implementability, and cost. The goal of this preliminary alternative screening process is to reduce the number of alternatives that will be included for subsequent detailed evaluation by identifying the most promising and cost-effective alternatives for remediation of the site.

The NCP includes requirements for development of remedial alternatives to ensure that the alternatives selected provide decision-makers with an appropriate range of options as well as sufficient information to compare the alternatives. The range of options is dependent on site-specific conditions, however, to the extent possible, one or more alternatives in each of the following categories should be developed:

1. A range of source control alternatives that includes treatment to reduce the toxicity, mobility, or volume of contaminants present, including:

   a. An alternative that removes or destroys contaminants to the maximum extent possible and minimizes the need for long-term management of remaining wastes or waste treatment residuals.

   b. One or more alternatives that vary in the degree of treatment and long-term management required.

   c. An alternative that involves little or no treatment but protects human health and the environment through containment or institutional controls to prevent exposure to hazardous materials.

2. For groundwater response actions, a range of alternatives that achieve the contaminant-specific remedial action levels within different time periods.

3. One or more innovative treatment technologies, if any such technologies appear promising (i.e., comparable or superior performance for lower cost).

4. The no or minimal action alternative.

The development, preliminary screening, and selection of a final range of remedial alternatives which addresses these NCP requirements is presented below.

4.2 DEVELOPMENT AND SCREENING OF PRELIMINARY REMEDIAL ALTERNATIVES

The source control technologies retained for further evaluation are listed in Table 4-1 by their general response categories. Deed and development restrictions have been retained in the institutional measures category and are intended to prohibit development of all or portions of the site in the event that no remediation of the source area is conducted. Although the no/minimal action alternative for the source area is not consistent with plans for redevelopment of the mall and is unlikely to be acceptable to NYSDEC, it is retained for evaluation in accordance with NCP requirements. Air sparging/soil vapor extraction was retained as the most applicable in situ treatment technology due to its potential ability to remove volatile organic constituents from unsaturated and saturated zone soils and groundwater in the source area and relatively low costs compared to other in situ technologies (e.g., thermal treatment technologies). Excavation was retained as it may be the most effective contaminant removal technology. The excavated soils may be treated on site using thermal desorption or transported off site to an approved TSDF for incineration or other treatment process and landfilling. Both on- and off-site soil treatment were retained for further evaluation to allow for a cost-benefit analysis of these options as part of the detailed evaluation.

Table 4-2 lists the retained groundwater remediation technologies by general response category. In the institutional measures category, groundwater use restrictions have been retained as appropriate for preventing human contact with contaminated groundwater. This option is only applicable, however, if an alternative source of water is supplied. Water supply options for the MPR homes and Route 6 businesses that have been retained include continued use of the POU treatment units or construction of a distribution system to convey treated water flows from the BPM production wells to the MPR residences. A number of different groundwater collection options exist, including increased pumping of the BPM production wells, placement of a recovery well in the source area, placement of a recovery well in the western portion of the site, and/or placement of a recovery well in the southeast portion of the site downgradient of the plume source. Treatment options for the extracted groundwater include the existing GAC treatment system for the BPM production wells or a new treatment system to handle separate flows from the recovery wells. On-site discharge to a stream was retained as the disposal option for treated groundwater not provided to a distribution system.

TABLE 4-1

REMEDIAL TECHNOLOGIES SUCCESSFULLY PASSING SCREENING: SOURCE AREA SOILS

Baldwin Place Mall

GENERAL RESPONSE CATEGORY	TECHNOLOGY
Institutional Measures	Deed/development restrictions
In Situ Treatment	Air sparging/soil vapor extraction
Removal	Excavation
Treatment	On-site thermal desorption Off-site incineration

Disk No.: H179 100233.XLS Table 4-1 11/1/94 10:21:36 AM

TABLE 4-2

REMEDIAL TECHNOLOGIES SUCCESSFULLY PASSING SCREENING: GROUNDWATER

Baldwin Place Mall

GENERAL RESPONSE CATEGORY	TECHNOLOGY
Institutional Measures	Groundwater use restrictions
Water Supply	Continue POU treatment for MPR homes Continue POU treatment for Route 6 businesses Distribution system to MPR homes
Collection	Increased pumping of BPM production wells Source area recovery well Western site recovery well Southeastern site recovery well
Treatment	Existing production well GAC treatment system Separate recovery well treatment system (GAC or air stripping)
Discharge	Discharge treated groundwater to on-site stream

Disk No.: H179 100233.XLS Table 4-2 11/29/94 12:34:49 PM

The technologies listed in Tables 4-1 and 4-2 were then combined into potential remedial alternatives for the site. Source area and groundwater alternatives were developed and screened separately as shown in Tables 4-3 and 4-4, however, it is recognized that source area actions impact the time frame and requirements for remediation of site groundwater. Site-wide alternatives were not developed during the screening of preliminary alternatives as the number of soil and groundwater treatment options involved would result in a large matrix of potential site-wide alternatives; such a matrix of alternatives would be too cumbersome for effective evaluation. Therefore, potential alternatives for source area and groundwater remediation were initially evaluated separately as discussed below. Site-wide remedial alternatives were then developed by combining retained source area and groundwater alternatives as discussed in the following section.

The source control alternatives listed in Table 4-3 include the no action alternative, an in situ treatment alternative, and four alternatives with varying excavation scenarios. Alternative 1, no/minimal action, was retained for evaluation in accordance with NCP requirements. Alternative 1 includes no active remediation of source area soils but relies on deed and development restrictions to prohibit development in this area of the site to minimize potential health risks as a result of exposure to remaining contamination. Alternative 2 includes air sparging/soil vapor extraction to address contamination present both above and below the water table in the source area. This alternative was retained as an in situ treatment option for comparison with excavation of the contaminated soils.

Source control Alternatives 3 through 6 include four different excavation scenarios for the purpose of evaluating the relative costs and benefits of increasing the area of excavation. Alternative 3 includes excavation of the estimated 25 yd^3 of highly contaminated unsaturated soils from the area shown on Figure 2-1. Excavation of these soils will not require any dewatering, simplifying the excavation process. Alternative 4 assumes excavation of both saturated and unsaturated soils; the area of saturated soils to be excavated will be based on removal of the most highly contaminated materials (i.e., soils exceeding 50 mg/kg PCE) as shown on Figures 4-1, 4-2, and 4-3. The total estimated excavation volume for Alternative 4 is 95 yd^3. Alternative 5 includes excavation of soils with PCE concentrations exceeding 10 mg/kg and would result in removal of approximately 135 yd^3 from the locations indicated on Figures 4-4, 4-5, and 4-6. Alternative 6 assumes that all identified soil contamination exceeding 1.4 mg/kg will be excavated; as shown on Figures 4-7, 4-8, and 4-9, this is approximately 185 yd^3 of soils.

Estimated costs were prepared for each of the four excavation scenarios, as shown in Table 4-5. Off-site incineration and landfilling was assumed for disposal of the excavated soils in each

TABLE 4-3

PRELIMINARY SOURCE AREA ALTERNATIVES

Baldwin Place Mall

ALTERNATIVE	Deed/Development Restrictions	Air Sparging/Soil Vapor Extraction	Excavate 25 yd^3 of Soil[a]	Excavate 95 yd^3 of Soil[b]	Excavate 135 yd^3 of Soil[c]	Excavate 185 yd^3 of Soil[d]	Soil Treatment[e]
1 (No/Minimal Action)	X						
2		X					
3			X				X
4				X			X
5					X		X
6						X	X

Shading indicates alternative that has been screened out.

a - Unsaturated soils only.
b - Soils with PCE contamination exceeding 50 mg/kg.
c - Soils with PCE contamination exceeding 10 mg/kg.
d - Soils with PCE contamination exceeding 1.4 mg/kg.
e - On-site thermal desorption or off-site incineration.

Disk No.: H179 100233.XLS Table 4-3 11/14/94 9:27:45 AM

TABLE 4-4

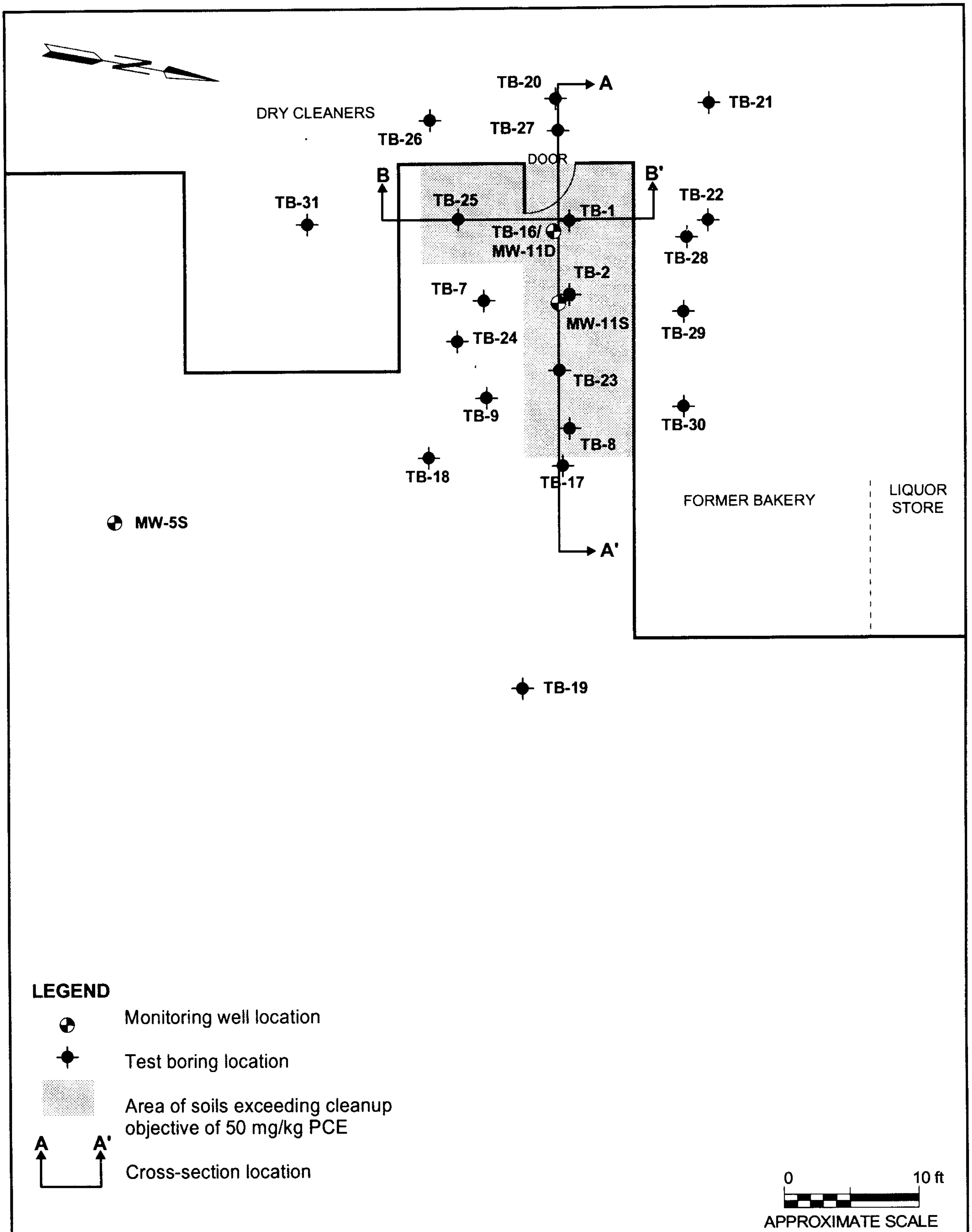
PRELIMINARY GROUNDWATER ALTERNATIVES

Baldwin Place Mall

ALTERNATIVE	ELEMENT: Continued Pumping of BPM Production Wells for Mall Supply	Continued POU Treatment for MPR Homes	Continued POU Treatment for Route 6 Businesses	Increased Pumping of BPM Production Wells	Source Area Recovery Well	Western Site Recovery Well	Southeastern Site Recovery Well	Separate Recovery Well Treatment System	Distribution System to MPR Homes	Discharge Treated Groundwater to On-Site Stream
1 (No/Minimal Action)	X	X	X							
2			X	X					X	
3			X	X	X			X	X	X
4			X	X	X	X		X	X	X
5			X	X	X	X	X	X	X	X
6		X	X	X	X	X	X			X

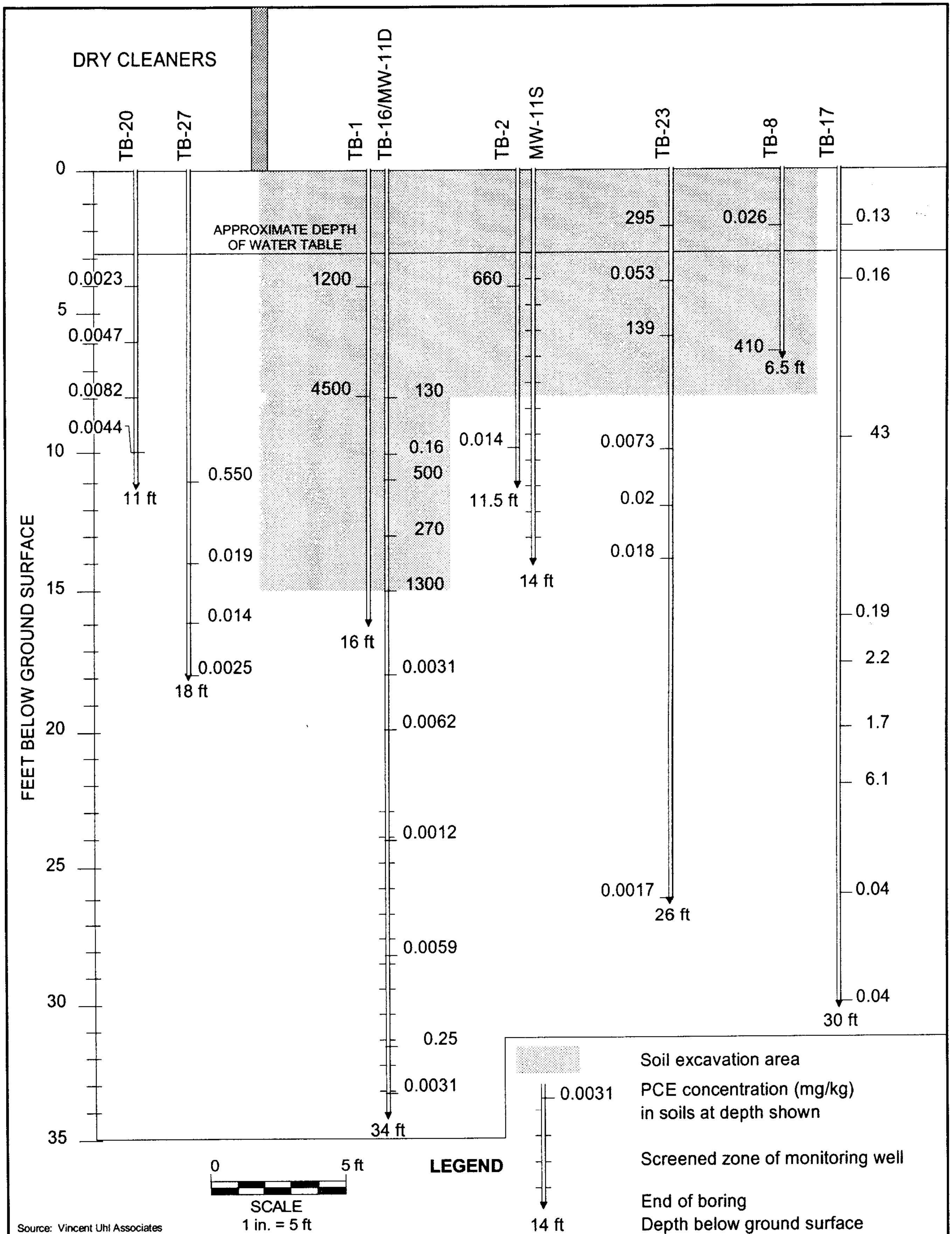
Shading indicates alternative that has been screened out.

Disk No.: H179 100233.XLS Table 4-4 11/29/94 3:42:44 PM



Map source: Vincent Uhl Associates

Lawler, Matusky & Skelly Engineers One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Source Area Alternative 4: Excavation of Soils Exceeding 50 mg/kg PCE** **BALDWIN PLACE MALL**	**Figure 4-1** \100\233.ds4



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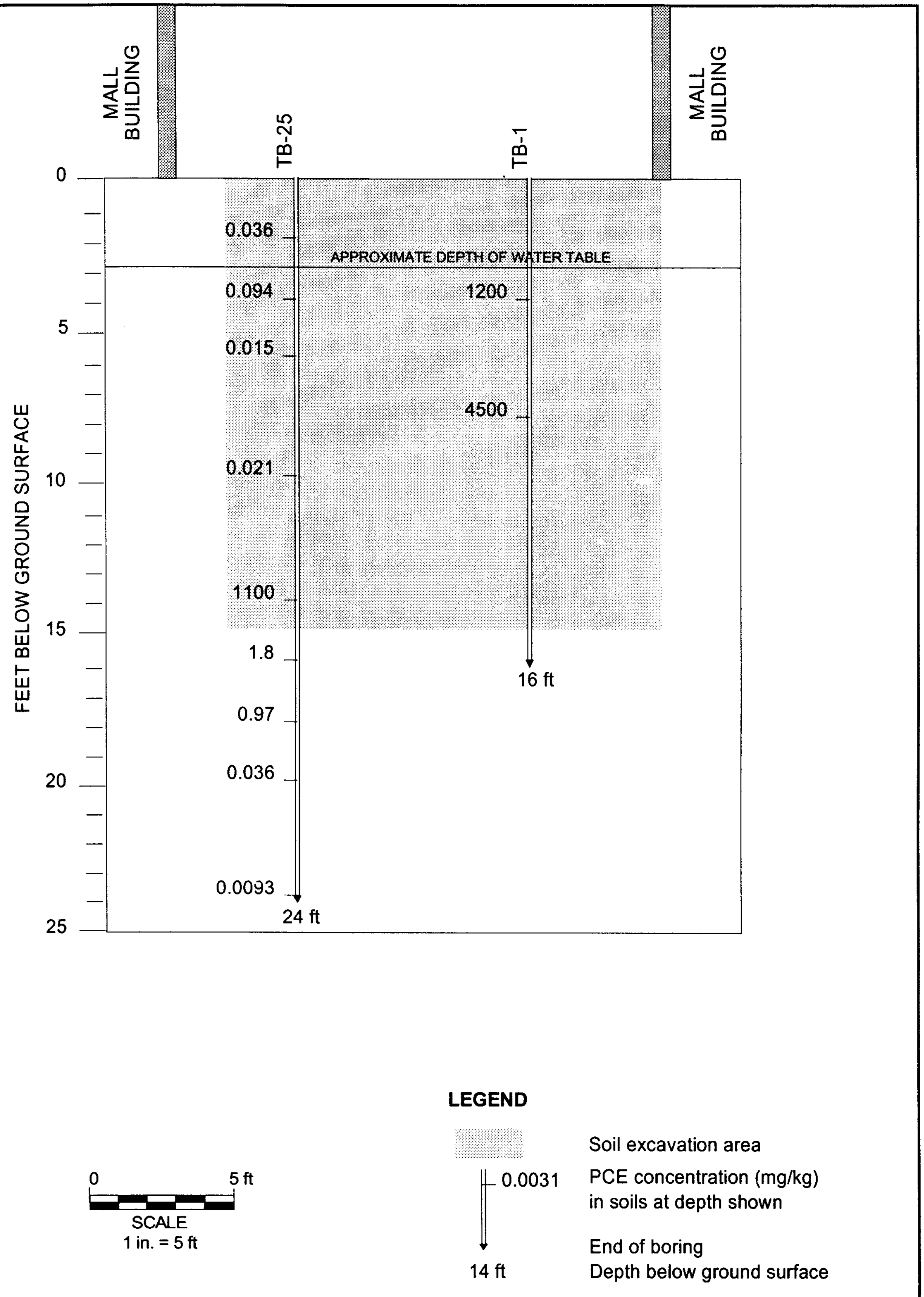
Cross Section A-A'

BALDWIN PLACE MALL

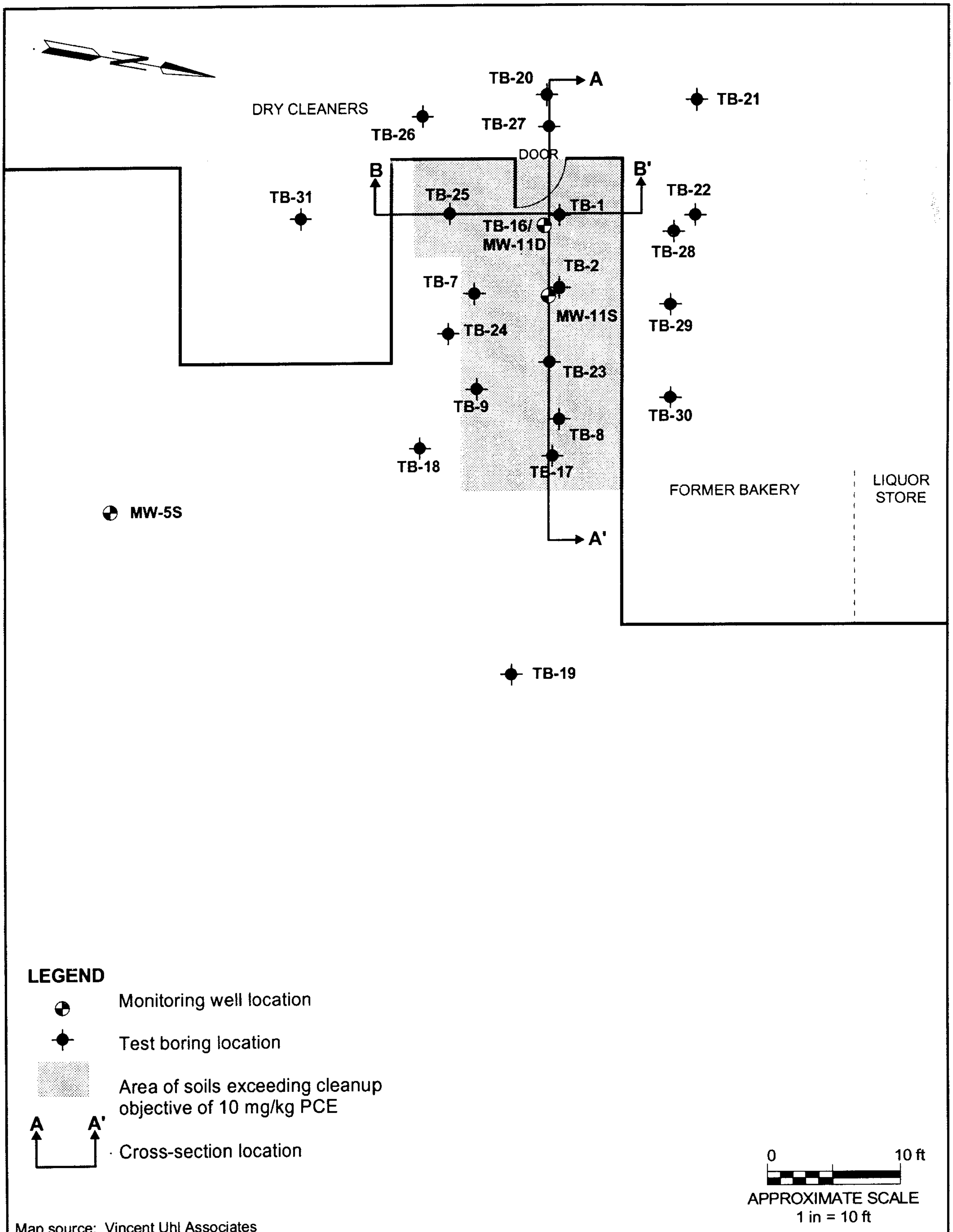
Figure 4-2

\100\233.ds4



Source: Vincent Uhl Associates

LMS Lawler, Matusky & Skelly Engineers One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Cross Section B-B'** **BALDWIN PLACE MALL**	**Figure 4-3** \100\233.ds4



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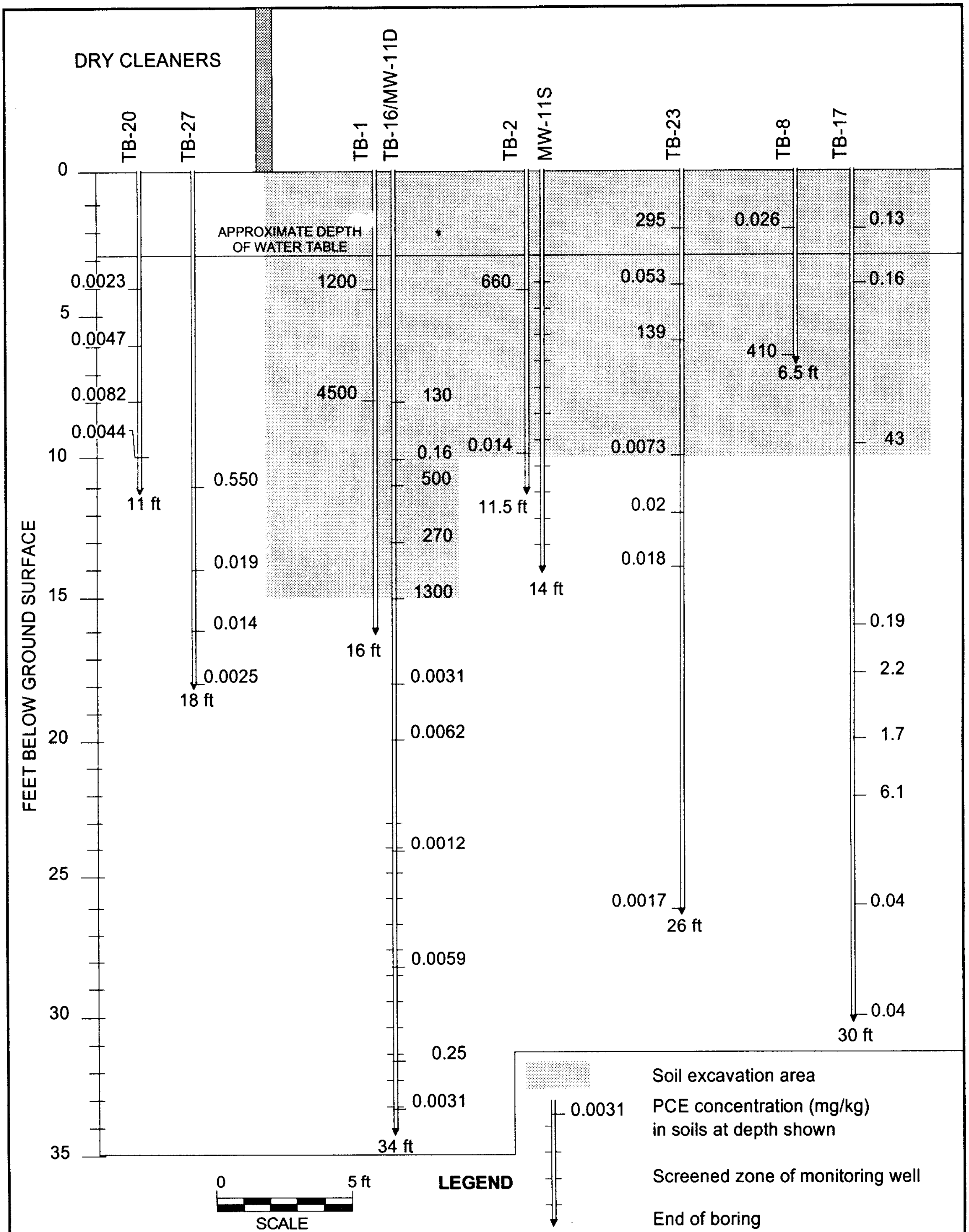
Source Area Alternative 5:
Excavation of Soils Exceeding 10 mg/kg PCE
BALDWIN PLACE MALL

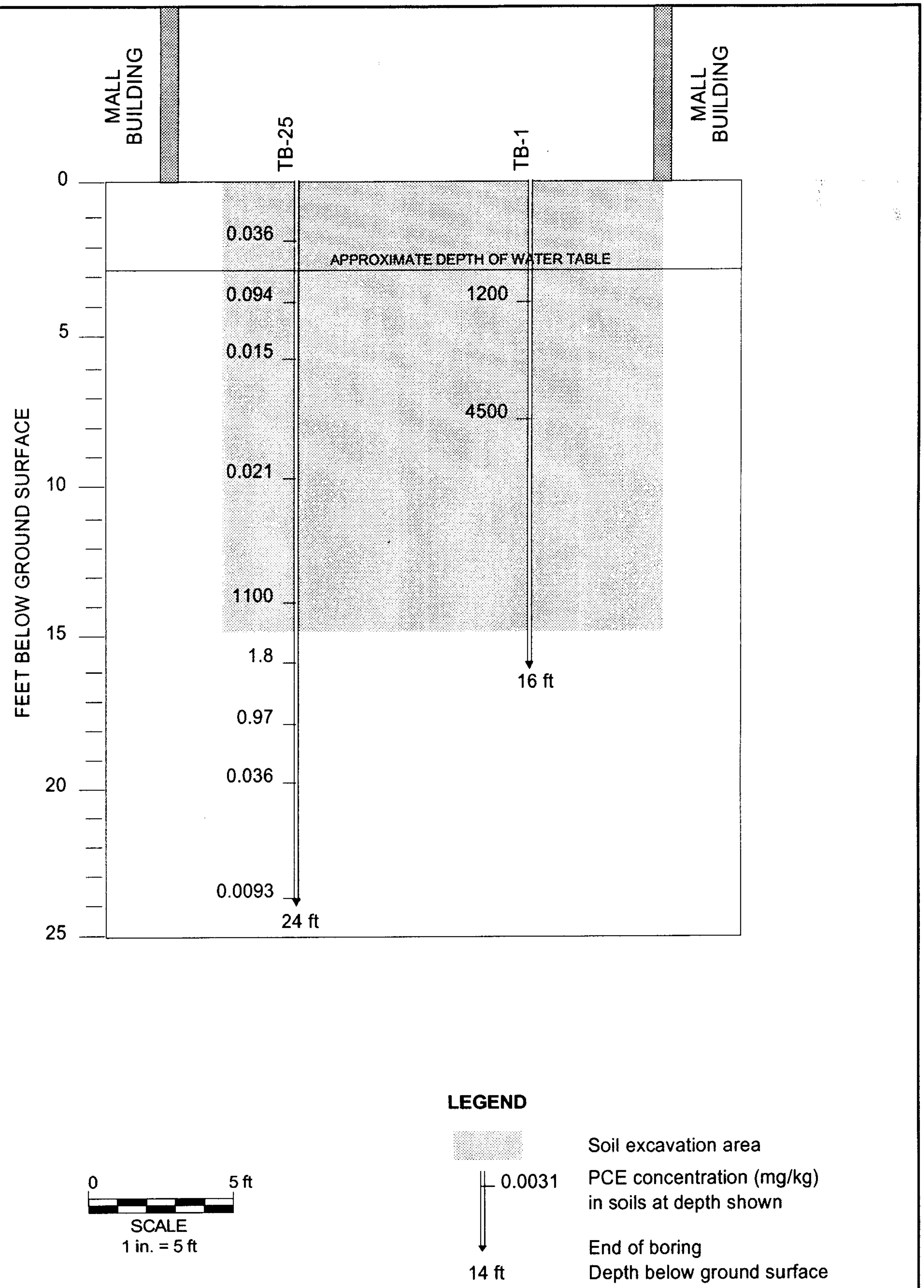
Figure 4-4

\100\233.ds4



Source: Vincent Uhl Associates

LMS Lawler, Matusky & Skelly Engineers One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Cross Section A-A'** **BALDWIN PLACE MALL**	**Figure 4-5** \100\233.ds4



Source: Vincent Uhl Associates

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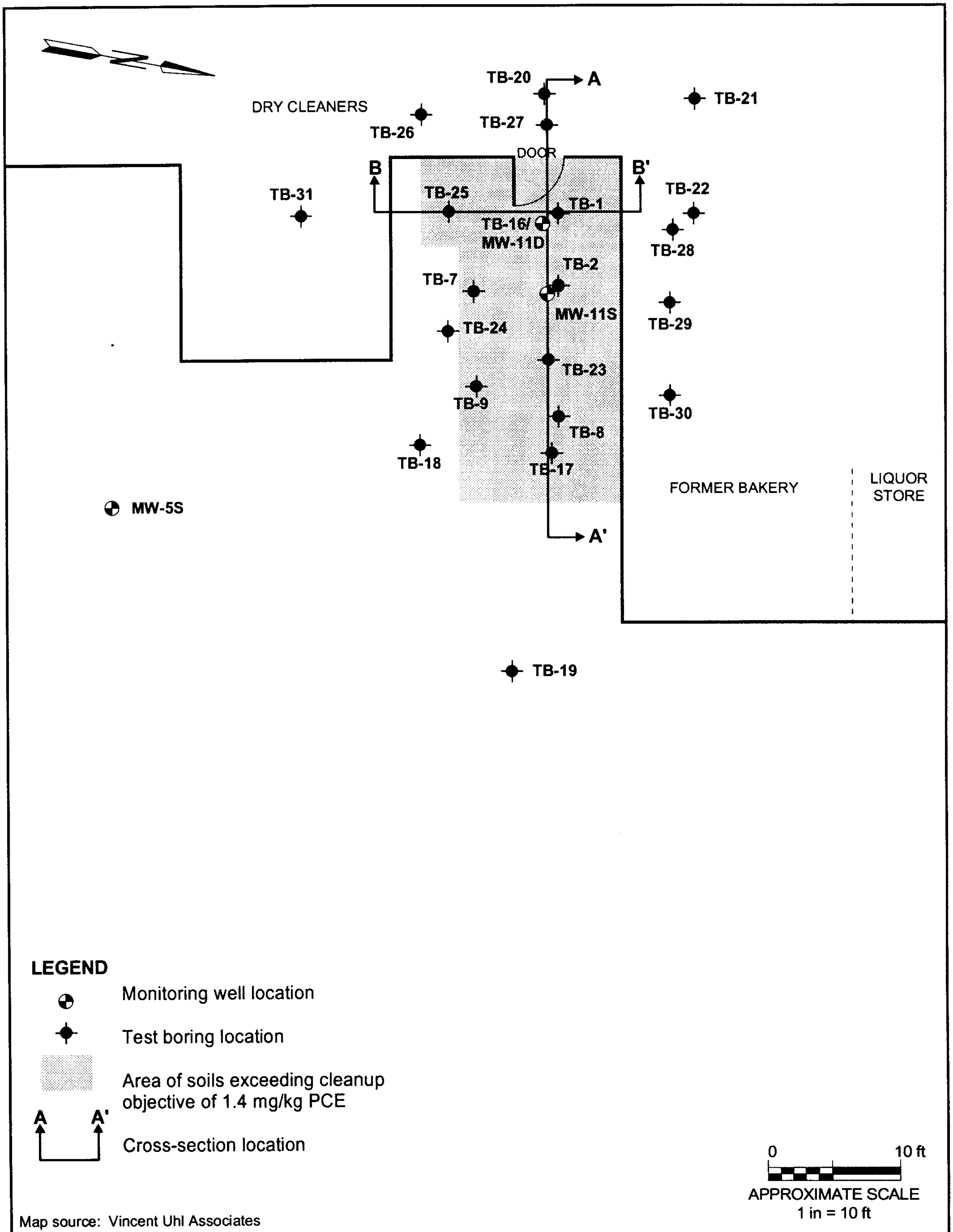
Cross Section B-B'

BALDWIN PLACE MALL

Figure 4-6

\100\233.ds4



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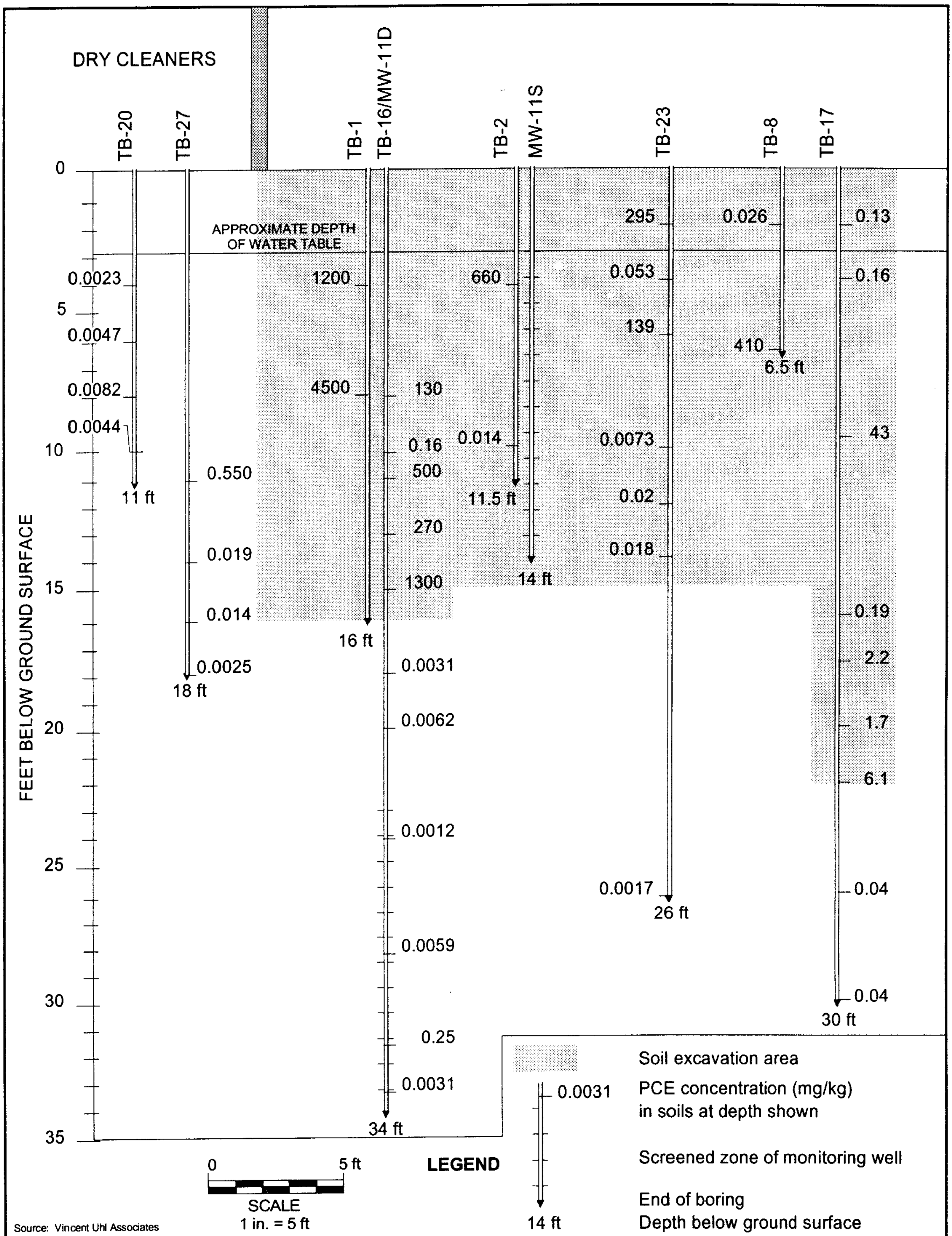
Source Area Alternative 6:
Excavation of Soils Exceeding 1.4 mg/kg PCE
BALDWIN PLACE MALL

Figure 4-7

\100\233.ds4



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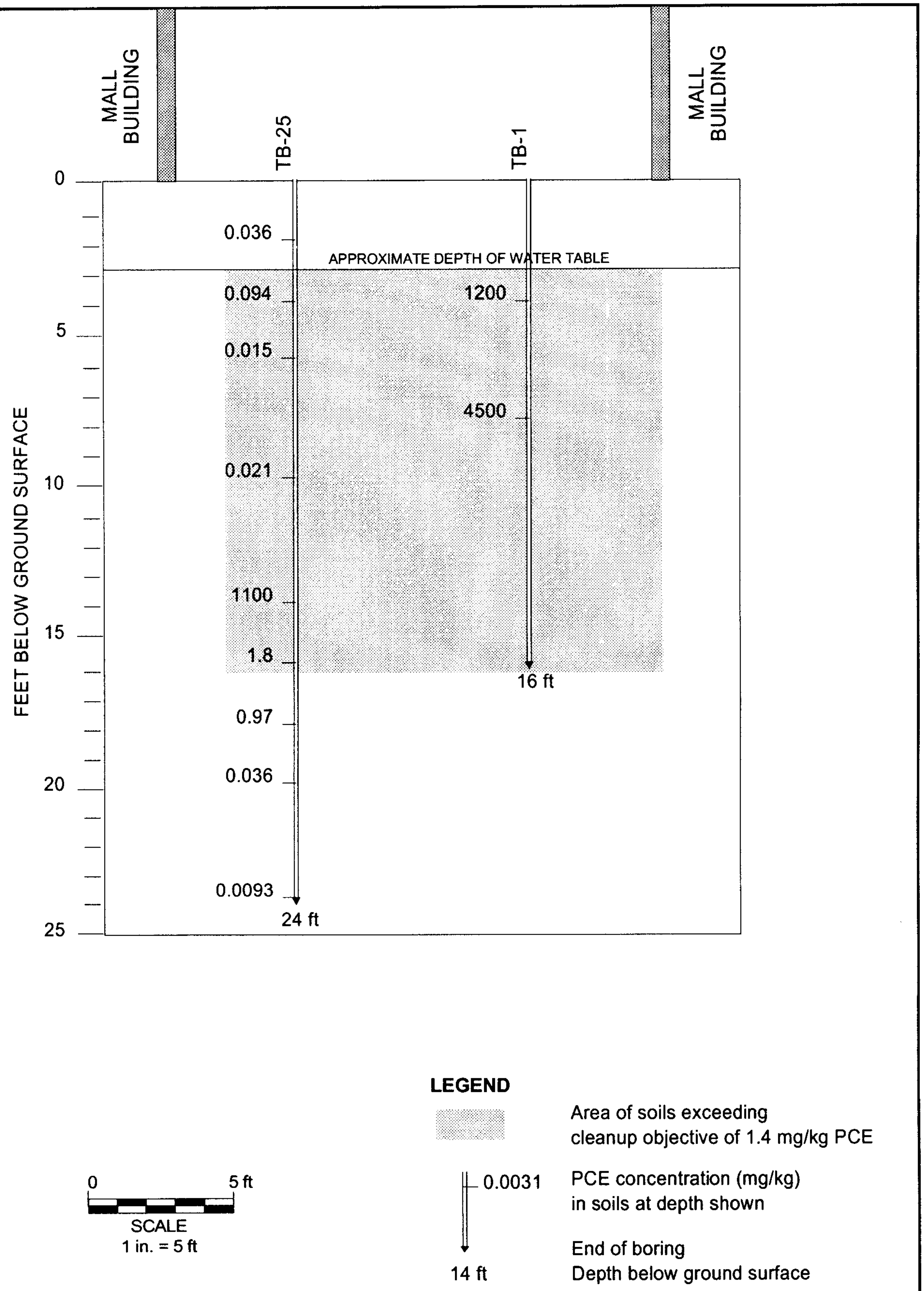
Cross Section A-A'

BALDWIN PLACE MALL

Figure 4-8

\100\233.ds4



Source: Vincent Uhl Associates

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Cross Section B-B'

BALDWIN PLACE MALL

Figure 4-9

\100\233.ds4

TABLE 4-5 (Page 1 of 2)

COST COMPARISON OF EXCAVATION SCENARIOS
Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a] 25 yd^3	95 yd^3	135 yd^3	185 yd^3
CAPITAL COSTS						
A. Direct Costs						
Site Preparation:						
Contractor mob/demob:	3,000 LS	-	3,000	3,000	3,000	3,000
Gutting/disposal of building interior:	4.13 $/ft^2$	12,000 ft^2	49,600	49,600	49,600	49,600
Building demolition:	0.22 $/ft^3$	27,000 ft^3	5,900	5,900	5,900	5,900
Removal of existing asphalt:	3.91 $/yd^2$	50 yd^2	200	200	200	200
Disposal of debris (nonhazardous):	45 /ton	15 tons	700	700	700	700
Wellpoint system for dewatering:	18,200 /month	0 - 1 month	0	18,200	18,200	18,200
Sheeting for excavations:	9.20 $/ft^2$	0-1500 $/ft^2$	0	9,200	10,100	13,800
Excavation:						
Excavation of soils:	23.25 $/yd^3$	25 - 185 yd^3	600	2,200	3,100	4,300
Confirmatory sampling - bottom of excavation:	200 /sample	6 - 11 samples	1,800	1,200	2,200	2,200
Liners for stockpiling soil:	0.16 $/ft^2$	520 - 3,830 ft^2	300	1,000	1,400	1,900
TCLP analyses of excavated soils:	250 /sample	1 - 7 samples	300	800	1,300	1,800
Wastewater Disposal:						
Transportation:	0.70 /gal	0 - 46,000 gal	0	20,300	24,500	32,200
TSDF acceptance fee:	1,000 LS	-	0	1,000	1,000	1,000
Incineration of wastewater:	2.03 /gal	0 - 46,000 gal	0	58,900	71,100	93,400

a - All costs rounded to the nearest $100.

Disk No.: H179 100233.XLS Table 4-5 11/29/94 12:26:26 PM

TABLE 4-5 (Page 2 of 2)

COST COMPARISON OF EXCAVATION SCENARIOS

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]			
			25 yd^3	95 yd^3	135 yd^3	185 yd^3
Site Restoration:						
Backfill:	10.54 /yd^3	21 - 179 yd^3	200	1,000	1,400	1,900
Topsoil:	25 /yd^3	4 -6 yd^3	100	100	200	200
Reseeding:	0.45 /ft^2	217 - 309 ft^2	100	100	100	100
Waste Treatment/Disposal:						
Transportation:	182 /ton	34 - 250 ton[b]	6,200	23,300	33,100	45,500
TSDF acceptance fee:	1,000 LS	-	1,000	1,000	1,000	1,000
Incineration of excavated soils:	1,108 /ton	34 - 250 ton[b]	37,700	141,800	201,700	277,000
		Subtotal:	107,700	339,500	429,800	553,900
B. Indirect Costs						
Engineering and Design @ 10%:			10,800	34,000	43,000	55,400
Legal and Administrative @ 5%:			5,400	17,000	21,500	27,700
Contingency @ 25%:			26,900	84,900	107,500	138,500
		Total:	150,800	475,400	601,800	775,500

a - All costs rounded to the nearest $100.
b - Assumes 1.35 tons/yd^3.

Disk No.: H179 100233.XLS Table 4-5 11/29/94 12:26:26 PM

scenario to allow for a comparison between the scenarios. These estimates indicate that the cost of excavation and disposal increases approximately proportionately to the quantity of material excavated, i.e., the cost of excavation and disposal of twice as much material results in approximately twice the cost. This linear relationship stems from the fact that off-site transportation and incineration are the most significant line item costs and are determined on a unit basis.

Selection of an appropriate excavation scenario for the site is based on the objectives of minimizing the amount of material excavated, while maximizing the mass of contaminants removed. Available soil analytical data was used to estimate the mass of PCE contamination removed under each excavation scenario (Table 4-6). As indicated in the table, excavation of the 25 yd^3 of unsaturated soils will achieve a removal of approximately 15% of the estimated mass of PCE present in the soils. Excavation of 95 yd^3 of soils (i.e., soils with greater than 50 mg/kg PCE) will achieve a removal of 203.54 lb of PCE, or 99.62% of the total identified PCE mass in soils. Excavation of an additional 40 yd^3 of soil (i.e., soils with PCE concentrations of 10-50 mg/kg PCE) will remove only an additional 0.59 lb of PCE, or 99.91% of the total estimated mass of PCE in soils. The fourth excavation scenario, removal of all soils exceeding 1.4 mg/kg PCE, will achieve a PCE mass removal of 204.32 lb, or only 0.19 lb more than the previous scenario, through excavation of an additional 50 yd^3 of soil.

Source control Alternative 4 was retained as the optimum excavation scenario for this site as it meets the criteria of removing the most substantial contamination (i.e., 99% of the estimated total mass of PCE in soils) while minimizing the quantity of excavated material. Alternative 3 was eliminated as highly contaminated materials would remain in the saturated zone and would therefore continue to leach contaminants to the groundwater. Since Alternatives 5 and 6 do not remove a substantially greater mass of contaminants than Alternative 4 for the additional volume of soils excavated (40 and 90 yd^3, respectively), they were not selected for further evaluation. (The percentage of PCE mass removed for Alternatives 5 and 6 exceed that of Alternative 4 by only 0.29 and 0.38%, respectively.)

Disposal options for all four excavation scenarios (source control Alternatives 3 through 6) include on-site thermal desorption or off-site incineration or other treatment followed by landfilling. Both options are retained for inclusion in the detailed evaluation, however, it is anticipated that for the relatively small quantity of soils to be excavated under any of these scenarios, on-site thermal treatment will not be as cost-effective as off-site disposal.

The groundwater remediation technologies listed in Table 4-2 were combined into six potential remedial alternatives as shown in Table 4-4. Alternative 1 is the no/minimal action alternative,

TABLE 4-6

EVALUATION OF EXCAVATION SCENARIOS

EXCAVATION SCENARIO	EXCAVATION QUANTITY (yd^3)	ESTIMATED CAPITAL COST ($)	MASS OF PCE REMOVED (lb)	PERCENT OF TOTAL PCE MASS IN SOIL REMOVED[a] (%)
Unsaturated Soils	25	151,000	29.92	14.64
Soils > 50 mg/kg PCE	95	475,000	203.54	99.62
Soils > 10 mg/kg PCE	135	602,000	204.13	99.91
Soils > 1.4 mg/kg PCE	185	776,000	204.32	100

a - Mass of PCE removed for each excavation scenario compared to mass removed for maximum excavation scenario (185 yd^3 scenario).

which assumes that the status quo will be maintained at the site, i.e., continued pumping of the BPM production wells for mall supply and continued use of the POU treatment units for the MPR homes and the businesses on Route 6. This alternative was retained in compliance with the NCP requirements.

Groundwater remediation Alternative 2 includes increased pumping of the BPM production wells with discharge of the treated water to a distribution system installed to convey the water to the MPR homes. POU treatment units will be maintained for the Route 6 businesses. Implementation of this alternative will require State and local approval for use of the treated groundwater as a community potable water supply. This alternative does not include optimization of groundwater remediation through use of recovery wells in addition to the BPM production wells, therefore, the time for remediation of site groundwater may be longer than for alternatives which include additional recovery wells. This alternative was retained to provide a comparison with alternatives which provide groundwater remediation in a shorter time frame.

Groundwater remediation Alternatives 3, 4, and 5 include installation and pumping of source area recovery wells, a recovery well in the western site area, and/or a recovery well in the southeastern site area downgradient of the source in addition to increased pumping of the BPM production wells. Source area recovery wells only are included in Alternative 3 while Alternative 4 includes the source area well and western site area recovery well. Alternative 5 includes potential recovery wells at all three locations. These three alternatives also assume that treated groundwater from the BPM production wells will be used to supply the MPR homes through installation of a new distribution system. Because of potential regulatory opposition to use of groundwater recovered from source areas or highly contaminated areas of the plume for potable supply (subsequent to treatment), the extracted groundwater from the recovery wells will be treated using a separate GAC or air stripping treatment system and disposed of to the on-site stream. The POU units will be maintained at the Route 6 businesses for all three alternatives. Alternative 6 assumes installation and pumping of recovery wells in all three potential locations (i.e., source area, western site area, and downgradient) in addition to increased pumping of the BPM production wells as in Alternative 5, however, this alternative assumes that all extracted groundwater will be treated and discharged on site. Since pumping and treating at all three locations may result in expedited cleanup of the groundwater, continued use of the POU units at the MPR residences is included in Alternative 6 rather than a water distribution system. The POU units will be maintained for both the MPR residences and the Route 6 businesses until remediation of the groundwater is complete.

Of the four recovery well alternatives (Alternatives 3, 4, 5, and 6), Alternatives 3 and 6 were retained for inclusion in the site-wide alternatives. Alternative 6 assumes that recovery wells will be installed so as to optimize plume recovery; this alternative is expected to achieve groundwater remediation in the shortest time frame possible. Alternative 6 was selected rather than Alternative 5 in order to evaluate the continued use of the existing POU treatment units until groundwater remediation is complete. Alternative 3 was retained as a point of comparison between increased pumping of the BPM wells only (Alternative 2) and optimization of the remediation scenario through use of recovery wells in several locations (Alternative 6); Alternative 4 does not differ significantly from either Alternatives 3 or 5 and was therefore not retained.

4.3 SITE-WIDE REMEDIAL ALTERNATIVES

Remedial alternatives for the site as a whole were developed from the source area and groundwater alternatives that were retained following the preliminary screening, as discussed in the previous section. The site-wide alternatives (Table 4-7) are intended to evaluate the effects of source area remediation on the overall time frame for remediation of groundwater. The alternatives selected do not include all potential combinations of the retained source area and groundwater alternatives, but are intended to allow for evaluation of each of the potential remedial elements. These elements may be recombined in the final remedial alternative selected for the site.

Alternative 1 is the no/minimal action alternative. This alternative assumes that the BPM production wells will continue pumping as needed to supply the mall and that the POU treatment units will be maintained for both the MPR residences and the Route 6 businesses. No additional remediation of site soils or groundwater is included. This alternative is retained for detailed evaluation in accordance with the NCP as a baseline for comparison with other alternatives.

In situ treatment of the source area using air sparging/soil vapor extraction constitutes site-wide Alternative 2. Although air sparging is expected to remediate groundwater in the source area, Alternative 2 also includes long-term groundwater remediation through increased pumping of the BPM production wells. The treated water from the production wells will be used as a potable supply for the MPR homes following construction of an appropriate distribution system. The POU treatment units will be maintained for the Route 6 businesses. Alternative 3 is the same as Alternative 2 with the exception of the source area remedial alternative; source area soils will be excavated as opposed to treated in situ. Alternatives 2 and 3 are therefore intended

TABLE 4-7

SITE-WIDE REMEDIAL ALTERNATIVES
Baldwin Place Mall

ALTERNATIVE	Continued Pumping of BPM Production Wells for Mall Supply	Continued POU Treatment for MPR Homes	Continued POU Treatment for Route 6 Businesses	Air Sparging/Soil Vapor Extraction for Source Area	Source Area Excavation	On- or Off-Site Treatment of Soils	Increased Pumping of BPM Production Wells	Recovery Well in Source Area	Recovery Well in Western Site Area/Southeastern Site Area	Separate Recovery Well Treatment System	Discharge Treated Groundwater to On-Site Stream	Distribution System to MPR Homes
	ELEMENT											
1 No/Minimal Action	X	X	X									
2 Air Sparging/Soil Vapor Extraction			X	X			X					X
3 Source Area Excavation with Production Well Pump and Treat			X		X	X	X					X
4 Source Area Excavation with Source Area Recovery Well			X		X	X	X	X		X	X	X
5 Source Area Excavation with Source Area/Western Area/Southeastern Area Recovery Wells		X	X		X	X	X	X	X		X	

Disk No.: H179 100233.XLS Table 4-7 11/29/94 3:39:25 PM

for comparison of the two different approaches to remediation of the source area (i.e., excavation vs air sparging/soil vapor extraction).

The soil quantity to be excavated in site-wide Alternative 3 is approximately 95 yd^3 of unsaturated and saturated soils based on the cost-effectiveness analysis discussed in the previous section. The mass of contamination remaining in the subsurface based on the selected excavation scenario is a critical input parameter in the groundwater model for calculating required groundwater cleanup times. An evaluation of the effect of different excavation scenarios on groundwater remediation times was also conducted and is discussed in Chapter 6.

Site-wide Alternatives 4 and 5 also include excavation of approximately 95 yd^3 of material but vary in their approach to remediation of site groundwater. Alternative 4 includes installation of source area recovery wells following excavation of contaminated soils. Capture of contaminated groundwater will be effected through pumping of the source area recovery well in addition to increased pumping of the BPM production well. The water from the recovery well will not be combined with the production well water, but will be separately treated using a newly constructed GAC treatment system and will then be discharged to the on-site stream. Treated production well water will be used to supply the MPR homes through a water supply distribution system; POU treatment units will be maintained for the Route 6 businesses.

Alternative 5 is intended to achieve groundwater cleanup objectives in the shortest time frame possible. Therefore, groundwater extraction will be conducted using a combination of increased pumping of the BPM production wells and recovery wells located in the source area, in the western site area, and in the southeastern site area downgradient of the plume. Location and pumping rates of these wells were selected as discussed in Chapter 5 so as to minimize cleanup times. Continued use of the POU treatment units for both the MPR homes and the Route 6 businesses is included in this alternative rather than a distribution system to the MPR area to compare these two elements further in light of the time for groundwater remediation.

CHAPTER 5

ALTERNATIVES FOR DETAILED EVALUATION

5.1 INTRODUCTION

Five remedial alternatives were selected for inclusion in the detailed evaluation of alternatives as discussed in the previous chapter. The technical elements included in each of these alternatives are summarized in Table 4-7. This chapter provides a detailed description of each of the five site-wide remedial alternatives. Chapter 6 presents the evaluation of these alternatives against the evaluation criteria specified in the NCP.

5.2 ALTERNATIVE 1: NO/MINIMAL ACTION

The no/minimal action alternative does not include any removal or treatment of contaminated soils or groundwater beyond that achieved by continued pumping of the BPM production wells at a low rate (i.e., 4 gpm), but does include institutional controls to minimize human contact with the contaminated media, including deed and development restrictions, continued use of the POU treatment units at the MPR homes and Route 6 businesses, and long-term monitoring. With the exception of deed and development restrictions, these technologies, as described below, have already been implemented and therefore Alternative 1 constitutes the status quo for the site.

5.2.1 Deed and Development Restrictions

Deed restrictions limit future uses of the site as a whole or for specific areas (i.e., the source area), as appropriate, in the event of transfer of the property to other ownership and are intended to notify prospective owners of the existence of remaining contamination and the limitations such contamination has on site uses prior to transfer of the property. Development restrictions apply to any new construction initiated by the current owners and might, for example, restrict building construction in the source area at the site.

5.2.2 Continued Pumping of BPM Production Wells

The BPM production wells are currently pumping at a rate of 4 gpm as required to supply the existing mall tenants. The extracted groundwater is treated using GAC filtration and disinfected prior to potable use. Alternative 1 assumes that the BPM production wells will continue to be pumped at a rate of 4 gpm (Table 5-1), thereby providing some degree of active groundwater remediation, however, a pumping rate of 4 gpm is not adequate for containing the off-site migration of contaminated groundwater in the bedrock aquifer (Appendix A).

5.2.3 Treatment Unit Maintenance

To prevent human contact with contaminants present in groundwater, Alternative 1 includes maintenance of the existing GAC treatment units for the BPM production wells and the POU treatment units at the MPR homes and Route 6 businesses. Maintenance of the POU treatment units for residences along Meadow Park Road is being conducted by Big V Supermarkets in accordance with the Order on Consent dated 12 September 1991 (NYSDEC 1991b). Twelve POU units are in place at the MPR homes (wells RW-05, -07, -08, -09, -10, -11, -12, -14, -15, -16, -17, and the second home connected to well RW-14) and four POU units are installed on Route 6 commercial wells (CW-20, -21, -22, and -23).

The estimated cost for Alternative 1 (presented in Chapter 6) assumes annual maintenance of the units at the twelve MPR homes and four Route 6 businesses, consisting of UV bulb and filter replacement and inspection of the units. Replacement of the carbon in the filters is assumed to be required every 15 years for the MPR homes and every four years for the Route 6 businesses, based on typical carbon exhaustion rates, average influent PCE concentrations, and average water usage rates. The actual need for carbon replacement in the POU treatment units will be evaluated based on the quarterly monitoring results from the long-term monitoring program as discussed below. Detection of PCE or its breakdown products in samples collected from between the two carbon filters included in each treatment unit will trigger replacement of the carbon filters (i.e., the second unit will replace the first unit and a new unit will be installed in the place of the second unit). Replacement of the carbon in the filters for the on-site production well GAC treatment units is estimated to be required every eight years based on typical carbon exhaustion rates, average influent PCE concentrations for groundwater currently pumped by the BPM wells, and pumping of the wells at the present rate (i.e., 4 gpm).

5.2.4 Long-Term Monitoring Program

The long-term monitoring program for Alternative 1 is summarized in Table 5-2 and includes sampling and analyses of monitoring and water supply wells. This monitoring program incorporates the requirements of the September 1991 Order on Consent (NYSDEC 1991b) with additional sampling to assess the migration and natural attenuation of unremediated groundwater by sampling of the on-site monitoring wells and off-site commercial wells. The long-term monitoring program is assumed to continue for a period of 30 years to allow for cost

TABLE 5-1

SUMMARY OF GROUNDWATER PUMPING SCENARIOS FOR FS REMEDIAL ALTERNATIVES

Baldwin Place Mall

WELL	DEPTH (ft)	ZONE OF INFLUENCE	PUMPING RATE ASSUMED FOR ALTERNATIVE (gpm)			
			1	3	4	5
BPM Production Wells	260/400	Bedrock aquifer	4	20	20	15
Shallow Source Area Recovery Well	30	Shallow till	NI	NI	0.4	0.4
Deeper Source Area Recovery Well	60	Till/shallow bedrock	NI	NI	0.25-0.50	0.25-0.50
Southeastern Site Recovery Well	> 80-85[a]	Bedrock aquifer	NI	NI	NI	15
Western Site Recovery Well	100[b]	Bedrock aquifer	NI	NI	NI	20

a - A downgradient recovery well will be installed in the upper portion of the bedrock aquifer, which is present at a depth of 80 to 85 bgs at this location.
b - A western site recovery well will be installed in the bedrock aquifer at a depth of approximately 100 ft at this location.
NI - Not included.

TABLE 5-2

ALTERNATIVE 1 MONITORING PROGRAM SUMMARY

Baldwin Place Mall

LOCATION	SAMPLING SCHEDULE/ANALYSES [a]		
	QUARTERLY	SEMI-ANNUALLY	ANNUALLY
Monitoring Wells:			
MW - 4S		HVOCs	AVOCs, MTBE
MW - 4D		HVOCs	AVOCs, MTBE
MW - 5S		HVOCs	AVOCs, MTBE
MW - 5D		HVOCs	AVOCs, MTBE
MW - 9S		HVOCs	AVOCs, MTBE
MW - 9D		HVOCs	AVOCs, MTBE
MW - 11S		HVOCs	AVOCs, MTBE
MW - 11D		HVOCs	AVOCs, MTBE
Water Supply Wells:			
PW - 1 [b]	HVOCs, AVOCs, Coliforms		MTBE
PW - 2 [b]	HVOCs, AVOCs, Coliforms		MTBE
RW - 01 to RW - 18 [c]	HVOCs		
CW - 20 [b]	HVOCs, MTBE		
CW - 21 [b]	HVOCs, MTBE		
CW - 22 [b]	HVOCs, MTBE		
CW - 23 [b]	HVOCs, MTBE		
CW - 25		HVOCs, MTBE	

a - Analyses to be performed:
HVOCs - halogenated volatile organic compounds (EPA Method 502.1)
AVOCs - aromatic volatile organic compounds (EPA Method 503.1)
MTBE-Methyl tert-butyl ether; analysis for MTBE may be conducted in conjunction with either of above analyses.
Coliforms - total coliforms

b - Three samples collected for analyses shown; one each from before, between, and after the two carbon filter units.

c - Residential wells RW-05,-07,-08,-09,-10,-11,-12,-13,-15,-16,-17 require collection of 3 samples for analyses shown; one each from before, between, and after the existing carbon filter units.

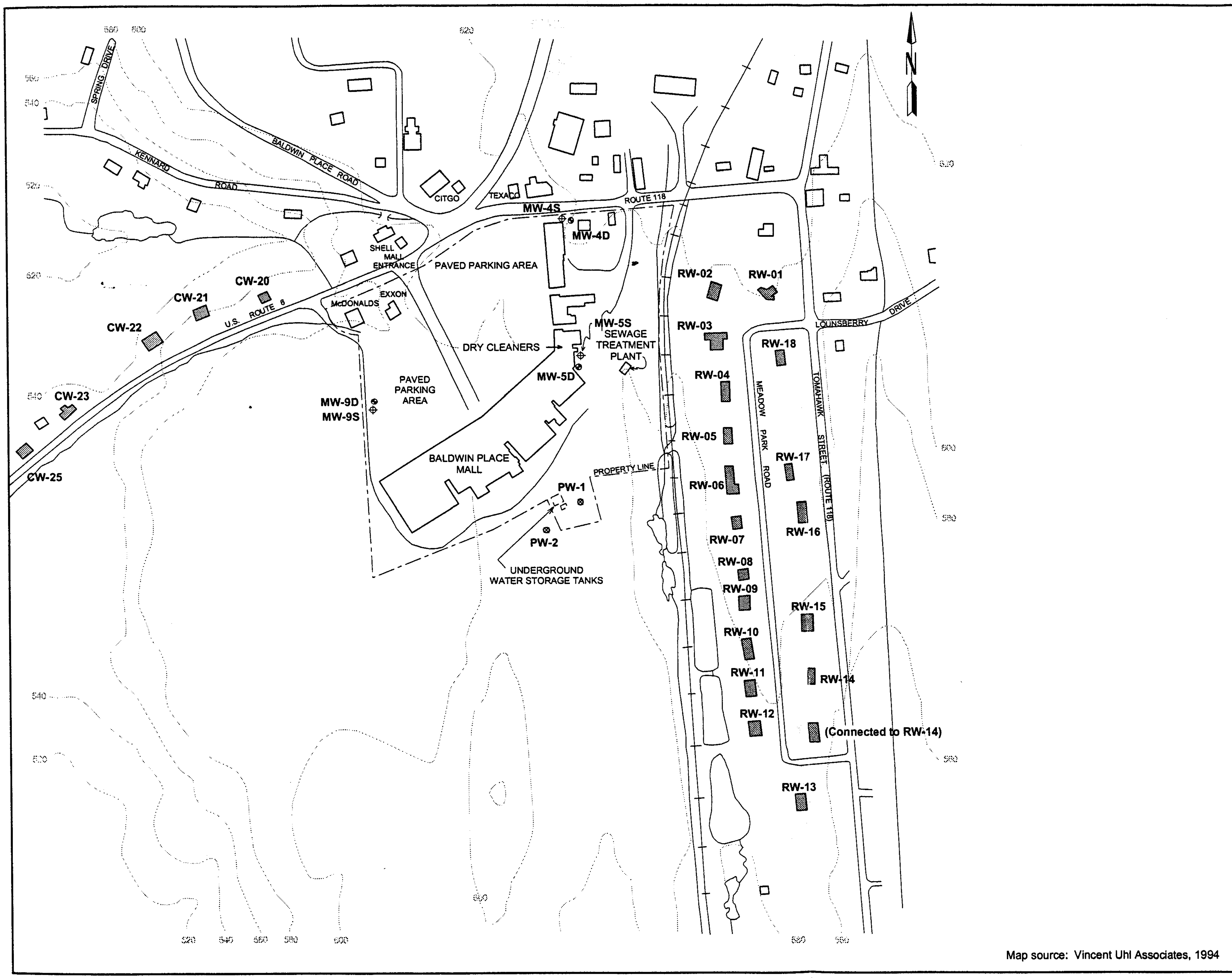
comparisons among alternatives. However, the actual need for this monitoring may be reevaluated and the program modified or discontinued at any time during the 30-yr period if contaminant levels remain below the groundwater standards for three consecutive years.

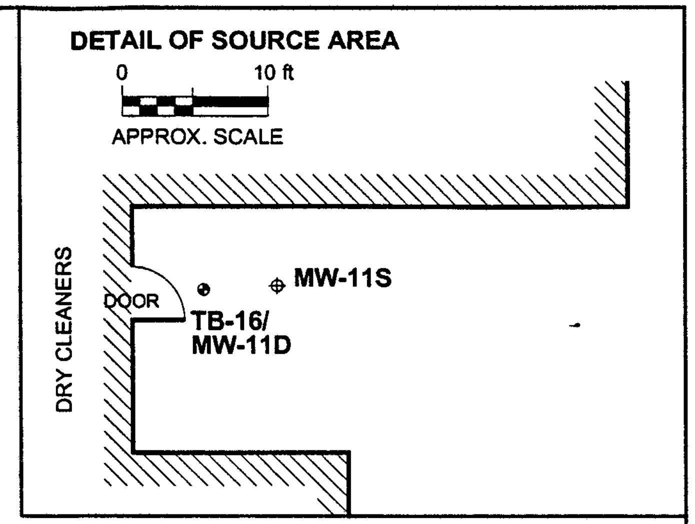
Four on-site monitoring well clusters, each consisting of one shallow well and one deep well (Figure 5-1), will be monitored to evaluate migration and attenuation of the on-site PCE plume. These wells include one upgradient well cluster (MW-4S and -4D), the source area well cluster (MW-11S and -11D), the well cluster located downgradient to the southeast of the source area (MW-5S and -5D), and one well cluster on the western portion of the site (MW-9S and -9D). These eight wells will be sampled semiannually and the samples analyzed for halogenated volatile organic compounds (HVOCs) inclusive of PCE and its breakdown products using EPA Method 502.1. To assess the potential for gasoline constituents to migrate on site from the service stations located just north of the site, sampling and analyses of these wells for MTBE and aromatic volatile organic compounds (AVOCs) using EPA Method 503.1 will be conducted annually.

Three samples are collected from the MPR and Route 6 wells currently fitted with POU treatment units; one each from before, between, and after the two filter cartridges included in each unit. The samples from the MPR homes are analyzed for HVOCs, while the samples from the Route 6 businesses are analyzed for HVOCs and MTBE. This quarterly POU monitoring program will be continued as part of the long-term groundwater monitoring program included in Alternative 1 and described in Table 5-2.

The 18 residential wells on Meadow Park Road will be sampled quarterly for HVOCs as part of this minimal action alternative to monitor plume dynamics. Four commercial wells on Route 6 (CW-20, -21, -22, and -23) will be sampled quarterly for HVOCs and MTBE. Well CW-25 will be sampled on a semiannual basis for HVOCs and MTBE. CW-25 is located farther west along Route 6 and has not shown contamination by site-related constituents.

The two on-site production wells (PW-1 and -2) are assumed to continue pumping at a rate of 4 gpm and will be sampled quarterly for HVOCs, AVOCs, and total coliforms. Samples will also be collected annually for MTBE analyses. Water from the on-site production wells is treated using GAC filters; samples will be collected from before, between, and after the filters to assess contaminant concentrations in the aquifer at this location as well as the effectiveness of the GAC filters in removing the contaminants.





LEGEND

- PW-1 Mall production well
- MW-3S Shallow RI monitoring well
- MW-3D Deeper RI monitoring well
- RW-01 Residential well
- CW-01 Commercial well

0 400 ft
SCALE
1 in. = 400 ft

FIGURE 5-1

Long-Term Monitoring Program: Monitoring and Supply Well Locations

BALDWIN PLACE MALL

Map source: Vincent Uhl Associates, 1994

LMS LAWLER, MATUSKY & SKELLY ENGINEERS
Environmental Science & Engineering Consultants

5.3 ALTERNATIVE 2: AIR SPARGING/SOIL VAPOR EXTRACTION

Based on additional evaluations of the technical feasibility of air sparging/soil vapor extraction for remediation of the source area, Alternative 2 was eliminated from further consideration. Air sparging/soil vapor extraction is not expected to be effective for removal of subsurface contaminants given the geologic conditions at the BPM site (R. Peterson, Terra Vac Corp., a vendor experienced in the installation of air sparging systems, 1994, pers. commun.). Site-specific constraints to the application of this technology include the low permeability of the till materials and the presence of sand/gravel lenses in the source area. Complete circulation of compressed air through low permeability materials is difficult or impossible to achieve, thereby limiting the effectiveness of air stripping for contaminant removal. Sand and gravel lenses provide preferential flow paths for volatilized constituents, preventing effective capture of the vapors by the vacuum extraction system.

Remediation of source area soils to the site cleanup objectives (e.g., 1.4 mg/kg PCE) is estimated to require two to three years. The longer time frame for remediation using air sparging/soil vapor extraction as compared to excavation may potentially increase the time required for remediation of the groundwater contaminant plume, and will prevent redevelopment of this area of the site during the period of operation. Although initial installation and start-up costs for an air sparging/soil vapor extraction system are relatively low (estimated at $60,000), continued operation of the system for a period of several years (monthly operations and maintenance [O&M] costs are estimated at $5,000) may result in overall costs comparable to or exceeding the cost of excavation and off-site treatment/disposal of the soils.

5.4 ALTERNATIVE 3: SOURCE AREA EXCAVATION

Alternative 3 includes remediation of the source area at the site through excavation of highly contaminated source area soils and groundwater containment/remediation through increased pumping of the existing on-site production wells. The water from the production wells will be used to supply the BPM as well as the MPR homes, therefore, this alternative includes the installation of a distribution system to convey the treated flows to Meadow Park Road. The elements of this alternative are described below.

5.4.1 Long-Term Monitoring Program

The long-term monitoring program included in Alternative 3 (Table 5-3) is intended to assess the impact of source area excavation and groundwater pumping and treatment on groundwater contaminant levels over time and will continue for a period of 30 years. If contaminant levels

TABLE 5-3

ALTERNATIVES 3, 4, AND 5 MONITORING PROGRAM SUMMARY

Baldwin Place Mall

LOCATION	SAMPLING SCHEDULE/ANALYSES[a]			
	Years 1-5		Years 6-30	
	QUARTERLY	SEMI-ANNUALLY	SEMI-ANNUALLY	ANNUALLY
Monitoring Wells:				
MW - 4S	HVOCs	AVOCs, MTBE		AVOCs, MTBE
MW - 4D	HVOCs	AVOCs, MTBE		AVOCs, MTBE
MW - 5S	HVOCs	AVOCs, MTBE		HVOCs
MW - 5D	HVOCs	AVOCs, MTBE		HVOCs
MW - 9S	HVOCs	AVOCs, MTBE		HVOCs
MW - 9D	HVOCs	AVOCs, MTBE		HVOCs
MW - 11S	HVOCs	AVOCs, MTBE		HVOCs
MW - 11D	HVOCs	AVOCs, MTBE		HVOCs
Water Supply Wells:				
PW - 1[b]	HVOCs, AVOCs, Coliforms	MTBE	HVOCs, AVOCs, Coliforms	MTBE
PW - 2[b]	HVOCs, AVOCs, Coliforms	MTBE	HVOCs, AVOCs, Coliforms	MTBE
RW - 01 to RW - 18[c]	HVOCs			HVOCs
CW - 20[b]	HVOCs, MTBE			HVOCs, MTBE
CW - 21[b]	HVOCs, MTBE			HVOCs, MTBE
CW - 22[b]	HVOCs, MTBE			HVOCs, MTBE
CW - 23[b]	HVOCs, MTBE			HVOCs, MTBE
CW - 25		HVOCs, MTBE		

a - Analyses to be performed:
HVOCs - halogenated volatile organic compounds (EPA Method 502.1)
AVOCS - aromatic volatile organic compounds (EPA Method 503.1)
MTBE- methyl tert-butyl ether; analysis for MTBE may be conducted in conjuction with either of above analyses.
Coliforms - total coliforms

b - Three samples collected for analyses shown, one each from before, between, and after the two carbon filter units.

c - Residential wells RW-05,-07,-08,-09,-10,-11,-12, -13,-15,-16,-17 require collection of 3 samples for analyses shown: one each from before, between, and after existing carbon filter units. Sampling will be discontinued when MPR homes are connected to distribution system and residential wells are abandoned (Alternatives 3 and 4). For Alternative 5, quarterly monitoring of wells RW-01 to RW-18 will be conducted for years 1-20 with annual sampling thereafter.

are below the groundwater standards for a period of three consecutive years, the need for monitoring may be reassessed. As with Alternative 1, sampling of wells with treatment units will include collection of three water samples; one sample each from before, between, and after the two carbon filter units.

Selected on-site monitoring wells (MW-4S, -4D, -5S, -5D, -9S, -9D, -11S, and -11D) will be sampled quarterly for HVOCs and semiannually for AVOCs and MTBE for the first five years of the monitoring program (Figure 5-1). For the remaining 25 years, samples will be collected annually from the on-site monitoring wells and analyzed for HVOCs, with the exception of the upgradient monitoring wells (MW-4S and -4D), which will be analyzed for AVOCs and MTBE to evaluate potential on-site migration of gasoline constituents.

The on-site production wells (PW-1 and -2) will be monitored quarterly for HVOCs, AVOCs, and total coliforms, and semiannually for MTBE, for the first five years. During the remaining 25 years of the monitoring program, the sampling frequency will be decreased to semiannually for HVOCs, AVOCs, and total coliforms, and annually for MTBE. Additional monitoring of the production wells will be conducted in accordance with the water quality monitoring requirements for community water systems included in 10 NYCRR Chapter I Subpart 5-1 (Public Water Systems) as discussed in Section 5.4.5.

The residential wells (RW-01 to RW-18) will be sampled quarterly for HVOCs, however, the sampling will be discontinued when the distribution system to the MPR homes is completed (assumed for costing purposes to be one year after implementation of the on-site elements of this alternative due to the additional time which may be required for administrative approvals of the distribution system) and the residential wells are closed. Quarterly samples will be collected from the commercial wells (CW-20 to CW-23) and analyzed for HVOCs and MTBE for the first five years. For the remaining 25 years, sampling of the commercial wells will be conducted on an annual basis, with analyses for HVOCs and MTBE. Commercial well CW-25 will be sampled for HVOCs and MTBE on a semiannual basis for the first five years only, since contaminant concentrations are assumed to remain below detection limits during this time frame.

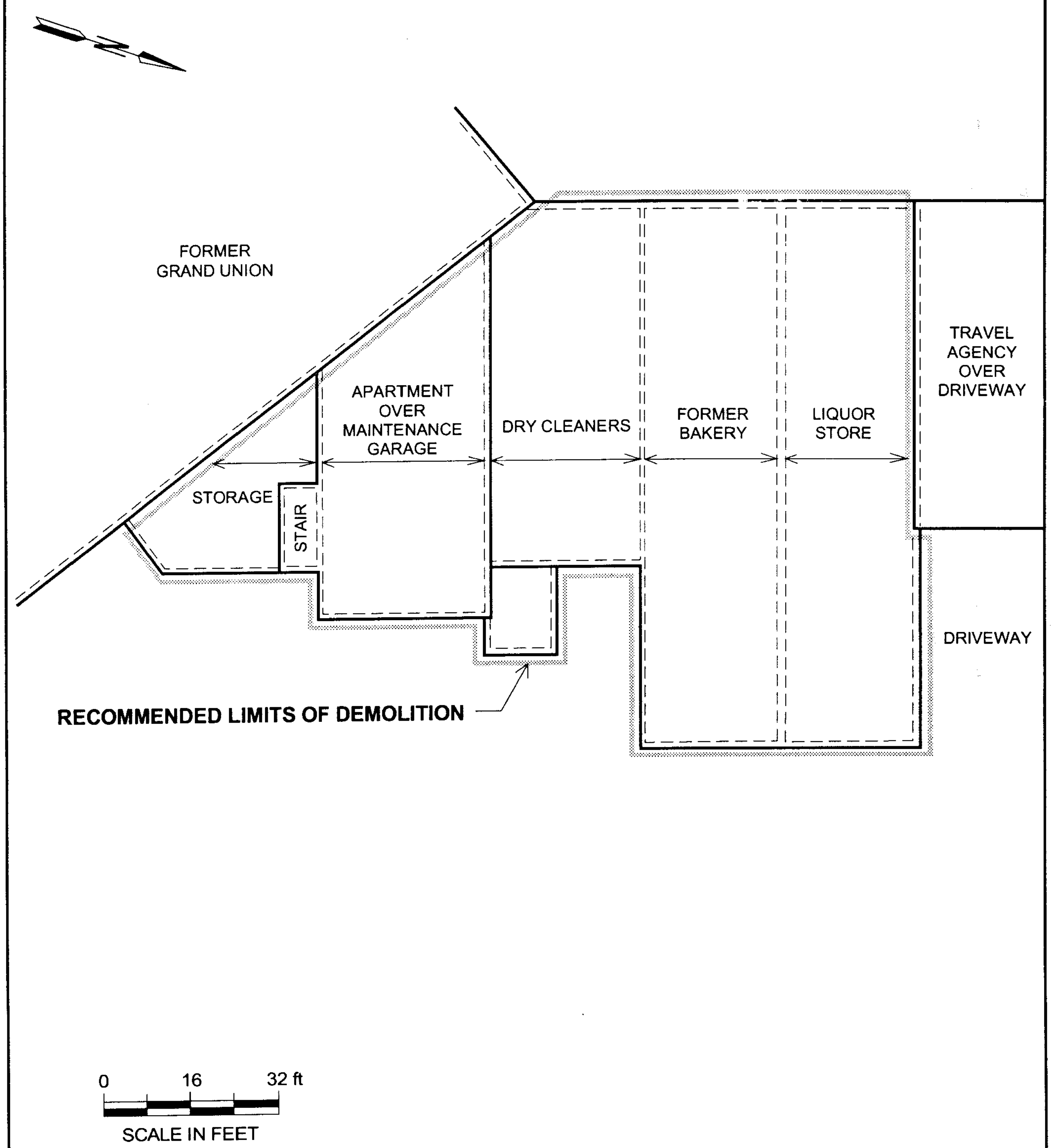
5.4.2 Source Area Excavation

Alternative 3 includes excavation of 95 yd^3 of PCE-contaminated soils in the source area to prevent continued migration of contaminants to and within groundwater. The area to be excavated is shown on Figures 4-1, 4-2, and 4-3, and is based on removal of all soils exceeding 50 mg/kg PCE. As discussed in Chapter 4, excavation of 95 yd^3 of soil removes more than 99% of the total identified PCE mass in soil.

Prior to excavation, portions of the existing mall buildings (Figure 5-2) will require demolition to allow for removal of the contaminated soils. The mall building area included for demolition is substantially larger than required simply for excavation of the source area soils; these buildings are in an area intended for redevelopment by Big V Supermarkets and therefore complete rather than partial demolition of the buildings has been included. Demolition will consist of gutting the building interiors, demolishing the walls and roof, removing the existing slab, and transporting these materials off site for disposal as nonhazardous construction and demolition (C&D) debris. The asphalt slab over the source area will also be removed and washed with high pressure water to remove attached soils after which it will be disposed with the other C&D wastes.

The majority of the contaminated soils to be excavated are present below the water table, therefore, dewatering of the excavation will be required. A well-point system will be installed to draw down the water table in the area of the excavation and dewater the soils. Sheet piling will be installed around the perimeter to below the maximum depth of excavation (i.e., greater than 15 ft). It is anticipated that pumping at a rate of 4 gpm will be sufficient to draw down the water table to below 15 ft. Pumping will be initiated three days prior to excavation and will be conducted on a 24-hr per day basis. Excavation of 95 yd^3 will require approximately two days to complete, during which time the dewatering system will continue to operate. An estimated total of 29,000 gal of contaminated water will be generated by the dewatering system, which will require appropriate disposal. The water may be collected in a tanker truck and transported off site for incineration at a TSDF as a hazardous waste or may be treated on site using GAC adsorption and disposed of to the eastern stream. Permission will need to be obtained for any on-site discharge of treated groundwater. The costs of on-site vs off-site treatment and disposal of the dewatering water will be evaluated during the remedial design to select the most appropriate option.

The excavation will be conducted using conventional earthmoving equipment, such as backhoes and front end loaders. Shoring will be used in accordance with OSHA requirements for excavations over 5 ft deep. Post-excavation samples will be collected from the bottom of the excavation at the rate of one sample for every five linear ft (total of six samples). The samples will be analyzed for total HVOCs. Following excavation to the specified depths and collection of the post-excavation samples, the excavations will be immediately backfilled with suitable clean fill material to within 6 in. of the original ground surface and the remaining 6 in. backfilled with topsoil. The cost estimate for this alternative assumes reseeding of the excavated area in the absence of any specific information on plans for redevelopment in this area of the site. The excavated and backfilled area may ultimately be covered by a concrete



Map source: Vincent Uhl Associates

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Building Demolition Plan for Source Area Excavation
BALDWIN PLACE MALL

Figure 5-2

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or asphalt slab as part of a building or parking lot. The post-excavation sampling data will be reviewed upon receipt and provided to the NYSDEC.

Excavated soils will be stockpiled on impervious liners to prevent cross-contamination of clean soils. Impervious covers will also be provided for the stockpiles to prevent infiltration and minimize runoff from precipitation. Alternatively, the excavated wastes may be placed directly into water-tight roll-off containers for off-site transport. Any runoff from the stockpiled wastes will be collected and combined with the water generated from the dewatering operations for off-site disposal. Three composite samples, approximately one sample per 30 yd^3 of excavated soils, will be taken of the stockpiled wastes to determine appropriate disposal of the materials. The samples will be analyzed for total and TCLP HVOCs.

Dust generation will be minimized during excavation using appropriate engineering controls such as water spraying or foam suppression. The majority of soils for excavation are within the saturated zone, therefore, dust generation is not anticipated to be a problem. Volatilization of contaminants from soils during excavation will also be minimized to the extent possible by minimizing handling of the soils and using impervious liners to cover excavated soils. Real-time air monitoring will be conducted during the excavation activities in accordance with an approved health and safety plan during the construction to evaluate the effectiveness of engineering controls in reducing contaminant emissions to air and appropriate corrective actions will be taken if necessary.

5.4.3 Waste Disposal

Two subalternatives for disposal of the excavated soils were retained for detailed evaluation: on-site thermal desorption and off-site incineration and/or landfilling at a TSDF. The relative advantages and disadvantages of these two technologies were considered with respect to site-specific conditions, as discussed below.

5.4.3.1 ***Off-Site Treatment/Disposal.*** Soils with contaminant concentrations exceeding the Federal or state allowable residual levels (Section 2.4.3) are banned from land disposal and must be treated to reduce the contaminant concentrations. Based on the results of the excavated soil sampling and analyses as discussed in the previous section, the need for soil treatment prior to landfilling will be determined. Excavated soils with residual contaminant concentrations exceeding allowable levels will be transported off site for incineration or other treatment (e.g., thermal desorption) at a licensed TSDF followed by landfilling of the treated soils. The closest such incineration facility is the Trade Waste Incinerator in Sauget, Illinois. The costs for incineration of the wastes are dependent on the BTU content; a BTU content of less than 2,500

BTU was assumed for the PCE-contaminated soils from the BPM site based on typical BTU values for soils and assuming PCE contamination of less than 1% by weight.

Soils with contaminant concentrations below the allowable residual levels may be directly landfilled without prior treatment, however, these soils are still classified as hazardous wastes and must therefore be disposed of at an approved hazardous waste landfill. The closest hazardous waste landfill to the site is the TSDF in Model City, New York, operated by Chemical Waste Management. The cost of direct landfilling is $250/ton as compared to $1,200/ton for incineration (based on a BTU content of less than 2,500) and subsequent disposal. For cost estimating purposes, it was assumed that all excavated soils from the site will require incineration.

5.4.3.2 *On-Site Treatment/Disposal.* The low-temperature thermal desorption treatment process involves heating contaminated soils to 200-600°F to drive off water and volatile constituents with transfer of the contaminants to a gas stream. The contaminated gas stream is then treated using vapor-phase carbon adsorption beds or in an afterburner. Low-temperature thermal desorption has been found to be effective for removal of volatile organics (e.g., PCE, TCE, and BTEX) from contaminated soils and is capable of reducing volatile organic constituent concentrations down to the part per billion (ppb) level. Treated soils meeting the cleanup objective of 1.4 mg/kg PCE may therefore be backfilled in the original excavation or disposed of elsewhere on site as opposed to off-site transport and disposal.

Typical mobilization costs for thermal desorption units range from $100,000-500,000, with unit costs for treatment ranging from $50-400 per ton. Smaller quantities of soil for treatment generally result in higher unit costs. Full-scale mobile thermal desorption units typically require a month or more for mobilization, with a processing rate of 60-100 tons per day. Treatment of the 95 yd^3 of contaminated soils present at the BPM site would require only one to two days to complete and would not be cost-effective to treat with a full-scale system due to the high mobilization and unit treatment costs as compared to the cost of off-site treatment and disposal.

Use of a pilot-scale unit as opposed to a full-scale unit at the BPM site may be more appropriate for the small quantity of contaminated wastes. Several vendors have pilot-scale units that process 24-30 tons per day; including mobilization/demobilization, treatment of the contaminated soils at the BPM site would require approximately three to four weeks to complete with such a pilot-scale system. Costs for on-site thermal desorption using a pilot-scale unit are expected to be approximately the same as the cost of off-site incineration (K. Shellum, Advanced Soil Technologies 1994, pers. commun.) for 95 yd^3 of soils ($340,000). The estimated cost for use of the pilot-scale thermal desorption unit is a lump sum cost and is not directly related to the volume of soils for treatment, therefore, thermal desorption may present a cost savings over incineration for larger volumes of soil as incineration costs are on a unit basis.

The advantages of on-site thermal treatment include no requirements for off-site transport of hazardous wastes and a potential cost savings over off-site incineration treatment if excavation quantities exceed those assumed here. Thermal desorption poses several administrative difficulties to implementation, however, including the need to obtain approval for an air emissions source and monitoring of air emissions from the unit during treatment. Approval for disposal of treated soils on site will also need to be obtained, otherwise, the treated soils will require off-site transport and landfilling at additional cost. Thermal treatment will require several weeks longer than off-site treatment and disposal for completion of remedial activities at the site, and may meet with public opposition to operation of such a unit at the site.

As the costs of on-site thermal desorption are comparable with off-site treatment and disposal and the on-site thermal desorption process does not offer substantial advantages, it was assumed for the purposes of this FS that excavated soils will be transported to an off-site TSDF for treatment and disposal. Further consideration of the appropriate off-site treatment and disposal option will be conducted during the design stage.

5.4.4 **Pumping and Treatment of Groundwater**

Alternative 3 includes increased pumping of the existing BPM production wells to contain the contaminant plume and to remediate existing groundwater contamination within the bedrock aquifer through extraction of groundwater with subsequent GAC treatment. The treated water will be used to supply both the BPM and the MPR homes. Pumping at a rate of 20 gpm (28,800 gpd) as necessary to supply both the BPM (assuming redevelopment of the BPM) and the MPR homes was assumed for this alternative (Table 5-1). At full capacity, the BPM water requirements are anticipated to be 20,000 to 25,000 gpd, while a water demand of 100 gal/person/day was assumed for an average of four persons per residence for the 19 MPR homes, resulting in a daily demand of 7,600 gpd. If the water demand is less than the estimated 28,800 gpd and it is determined that pumping at a rate of 20 gpm is necessary for containment of the on-site bedrock contaminant plume, the excess treated water will be discharged to the on-site eastern stream in accordance with the technical requirements of a SPDES permit.

The BPM production wells are not located directly downgradient of the source area but are on the western edge of the bedrock groundwater plume. The hydrogeologic evaluations conducted by VUA (Appendix A) indicate that pumping the BPM production wells at a rate of 20-30 gpm is projected to be adequate to prevent off-site contaminant migration to the southeast (i.e., towards the MPR homes) in the bedrock aquifer. The contaminant transport model also indicates that pumping at a rate of 30 gpm does not decrease the overall time frame for remediation of the groundwater as compared to pumping at 20 gpm. Therefore, pumping as required to supply the BPM and MPR homes is also adequate for remediation of the groundwater contaminant plume; pumping at an increased rate will not provide any added benefits and would require disposal of the excess treated groundwater. The actual pumping rate required to achieve containment of the contaminant plume will be determined in the field; any excess flow beyond that required for supply to the BPM and MPR homes will need to be disposed of on site.

Treatment of the extracted groundwater will be achieved using the existing GAC treatment units for the BPM production wells. The treatment units consist of two carbon filters with 1600 lb of GAC and a capacity of 60 gpm each, followed by chlorination for disinfection of the treated water. The existing system has been effective in reducing contaminant (i.e., PCE, TCE, and intermittent trace MTBE) concentrations to below detectable levels to date, and is assumed to be adequate for treatment of the increased flowrate, with minor modifications. The costs for this alternative assume installation of an additional chlorine feed pump as a standby unit in case of failure of the existing unit, as required for community water supply systems.

Maintenance of the treatment system is included in the O&M costs for Alternative 3, and includes monthly pump inspection and maintenance, chemical usage costs for the chlorination system, replacement of the production well pumps every five years, and yearly replacement of the carbon in the GAC filters. This frequency of carbon replacement is based on the increased flowrate through the filters (20 gpm), average PCE influent concentrations for BPM production well water observed to date, and typical carbon exhaustion rates; actual replacement times will be determined based on breakthrough of the filters as observed in the monitoring program results.

5.4.5 Distribution System to MPR Homes

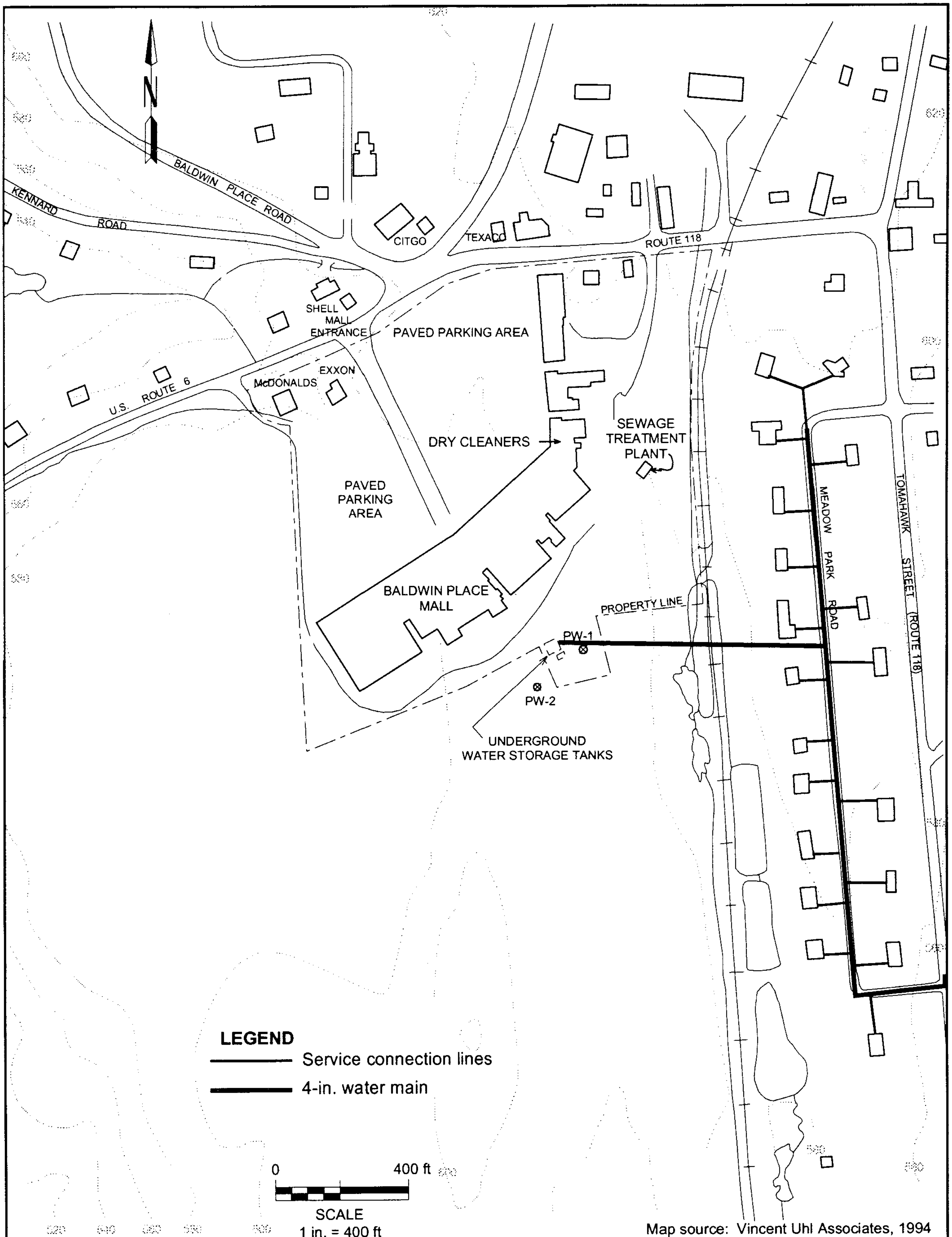
Alternative 3 includes installation of a water distribution system to convey treated flows from the BPM production wells to the homes on Meadow Park Road. Approval of the distribution system plans will be required by the NYSDOH and WCDOH, with review of the plans by the Town of Somers. The distribution system as described here does not include the provision of fire protection, however, these agencies have indicated that inclusion of fire protection in the system may be required for approval of the plans.

Estimated average daily water demand for the MPR homes is 7,600 gpd based on 100 gal/person/day with an average of four persons per home and 19 homes, resulting in a required flow rate of 5 gpm. Maximum day and maximum hour demand requirements are estimated at 7.5 and 15 gpm, respectively, based on a maximum day multiplier of 1.5 and a maximum hour multiplier of 3.0 (Lindeburg 1989). The existing storage tanks at the BPM have a capacity of 141,000 gal (JRFA 1991), which is sufficient to provide both the maximum day and maximum hour demand requirements.

A preliminary layout of the distribution system is included in Figure 5-3. Approximately 2,600 linear ft of 4 in. ductile iron pipe will be used for the pressure main to convey flows to the MPR homes, as required by the Town of Somers. The main will continue to the southern intersection of Meadow Park Road with Route 118 (Tomahawk Street) to provide a tie-in point for future connection of the MPR system with the ASWD distribution system. As discussed earlier, the MPR area may be administratively incorporated into the ASWD without physical connection of the two distribution systems. Such a connection may be installed, however, if the ASWD is connected to the WCWD No. 2 and is supplied by county water. The MPR homes may then also be supplied by WCWD No. 2 via the ASWD distribution system with construction of only a connecting line from Meadow Park Road and Route 118 to the ASWD tie in located on Overhill Road.

Laterals for connection of the MPR homes to the pressure main will consist of 1 in. polyvinyl chloride (PVC) lines. Upon connection of each home to the distribution system, the existing residential wells will be closed by pulling the pump and filling in the well with a cement/bentonite slurry.

Long-term maintenance of the water supply distribution system will be required and the cost of such maintenance has been included here. Maintenance activities will include monthly inspection and repair of all pumps with replacement as needed, water line cleaning (assumed to occur every 10 years for the complete water main), and pipe repair and/or replacement as needed (assumed at 50 linear ft per year for costing purposes). Water quality monitoring will also be required in accordance with the requirements for community water systems utilizing groundwater supplies (10 NYCRR Chapter I Subpart 5-1). Table 5-4 summarizes the anticipated water quality monitoring program; the NYSDOH has discretion over the monitoring requirements to be implemented and may modify this program.



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Distribution System to MPR Homes

BALDWIN PLACE MALL

Figure 5-3

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TABLE 5-4

DISTRIBUTION SYSTEM WATER QUALITY MONITORING PROGRAM[a]

Baldwin Place Mall

CONSTITUENT	FREQUENCY OF MONITORING
Asbestos	1 sample every 9 years
Inorganics:	1 sample per source well every 3 years
Arsenic	
Barium	
Cadmium	
Mercury	
Selenium	
Fluoride	
Nitrate/Nitrite	1 sample initially[b]
Inorganics:	1 sample per source well initially[b]
Antimony	
Beryllium	
Nickel	
Sulfate	
Thallium	
Cyanide	
Total trihalomethanes:	1 sample per year of post-disinfection water[c]
Organic contaminants:	At NYSDOH discretion based on potential contaminants[d]
Total coliforms:	1 sample per quarter
Combined radium - 226 and radium - 228 and gross alpha activity:	1 composite sample of 4 quarterly samples every 4 years

a - Source: 10 NYCRR Chapter I Subpart 5-1: Requirements for monitoring of a community water supply system serving less than 1000 persons.

b - If contaminant is above acceptable levels, monitoring frequency will be established by NYSDOH.

c - Monitoring frequency established at NYSDOH discretion.

d - Assume quarterly monitoring for HVOCs and AVOCs and annual monitoring for MTBE for first five years and semiannually thereafter per long-term monitoring program.

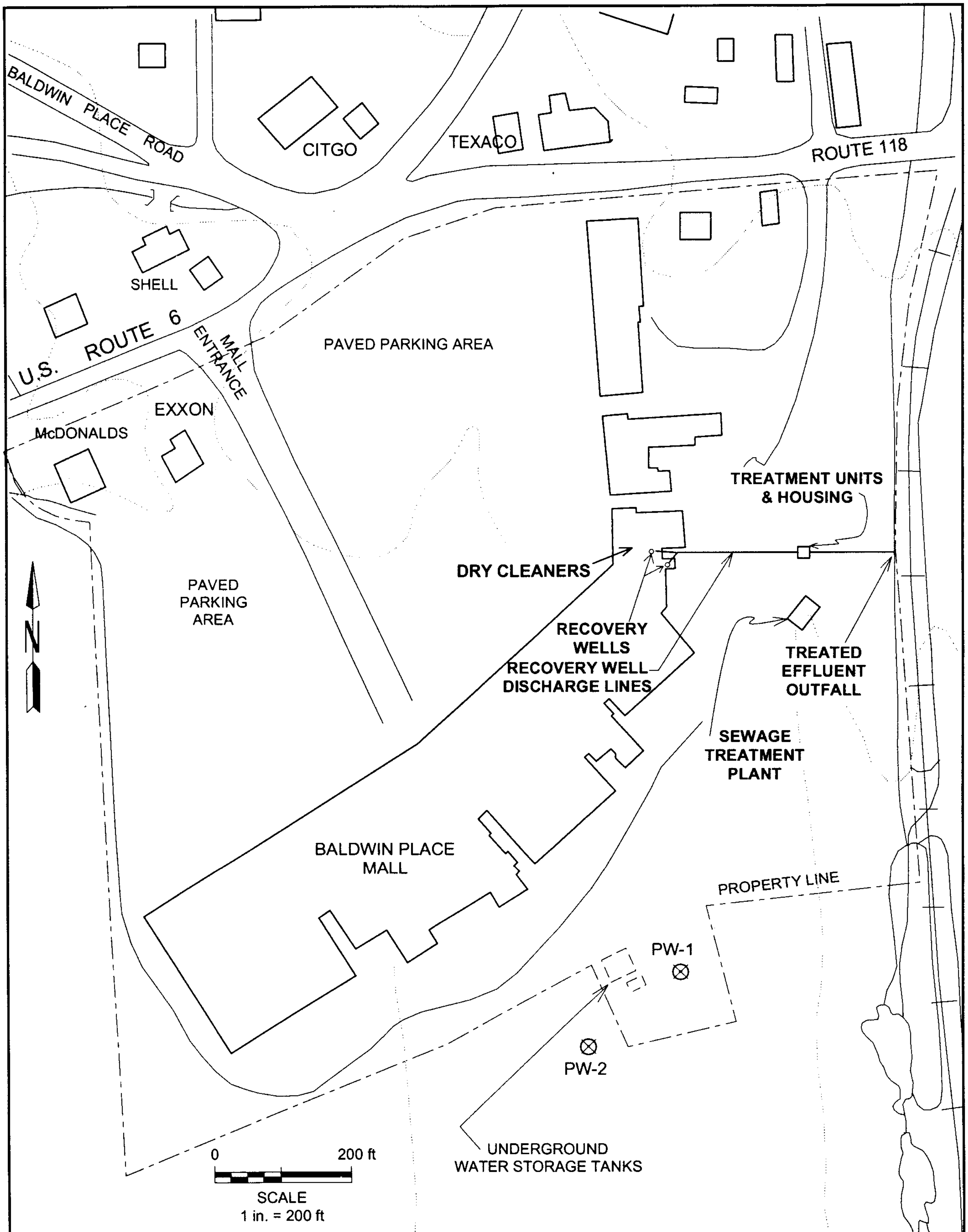
5.5 ALTERNATIVE 4: SOURCE AREA EXCAVATION WITH SOURCE AREA RECOVERY WELLS

Alternative 4 has a number of technical components in common with Alternative 3, including excavation of 95 yd^3 of source area soils, increased pumping of the BPM production wells (20 gpm) to supply the mall and the MPR homes, and construction of a distribution system to convey treated flows from the BPM wells to Meadow Park Road. The long-term monitoring program included in Alternative 4 is also the same as that included in Alternative 3 (Table 5-3). In addition to these components, Alternative 4 includes the installation of recovery wells in the source area at the site with separate treatment and on-site disposal of the extracted groundwater. Only these additional components that differ between Alternatives 3 and 4 are described below.

5.5.1 Source Area Recovery Wells

Alternative 4 includes installation of recovery wells in the source area at the site with the goal of reducing the time required for groundwater remediation within the till and containing contaminant migration from the source area. The till modelling conducted by VUA (Appendix A) indicates that the optimum configuration of a recovery well system in the source area includes two wells; one completed in the weathered zone of the bedrock aquifer to the top of the competent bedrock (a depth of approximately 75 ft) immediately beneath the source area to contain groundwater migrating vertically into the bedrock, and the second completed in the shallow till (to a depth of 30 ft) to contain groundwater migration in the till to the west (Figure 5-4). Pumping rates as required to prevent groundwater migration from the source area were estimated to be 0.25-0.5 gpm for the bedrock recovery well and 0.4 gpm for the shallow recovery well (Table 5-1). Actual pumping rates for the recovery wells will be determined during the design and implementation of the groundwater remediation system from actual well yields and drawdowns as determined in the field. Monitoring and contingency responses for early stages of the remedial action will be determined during the design stage to ensure that site remedial action objectives (e.g., containment of the on-site contaminant plume) are being achieved by the proposed pumping and treatment of groundwater included in this alternative.

Pumping of these wells will be conducted in conjunction with pumping of the BPM production wells at a rate of 20 gpm to contain and remediate the bedrock groundwater contaminant plume. The flow from the recovery wells will be collected and treated separately from the BPM production well treatment system.



Map source: Vincent Uhl Associates, 1994

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Source Area Recovery Wells and Treatment System

BALDWIN PLACE MALL

Figure 5-4

\100\233SITE.ds4

5.5.2 Recovery Well Water Treatment

A new GAC treatment system will be installed to handle flows of up to 1 gpm from the source area recovery wells. GAC treatment was selected over air stripping as GAC has been effective to date for removal of PCE and its breakdown products as well as BTEX and MTBE from site groundwater. Air stripping, although expected to be effective for removal of volatile constituents, would require an air permit for operation, and may need to be used in conjunction with GAC treatment to reduce contaminant concentrations to below detection limits.

The treatment system will consist of an equalization tank followed by two 55-gal GAC filter units in series with associated pumps, piping, and instrumentation. Housing will be constructed on site for the treatment equipment (Figure 5-4). The treated groundwater will then be discharged to the eastern stream in accordance with the technical requirements for a SPDES permit. Discharge limitations are assumed to be based on the NYSDEC surface water standards for the receiving waters, i.e., Class B surface water standards as applicable to a subtributary of the Muscoot River wherein standards for PCE and TCE are 1 and 11 μg/l, respectively. A new surface water discharge within the watershed may be prohibited in accordance with the proposed NYCDEP regulations for New York City water supply watersheds (NYCDEP 1994), therefore, a waiver may need to be obtained for the proposed discharge.

Costs for this alternative assume replacement of the recovery well pumps every five years, annual maintenance of the treatment system including replacement of the spent carbon every four months, and monthly monitoring of the treated water for HVOCs, AVOCs, and MTBE prior to discharge (actual monitoring requirements will be specified by NYSDEC).

5.6 ALTERNATIVE 5: SOURCE AREA EXCAVATION WITH SOURCE AREA/WESTERN SITE/SOUTHEASTERN SITE RECOVERY WELLS

Alternative 5 includes excavation of 95 yd^3 of contaminated source area soils and active groundwater remediation through increased pumping of the BPM production wells and installation of recovery wells in the source area, in the southeastern site area downgradient of the source area, and on the western side of the site. Alternative 5 also assumes continued use of POU systems, as described in Alternative 1, instead of a water distribution system as described in Alternatives 3 and 4. This will allow for comparison of the impacts of a distribution system with those of continued use of POU treatment units while groundwater remediation is in progress. The elements of this alternative are described below, with the exception of remediation of the source area soils, which is the same as that described for Alternative 3.

5.6.1 Long-Term Monitoring Program

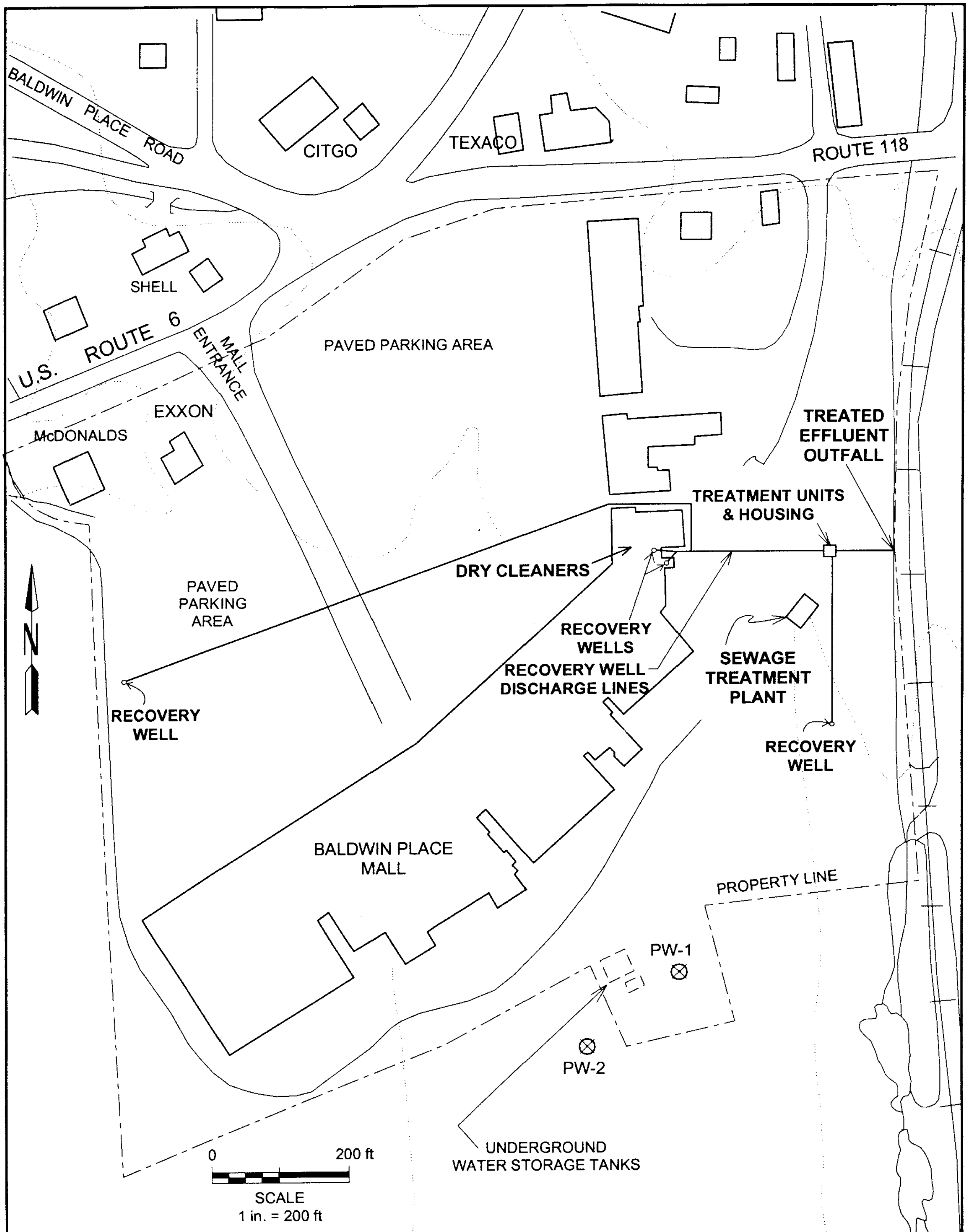
The long-term monitoring program included in Alternative 5 is essentially the same as that included in Alternatives 3 and 4 (Table 5-3), with quarterly sampling of the on-site monitoring wells and production wells for the initial five years of the program and annual sampling for the remaining 25 years of the monitoring program. The monitoring program for Alternative 5, however, includes continued quarterly sampling of the water supply wells on Meadow Park Road for the first 20 years and annually thereafter. (Alternatives 3 and 4 assume that sampling of these MPR wells will be discontinued when the distribution system from the BPM production wells is complete, i.e., after approximately one year.)

5.6.2 Pumping and Treatment of Groundwater

The groundwater remediation program included in Alternative 5 is intended to minimize the time required to meet groundwater cleanup objectives by maximizing groundwater recovery, therefore, this alternative includes increased pumping of the existing BPM production wells, with installation of additional recovery wells in the source area, on the southeastern portion of the site, and on the western portion of the site. Continued use of the POU treatment units by the businesses on Route 6 and the MPR homes until groundwater remediation is achieved was assumed for this alternative, therefore, all groundwater extracted from the site will be discharged to the eastern stream following treatment, with the exception of that portion of the flow from the BPM production wells which will be used to supply the mall demand.

The pumping rate assumed for the BPM production wells in Alternative 5 is 15 gpm for mall water supply following redevelopment. The water will be treated using the existing GAC treatment system, however, no modifications to this system (i.e., installation of a new chlorine solution feed pump) were included in the costs for this alternative as these modifications are only necessary for community water systems as required for distribution of treated BPM production well water to the MPR homes.

Two recovery wells, a shallow till well and a bedrock well, will be installed in the source area as discussed in Alternative 4. These wells will be pumped at a combined rate of up to 1.0 gpm as required to contain groundwater in the source area and prevent its migration to the bedrock aquifer and western site area. An additional recovery well will be installed in the southeastern site area downgradient of the source area as shown on Figure 5-5. This downgradient recovery well will be screened in the upper portion of the competent bedrock, which is present at a depth of 80-85 ft bgs in this area. Only a deep (bedrock) recovery well is included at this downgradient location as groundwater contamination is present in the bedrock and not within



Map source: Vincent Uhl Associates, 1994

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Source Area/Western Site/Southeastern Site Recovery Wells and Treatment System
BALDWIN PLACE MALL

Figure 5-5

\100\233SITE.ds4

the till at this location. Actual placement of the well screen will be determined during installation based on water strikes during drilling. The optimum pumping rate for the downgradient recovery well as determined by VUA (Appendix A) is 15 gpm; increasing the pumping rate to 20 gpm does not decrease the time required for groundwater remediation.

A recovery well will also be installed in the western site area (Figure 5-5) in bedrock at a depth of approximately 100 ft bgs. The well screen placement for the western recovery well will be selected in the field based on water strikes during drilling. Pumping of the western recovery well at rates of 5-20 gpm were evaluated in the groundwater modelling effort; 20 gpm resulted in the shortest time frame for groundwater remediation and is therefore included as the optimum pumping rate for Alternative 5. As discussed for Alternative 4, actual pumping rates will be determined during implementation of the remedial alternative based on field data. Monitoring and contingency responses for early stages of the remedial action will be determined during the design stage to ensure that site remedial action objectives are being achieved by the proposed pumping and treatment of groundwater included in this alternative. The recovery well depths and pumping rates assumed for Alternative 5 are summarized in Table 5-1.

The groundwater extracted from the four recovery wells will be treated at newly constructed on-site treatment facilities and disposed of to the eastern stream in accordance with the technical requirements for a SPDES permit. The treatment system will be similar to that included in Alternative 4 (i.e., equalization tank followed by two parallel trains with two 55-gal carbon filtration units each in series), but will be designed for a flowrate of approximately 36 gpm rather than 1 gpm. Housing will be provided for the treatment system on the eastern portion of the site as shown on Figure 5-5 and piping will be installed to convey the water from each of the recovery wells to the treatment plant. Maintenance of filtration units and pumps will be performed on an annual basis. The treated groundwater will be sampled for HVOCs, AVOCs, and MTBE prior to discharge in accordance with the discharge requirements; the costs for this alternative assume that monthly sampling will be required.

CHAPTER 6

DETAILED EVALUATION OF ALTERNATIVES

6.1 INTRODUCTION

This chapter presents the detailed evaluation of the remedial alternatives described in Chapter 5. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative as well as key tradeoffs among them. The criteria used to evaluate the alternatives are specified in the NCP and are as follows:

- **Overall Protection of Human Health and the Environment:** This criterion evaluates the extent to which the alternative will achieve and maintain protection of human health and the environment and how the protection will be achieved, i.e., through treatment, engineering, or institutional controls.

- **Compliance with ARARs:** This criterion evaluates the compliance of the alternative with all identified chemical-, location-, and action-specific ARARs for the site. Site-specific ARARs are discussed in Section 2.4.

- **Long-Term Effectiveness and Permanence:** Each alternative is evaluated for its long-term effectiveness in protecting human health and the environment following completion of the remedial action.

- **Reduction of Toxicity, Mobility, and Volume through Treatment:** The NCP specifies that preference be given to alternatives that reduce the toxicity, mobility, or volume of contamination present through treatment. The degree to which each alternative results in a reduction is evaluated by this criterion.

- **Short-Term Effectiveness:** This criterion evaluates the impacts of each alternative on human health and the environment during the construction and implementation of the remedy.

- **Implementability:** The technical and administrative feasibility of implementing each alternative, including site features that may restrict application of the alternative, are evaluated for this criterion.

- **Cost:** The relative capital costs have been estimated for each alternative. O&M costs for each alternative are also included based on a 30-yr life (EPA 1988). Actual operational time frames (time required for long-term groundwater monitoring or pumping and treatment of groundwater) may be shorter or longer than 30 years depending on the time for achievement of site remedial action objectives. The cost estimates included in this FS are for comparative purposes; detailed cost estimates will be prepared in the remedial design phase.

Community and state acceptance are also criteria to be considered in evaluating the remedial alternatives. Community acceptance cannot be assessed until public comments have been received on the proposed remedial action plan. The Record of Decision (ROD) for the site will address community acceptance. State acceptance of the proposed remedial action plan will also be addressed in the ROD.

6.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

The individual analysis of the remedial alternatives with respect to the seven evaluation criteria is presented below.

6.2.1 Alternative 1: No/Minimal Action

6.2.1.1 ***Protection of Human Health and the Environment.*** Alternative 1 is protective of human health through the use of institutional measures (deed and development restrictions) to prevent human contact with the contaminants that will remain at the site; however, the potential for human exposure to the contaminants will remain. Remaining contaminants in source area soils may volatilize to the atmosphere or leach into the groundwater.

Contaminants already present in groundwater or leaching from source area soils will continue to migrate off site in this alternative. The POU treatment units for the residential and commercial wells and treatment of the BPM production well flows using GAC have been effective to date in preventing human contact with contaminants in groundwater, however, long-term monitoring and maintenance of these units is required to ensure that future exposures do not occur. Alternative 1 will allow uncontrolled migration of contaminated groundwater to the west and southeast of the site. The long-term monitoring program will assess the movement and natural attenuation of the site-related constituents over time.

6.2.1.2 ***Compliance with ARARs and TBCs***. Chemical-specific ARARs for the site, including Class GA groundwater standards and the Federal and state MCLs for drinking water, will not be achieved by Alternative 1 within the 30-year time frame for evaluation of the alternatives included here. Alternative 1 will also not achieve the NYSDEC recommended soil cleanup objectives, which are chemical-specific TBCs for this site. Natural attenuation of groundwater contamination and continued pumping of the BPM production wells at a low rate (4 gpm) is estimated to require 40 years for remediation of on-site groundwater and greater than 40 years for the MPR area based on the contaminant transport modelling performed by VUA (Appendix A). There are no location- or action-specific ARARs or TBCs that are applicable to the remedial activities included in this alternative, i.e., continued pumping of the BPM production wells at the current rate. Alternative 1 does not comply with Section 121, Subsections 104 and 106, of CERCLA, which states that the selected remedial alternative must attain a cleanup level that is protective of human health and the environment.

6.2.1.3 ***Long-Term Effectiveness and Permanence.*** As the minimal action alternative, Alternative 1 does not provide a high degree of long-term effectiveness and permanence. Environmental degradation may continue to occur due to migration of contaminants from the source area soils to groundwater. Although human health risks may be minimized through use of the POU treatment units for the MPR homes and Route 6 businesses and GAC filtration for the BPM water supply, continued monitoring and maintenance is required to ensure that these units remain effective. The expected time frame for natural attenuation of groundwater contamination to below the drinking water standard for PCE of 5 μg/l is 40 years for on-site groundwater and greater than 40 years for the MPR area, assuming continued pumping of the BPM production wells at a rate of 4 gpm and a PCE half-life in the bedrock aquifer of 11 years (Appendix A).

6.2.1.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** Alternative 1 will not result in a reduction in the toxicity, mobility, or volume of contamination present at the BPM site. The long-term monitoring program will evaluate the extent of natural attenuation of groundwater contamination that is occurring.

6.2.1.5 ***Short-Term Effectiveness.*** Implementation of Alternative 1 will not result in any short-term human health or environmental impacts as the only remedial activities that will occur at the site are continued pumping of the BPM production wells and use of the POU treatment units, therefore, no construction activities are included in this alternative. Long-term monitoring and maintenance of the GAC treatment units will pose minimal risks to workers during these activities.

6.2.1.6 ***Implementability.*** Implementation of this alternative is already underway since this is the status quo for the site and therefore does not depend on the availability of vendors, materials, or services other than those currently being provided at the site. Long-term monitoring and treatment unit maintenance activities are currently being conducted in accordance with the Order on Consent (NYSDEC 1991b) and do not pose any technical or administrative difficulties for continued implementation of Alternative 1.

6.2.1.7 ***Cost.*** Estimated capital and long-term O&M costs for Alternative 1 are included in Table 6-1. These costs are based on the assumptions included in the description of the alternative provided in Chapter 5, and have a range of accuracy of -30% to +50%. The

TABLE 6-1 (Page 1 of 2)

COST ESTIMATE FOR ALTERNATIVE 1: NO/MINIMAL ACTION

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
CAPITAL COSTS:			
A. Direct Costs:			
Deed and Development Restrictions:			-[b]
B. Indirect Costs:			-[b]
		TOTAL:	-[b]
O&M COSTS:			
Treatment System Maintenance:			
Carbon treatment:	5,000/change	4 changes[c]	20,000
		Annual Cost:	1,000/yr
POU Treatment Unit Maintenance-MPR Homes:			
Annual maintenance and carbon replacement as needed[d]:			2,000/yr
POU Treatment Unit Maintenance-Route 6 Businesses:			
Annual maintenance and carbon replacement as needed[e]:			1,000/yr
Long-Term Monitoring Program:			
On-Site Monitoring Wells:			
Well sampling cost for semiannual collection of samples:	600/well	16 wells	10,000/yr
Semiannual analyses for HVOCs:	200/sample	16 samples	3,000/yr
Annual analyses for AVOCs and MTBE:	200/sample	8 samples	2,000/yr
Replacement of 2 wells being monitored every 5 years:	10,500/cluster	6 clusters	63,000
		Annual Cost:	2,000/yr

a - Costs rounded to nearest $1000.
b - Costs cannot be determined at this time.
c - Assumes carbon requires replacement every 8 years starting in 3 years.
d - Assumes carbon requires replacement every 15 years.
e - Assumes carbon requires replacement every 4 years.

COST ESTIMATE FOR ALTERNATIVE 1: NO/MINIMAL ACTION

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
Water Supply Wells:			
Well sampling cost for quarterly collection of samples:	600/well	96 wells[f]	58,000/yr
Quarterly analyses of production well samples for HVOCs, AVOCs, and total coliforms:	420/sample	24 samples[g]	10,000/yr
Quarterly analyses of residential well samples for HVOCs:	200/sample	168 samples[g]	34,000/yr
Quarterly analyses of commercial well samples for HVOCs and MTBE:	200/sample	48 samples[g]	10,000/yr
Semiannual sampling of CW-25 for HVOCs and MTBE:	800/sample[h]	2 samples	2,000/yr
		Annual Cost for Long-Term Monitoring Program:	131,000/yr
		TOTAL O&M COSTS:	135,000/yr
PRESENT WORTH:			
Based on a 30-yr life and a 5% interest rate:			2,075,000

a - Costs rounded to nearest $1000.
f - Includes PW-01, -02, RW-01 to RW-18, CW-20, -21, -22, and -23.
g - Includes collection of 3 samples/well; one each before, between, and after the two carbon filters for all wells with treatment units (see Table 5-2).
h - Includes well sampling cost and analytical cost.

estimated capital cost for Alternative 1 is unknown at this time as the cost of implementing the deed and development restrictions is unknown. Annual O&M costs are estimated at $135,000 per year for 30 years. Based on a 5% interest rate (EPA 1988), the present worth of this alternative is $2,075,000.

6.2.2 Alternative 2: Air Sparging/Soil Vapor Extraction

As discussed in Chapter 5, Alternative 2 was eliminated from further consideration as a result of additional investigations of the air sparging/soil vapor extraction technology, which indicated that this technology is not technically feasible for implementation at this site. In addition, in situ treatment of the soils is unlikely to be cost-effective due to the relatively small volume of contaminated source area materials and would pose greater on-site adverse impacts (e.g., noise, air emissions, truck traffic) over a longer time frame than that required for excavation of the soils.

6.2.3 Alternative 3: Source Area Excavation

6.2.3.1 ***Protection of Human Health and the Environment.*** Alternative 3 is protective of human health and the environment through excavation of source area soils and increased pumping of the BPM production wells to remove contaminants from the groundwater. In addition, installation of a distribution system to provide potable water supply to the MPR homes will eliminate the potential for contact with groundwater contaminants through use of untreated residential well water or failure of the existing POU treatment units at the residential wells. Removal of contaminated soils from the source area will eliminate the potential for public exposure to volatilized contaminants and will also prevent further contamination of groundwater. Pumping of the BPM production wells at a rate of 20 gpm is expected to contain the groundwater contaminant plume from further off-site migration; the extracted water will be treated before use at the BPM or introduction into the MPR distribution system to ensure that chemical concentrations are at or below acceptable public potable water criteria.

6.2.3.2 ***Compliance with ARARs and TBCs.*** Excavation of 95 yd^3 of contaminated soils from the source area will comply with the NYSDEC recommended soil cleanup objective of 1.4 mg/kg for unsaturated zone soils.

The cleanup objective for saturated soils is based on protection of groundwater quality (Section 2.2). Evaluation of the different excavation scenarios included in Chapter 4 was conducted as part of the groundwater modelling effort (Appendix A). The time to achieve a groundwater cleanup objective of 5 μg/l for PCE in the source area till groundwater assuming removal of

95 yd^3 of soils and 185 yd^3 of soils was estimated at 25 to 30 years for both excavation scenarios. Since additional excavation of soils does not have an impact on the estimated time frame for groundwater remediation within the source area, excavation of 95 yd^3 of the most substantially contaminated soils as included in this alternative is therefore deemed to comply with the intent of the saturated soil cleanup objective.

The Class GA groundwater standards and NYSDOH MCLs for PCE and its breakdown products will be achieved by this alternative in the bedrock groundwater in an estimated time frame of 17 to 18 years on site and 20 years in the MPR area. Until bedrock groundwater remediation is achieved, extracted groundwater will be treated using GAC adsorption either at the on-site production wells or at individual POU treatment units to reduce contaminant concentrations to below the chemical-specific ARARs for the site (i.e., drinking water standards).

There are no promulgated ambient air quality standards for the contaminants of concern at this site under Federal or state regulations, however, the NIOSH IDLH and OSHA PEL levels may be used as guidelines to assess chemical concentrations in air during excavation activities.

Potential impacts to the two wetland areas on site constitute the only applicable location-specific ARAR. Construction of the distribution system to the MPR homes which will require excavation in the area of the eastern stream is the only remedial activity expected to disturb the wetlands. These wetland areas have already been adversely impacted by site construction activities and are not expected to be substantially altered by the distribution system construction activities, which will be conducted so as to minimize impacts. Applicable permits for alterations to wetland areas will be obtained prior to construction. Requirements for public water distribution system design, maintenance, and monitoring as included in 10 NYCRR Chapter I Subpart 5-1 and the Ten State Standards will be complied with by Alternative 3.

The excavated soils and dewatering groundwater will be treated and disposed of off site at a licensed TSDF as hazardous wastes (F002 or U210 wastes). Transportation will be in accordance with all required hazardous waste manifesting and transportation requirements. Alternative 3 will comply with Section 121, Subsections 104 and 106, of CERCLA, which states that the selected remedial alternative must attain a cleanup level that is protective of human health and the environment.

6.2.3.3 ***Long-Term Effectiveness and Permanence.*** Excavation of substantially contaminated soils (i.e., 95 yd^3) will permanently remove the source of PCE contamination in groundwater at the site. Off-site treatment and landfilling will ensure that contaminants in soils are not released to the environment. Extraction of contaminated groundwater via increased pumping of the BPM production wells will permanently remove contaminants from groundwater and is also expected to contain the off-site migration of contaminants. Groundwater remediation (i.e., achievement of the groundwater cleanup objectives) is estimated to be completed in 17 to 18 years for on-site bedrock groundwater, approximately 20 years in the MPR area bedrock groundwater, and 25 to 30 years for the on-site shallow till groundwater. Continued monitoring and maintenance and periodic replacement of the GAC treatment system for the BPM wells is required to ensure that contaminants are removed from the water prior to use as a potable water supply for the BPM and MPR homes. Installation of a distribution system and abandonment of the residential wells will permanently remove the risk of contact with contaminated groundwater in the MPR area and will also allow for potential future connection of the homes to an off-site source of water supply should such a supply become available.

6.2.3.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** Soils excavated from the source area will be treated by incineration or thermal desorption at an off-site TSDF. Either treatment process will result in the removal and ultimate destruction of the organic contaminants in soil and will thereby reduce both the toxicity and volume of contamination in the soils. Extracted groundwater will be treated using GAC adsorption, which transfers contaminants from the incoming water flow to the adsorption sites on the carbon, thereby reducing the volume of contaminated media. Periodic removal of the carbon for regeneration through thermal destruction of the contaminants present will ultimately reduce the toxicity of the remaining contaminants.

6.2.3.5 ***Short-Term Effectiveness.*** Excavation of PCE-contaminated soils will pose potential short-term risks to workers performing the remediation through contact with the contaminated soils and water or inhalation of volatilized constituents. Exposure to the contaminants will be minimized through use of personal protective equipment, on-site air monitoring during construction, and engineering controls to minimize dust and vapor generation. Engineering controls will also be used to ensure that potential exposures to contaminated dust or volatilized constituents for the surrounding public are minimized. Completion of the source area excavation is expected to require two weeks; increased truck traffic and noise at the site will occur during this time frame.

Construction of the distribution system is also expected to cause both on- and off-site (i.e., in the MPR area) impacts. Installation of the lines and connection of the homes to the water main will require approximately 12 weeks for completion following approval of the distribution system design. Impacts to human health and the environment are expected to be minimal as the construction will occur in uncontaminated areas of the site, however, disruption of traffic, noise, and other construction-related impacts may occur during this time frame.

Implementation of the groundwater remedial program will not cause any substantial short-term impacts for workers or the surrounding public. The existing BPM production wells will be used for groundwater pumping, with only minor modifications to the treatment system as required for use as a community water system, i.e., provision of a new chemical feed pump.

6.2.3.6 ***Implementability.*** Implementation of the remedial technologies included in Alternative 3 is readily achievable with standard equipment and vendors. Excavation of the source area soils may be conducted using conventional earthmoving equipment, however, installation of an appropriate dewatering system will be required. Acceptance of the excavated soils and dewatering wastewater at a TSDF is required for disposal. The existing BPM production wells and GAC treatment system have adequate capacity for the additional pumping included in this alternative. Installation of the distribution system to the MPR homes is readily implementable from a technical standpoint, however, administrative difficulties such as incorporation of the MPR area into the ASWD or creation of a new water district and approval of the proposed system by the Town of Somers, WCDOH, and NYSDOH may delay or prohibit implementation. Long-term monitoring of groundwater is readily accomplished.

6.2.3.7 ***Cost.*** The estimated costs for the elements of Alternative 3 as described in Chapter 5 are included in Table 6-2 and are accurate to within a range of -30% to +50%. The capital cost for this alternative is $828,000 and annual O&M costs are $170,000 year for the first year, $93,000 for years 2-5, $47,000 for years 6-20, and $46,000 for years 21-30. Based on a 30-yr life and a 5% interest rate, the present worth for Alternative 3 is $1,781,000.

6.2.4 Alternative 4: Source Area Excavation with Source Area Recovery Wells

6.2.4.1 ***Protection of Human Health and the Environment.*** Alternative 4 is protective of human health and the environment through excavation of the majority of PCE remaining in source area soils and through active groundwater remediation. Excavation of contaminated soils from the source area will eliminate the potential for public exposure to volatilized contaminants and will also prevent further impacts to groundwater quality. Treatment and appropriate disposal of excavated soils will ensure that contaminants will not be released to the environment following disposal.

Installation of a water supply distribution system to convey treated water to the MPR homes from the BPM production wells will eliminate the potential for contact with groundwater contaminants through use of untreated residential well water or failure of the existing POU treatment units at the residential wells. Pumping of the BPM production wells and source area recovery wells will contain the groundwater contaminant plume and prevent further off-site

COST ESTIMATE FOR ALTERNATIVE 3: SOURCE AREA EXCAVATION

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
CAPITAL COSTS:			
A. Direct Costs:			
Excavation of 95 yd^3 of Soils with Off-Site Treatment and Disposal (see Table 4-5):			340,000
BPM Treatment System Modifications:			
Chlorine solution feed pump:	1,100/ea.	1	1,000
Distribution System:			
Pressure water main installation:	65/ft	2,800 ft	182,000
Service connections, including piping and well closure:	1,500/home	19 homes	29,000
		Subtotal:	552,000
B. Indirect Costs:			
Engineering and Design @ 15%:			83,000
Legal and Administrative @ 10%:			55,000
Contingency @ 25%:			138,000
		TOTAL:	828,000
O&M COSTS:			
BPM Treatment System Maintenance:			
BPM production well pump replacement[b]:	4,342/pump	12 pumps	52,000
		Annual Cost:	2,000/yr
Chemical costs-chlorine:	5.90/kg	1,486 kg	9,000/yr
Pump maintenance:			6,000/yr
Carbon replacement:			5,000/yr
Distribution System Maintenance:			
Pipe repair/replacement:	36/ft	50 ft	2,000/yr
Pipe cleaning:	3.60/ft	260 ft	1,000/yr
Water quality monitoring:			1,000/yr
POU Treatment Unit Maintenance-Route 6 Businesses (Years 1-20)			
Same as Alternative 1:			1,000/yr

a - Costs rounded to nearest $1000.
b - Assumes replacement of pumps required every 5 years.
LS - Lump sum.

COST ESTIMATE FOR ALTERNATIVE 3: SOURCE AREA EXCAVATION
Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
Long-Term Monitoring Program (Years 1-5):			
On-Site Monitoring Wells:			
Well sampling cost for quarterly collection of samples:	600/well	32 wells	19,000/yr
Quarterly analyses for HVOCs:	200/sample	32 samples	6,000/yr
Semiannual analyses for AVOCs and MTBE:	200/sample	16 samples	3,000/yr
Replacement of 2 wells being monitored every 5 years:	10,500/cluster	1 cluster	11,000
		Annual Cost:	2,000/yr
Water Supply Wells - Residential (Year 1 only):			
Well sampling cost for quarterly collection of samples:	600/well	72 wells	43,000/yr
Quarterly analyses for HVOCs:	200/sample	168 samples[c]	34,000/yr
Water Supply Wells - Commercial and Production (Years 1-5):			
Well sampling cost for quarterly collection of samples:	600/well	24 wells	14,000/yr
Quarterly analyses of production well samples for HVOCs, AVOCs, and total coliforms:	420/sample	24 samples[c]	10,000/yr
Quarterly analyses of commercial well samples for HVOCs and MTBE:	200/sample	48 samples[c]	10,000/yr
Semiannual sampling of CW-25 for HVOCs and MTBE:	800/sample[d]	2 samples	2,000/yr
		Annual Cost for Monitoring Program (Year 1):	143,000/yr
		Annual Cost for Monitoring Program (Years 2-5):	66,000/yr
Long-Term Monitoring Program (Years 6-30):			
On-Site Monitoring Wells:			
Well sampling cost for annual collection of samples:	600/well	8 wells	5,000/yr
Annual analyses for HVOCs or AVOCs and MTBE:	200/sample	8 samples	2,000/yr
Replacement of 2 wells being monitored every 5 years:	10,500/cluster	5 clusters	53,000
		Annual Cost:	2,000/yr

a - Costs rounded to nearest $1000.
c - Includes collection of 3 samples/well; one each from before, between, and after the two carbon filters for all wells with treatment units (see Table 5-3).
d - Includes well sampling cost and analytical cost.

TABLE 6-2 (Page 3 of 3)

COST ESTIMATE FOR ALTERNATIVE 3: SOURCE AREA EXCAVATION

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
Water Supply Wells - Production:			
Well sampling cost for semiannual collection of samples:	600/well	4 wells	2,000/yr
Semiannual analyses for HVOCs, AVOCs, and total coliforms:	420/sample	12 samples[c]	5,000/yr
Water Supply Wells - Commercial:			
Well sampling cost for annual collection of samples:	600/well	4 wells	2,000/yr
Annual analyses for HVOCs and MTBE:	200/sample	12 samples[c]	2,000/yr
	Annual Cost for Monitoring Program (Years 6-30):		20,000/yr
	TOTAL O&M COSTS:	**Year 1:**	170,000/yr
		Years 2-5:	93,000/yr
		Years 6-20:	47,000/yr
		Years 21-30:	46,000/yr
PRESENT WORTH:			
Based on a 30-yr life and a 5% interest rate:			1,781,000

a - Costs rounded to nearest $1000.

c - Includes collection of 3 samples/well; one each from before, between, and after the two carbon filters for all wells with treatment units (see Table 5-3).

migration of the contaminants. The water extracted from the recovery wells will be treated to reduce contaminant concentrations to below the required discharge limits in accordance with the technical requirements for a SPDES permit prior to discharge to the on-site eastern stream, while water from the BPM production wells will be treated to ensure that chemical concentrations are below detection limits prior to use at the BPM or introduction into the MPR distribution system.

6.2.4.2 ***Compliance with ARARs and TBCs***. Excavation of the source area as included in Alternative 4 will comply with the NYSDEC recommended soil cleanup objective of 1.4 mg/kg PCE for unsaturated zone soils. Achievement of the cleanup objectives for saturated soils is based on the objective of protecting groundwater quality (Section 2.2). The effect of varying excavation scenarios on groundwater remediation time frames for the source area till groundwater was evaluated as part of the groundwater modelling effort (Appendix A). Since the time frame for achievement of a cleanup objective of 5 $\mu g/l$ PCE in the till groundwater assuming excavation of soils and pumping of two source area recovery wells is estimated at 10 to 15 years for both excavation scenarios, an excavation of 95 yd^3 of soils is considered to be in compliance with the goal of achieving groundwater cleanup objectives within the source area.

Achievement of the NYSDEC Class GA groundwater standards and NYSDOH MCLs for PCE and its breakdown products in bedrock groundwater is estimated to require 15 to 17 years on site and approximately 20 years in the MPR area. Until groundwater remediation within the bedrock aquifer is achieved, drinking water standards will be met for extracted groundwater using GAC treatment, either at the on-site treatment facilities (BPM production well treatment system) or at the POU treatment units for businesses on Route 6.

The discharge from the source area recovery wells will be treated to meet the discharge limitations established for compliance with the technical requirements of a SPDES permit, which may be based on the NYSDEC Class B surface water standards for the eastern stream. The NYCDEP will review the discharge limitations since on-site disposal of the treated recovery well water must comply with all requirements for point-source discharges within a New York City watershed.

As previously discussed, NIOSH IDLH and OSHA PEL-TWA guidelines for contaminants in air may be used to assess chemical emissions during the source area remedial activities. Construction of the water distribution system will be conducted so as to minimize impacts to the on-site wetlands, and any applicable permits for alterations to wetland areas will be obtained prior to the start of construction. The distribution system design, maintenance, and monitoring will be in compliance with 10 NYCRR Chapter I Subpart 5-1 and the Ten State Standards.

Excavated soils and dewatering water will be treated and disposed of at a licensed TSDF as hazardous wastes (F002 or U210 wastes). Transportation will be in accordance with all applicable hazardous waste manifesting and transportation requirements. Alternative 4 will comply with Section 121, Subsections 104 and 106, of CERCLA, which state that the selected remedial alternative must attain a cleanup level that is protective of human health and the environment.

6.2.4.3 ***Long-Term Effectiveness and Permanence.*** In Alternative 4, the source of PCE contamination in groundwater, i.e., contaminated soils, will be removed and the excavated soils will be transported off site for treatment to destroy the contaminants present. The treated soils will be landfilled to ensure that any remaining contaminants do not migrate to the environment. Source area groundwater pumping is expected to be effective in preventing the continued off-site migration of contaminants; remediation of the on-site till groundwater will require an estimated 10 to 15 years and remediation of on-site bedrock groundwater will require about 15 to 17 years. Bedrock groundwater contaminant concentrations in the MPR area will be reduced to below groundwater cleanup objectives in approximately 20 years. Continued maintenance and periodic replacement of the GAC treatment systems for the BPM production well and recovery well treatment systems is required during the period of active groundwater remediation. Installation of a distribution system and closure of the residential wells will permanently remove the risk of contact with contaminated groundwater and will also allow for potential future connection of the homes to an off-site source of water supply.

6.2.4.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** Alternative 4 will reduce the toxicity and volume of contamination in soils through excavation and off-site incineration, which will result in destruction of the volatile organic constituents present in the soils. PCE concentrations in groundwater will be reduced through extraction of the groundwater and treatment with GAC. Spent carbon will then be transported off site for regeneration using thermal destruction resulting in a reduction in toxicity of the remaining contaminants.

6.2.4.5 ***Short-Term Effectiveness.*** Potential human health risks may be posed to workers and the surrounding public during excavation of the contaminated source area soils, however, these risks will be minimized through use of personal protective equipment for workers and engineering controls to minimize dust generation and contaminant volatilization. Completion of the source area excavation is expected to require two weeks; increased truck traffic and noise at the site is expected during this time frame.

Installation of the recovery wells in the source area, construction of the recovery well treatment system, and construction of the distribution system to the MPR homes will also result in increased truck traffic and disruption of site activities. These activities are expected to require approximately 12 weeks for completion, following approval of the distribution system design by the approving agencies. As with excavation of the source area soils, potential health risks to workers may result from installation of the recovery wells in the source area, however, the appropriate personal protective equipment and air monitoring will be used for worker protection. Installation of piping to the recovery well treatment system and for the MPR distribution system are expected to pose minimal impacts to human health and the environment as the construction will occur in uncontaminated areas of the site. Construction of the distribution system may result in temporary inconveniences for the MPR residents.

6.2.4.6 ***Implementability***. The technologies included in Alternative 4 do not pose any unusual problems for its implementation. Excavation of the source area soils may be conducted using conventional equipment, however, dewatering and sheeting of the excavation will be required for removal of saturated zone soils. Disposal of the excavated soils and dewatering water will require acceptance by an appropriate TSDF.

Installation of recovery wells, construction of a recovery well treatment system, modification of the BPM treatment system, and installation of a distribution system to the MPR area are all implementable using readily available vendors and equipment. Several administrative difficulties may however impact the implementability of this alternative. Provision of potable water to the MPR homes requires creation of a new water district or incorporation of the MPR area into an existing district such as the ASWD. The distribution system design must also receive approval by the NYSDOH, the WCDOH, and the Town of Somers. The on-site discharge of treated recovery well water will require compliance with all technical requirements for a SPDES permit; due to the location of the site within a New York City water supply system watershed, the NYCDEP will also review the discharge requirements and may require more stringent monitoring or effluent limitations.

6.2.4.7 ***Cost***. The estimated capital cost for Alternative 4 is $940,000 (Table 6-3) and is accurate within a range of -30% to +50%. The annual O&M costs for this alternative are $189,000 for the first year, $112,000 for years 2-5, $66,000 for years 6-15, $47,000 for years 16-20, and $46,000 per year for the final 10 years. The present worth is $2,081,000 based on a 5% interest rate and a 30-yr life.

COST ESTIMATE FOR ALTERNATIVE 4: SOURCE AREA EXCAVATION WITH SOURCE AREA RECOVERY WELLS

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
CAPITAL COSTS:			
A. Direct Costs:			
Excavation of 95 yd³ of Soils with Off-Site Treatment and Disposal (see Table 4-5):			340,000
BPM Treatment System Modifications (Same as Alternative 3):			1,000
Distribution System (Same as Alternative 3):			211,000
Source Area Recovery Wells and Treatment System:			
Installation of shallow till recovery well:	3,000/well	1 well	3,000
Installation of deeper till recovery well:	4,500/well	1 well	5,000
Submersible well pumps and appurtenances:	1,700/well	2 wells	3,000
Piping to recovery well treatment system:	15/ft	350 ft	5,000
Treatment system including housing:	LS	-	58,000
		Subtotal:	626,000
B. Indirect Costs:			
Engineering and Design @ 15%:			94,000
Legal and Administrative @ 10%:			63,000
Contingency @ 25%:			157,000
		TOTAL:	940,000
O&M COSTS:			
BPM Treatment System Maintenance (Same as Alternative 3):			22,000/yr
Distribution System Maintenance: (Same as Alternative 3):			4,000/yr
POU Treatment Unit Maintenance-Route 6 Businesses (Years 1-20) Same as Alternative 1:			1,000/yr

a - Costs rounded to nearest $1000.
LS - Lump sum.

COST ESTIMATE FOR ALTERNATIVE 4: SOURCE AREA EXCAVATION WITH SOURCE AREA RECOVERY WELLS

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
Recovery Wells and Treatment System Maintenance (Years 1-15):			
Inspection and maintenance of well pumps:	1,120/pump	2 pumps	2,000/yr
Replacement of well pumps every 5 years:	1,700/pump	6 pumps	10,000
		Annual Cost:	1,000/yr
Treatment plant maintenance:			2,000/yr
Carbon replacement:			9,000/yr
Treatment plant discharge sampling and analyses:	400/sample	12 samples[b]	5,000/yr
Long-Term Monitoring Program (Same as Alternative 3):		Year 1:	143,000/yr
		Years 2-5:	66,000/yr
		Years 6-30:	20,000/yr
	TOTAL O&M COSTS:	**Year 1:**	189,000/yr
		Years 2-5:	112,000/yr
		Years 6-15:	66,000/yr
		Years 16-20:	47,000/yr
		Years 21-30:	46,000/yr
PRESENT WORTH:			
Based on a 30-yr life and a 5% interest rate:			2,081,000

a - Costs rounded to nearest $1000.
b - Assumes monthly sampling of treatment system discharge.

6.2.5 Alternative 5: Source Area Excavation with Source Area/Western Site/Southeastern Site Recovery Wells

6.2.5.1 ***Protection of Human Health and the Environment.*** Protection of human health and the environment is achieved by Alternative 5 through excavation of contaminated source area soils and expedited groundwater recovery through a combination of BPM production well pumping and installation of recovery wells in the source area, in the southeastern site area, and in the western site area. Removal of the source area soils will eliminate the potential for human contact with volatilized constituents as well as the continued leaching of contaminants to groundwater. Off-site treatment and disposal will result in permanent removal of the contaminants in soil from the site.

Pumping of the BPM production wells and four recovery wells will eliminate further off-site migration of contaminants. Achievement of groundwater cleanup objectives in the source area shallow till groundwater is estimated to require 10 to 15 years. Achievement of groundwater cleanup objectives in the bedrock is estimated to require 10 years for the southeastern site recovery well, 10 to 15 years for the source area recovery wells, 15 to 17 years for the BPM production wells, 15 to 20 years for the MPR area, and 21 to 22 years for the western site area. Continued use of the existing POU treatment units at the MPR homes during the period of active groundwater remediation as included in Alternative 5 will protect human health by maintaining acceptable water quality (i.e., concentrations below the drinking water MCLs) for potable use, however, the potential for human contact with groundwater contaminants does exist in the event of failure of the POU units or use of untreated groundwater. The long-term POU monitoring and maintenance program is intended to ensure that failure of the units does not occur. Treatment of the BPM production well water for use at the BPM and the recovery well groundwater for discharge to the eastern stream is also expected to be adequately protective of human health and the environment.

6.2.5.2 ***Compliance with ARARs and TBCs.*** Alternative 5 will comply with the NYSDEC recommended soil cleanup objective of 1.4 mg/kg for unsaturated soils. As discussed for Alternative 4, excavation of 95 yd^3 of soils is in compliance with the cleanup objective for saturated soils which is based on protection of groundwater quality. Excavation of a soil volume greater that 95 yd^3 will not reduce the time frame for remediation of source area till groundwater and is therefore not cost-effective given the difficulties of excavating in a saturated environment.

Alternative 5 is estimated to achieve the NYSDEC Class GA groundwater standards and NYSDOH MCLs for the site-related constituents within the range of 10 years for the southeastern site recovery well to 22 years for the western site recovery well. Until groundwater remediation within the bedrock aquifer is achieved, drinking water standards will be achieved for the extracted groundwater using GAC treatment, either at the on-site BPM production well treatment system or using the POU treatment units at the MPR homes and Route 6 businesses. Groundwater from the recovery wells will be treated to below applicable discharge limits to meet the technical requirements of a SPDES permit prior to discharge to the eastern stream.

The NIOSH IDLH and OSHA PEL-TWA guidelines for contaminants in air will be used during the excavation activities to assess contaminant concentrations in air. Excavated soils and dewatering water will be disposed of at an off-site TSDF as hazardous wastes (F002 or U210 wastes). Transportation will be in accordance with all applicable hazardous waste manifesting and transportation requirements. Alternative 5 is in compliance with Section 121, Subsections 104 and 106, of CERCLA, which state that the selected remedial alternative must attain a cleanup level that is protective of human health and the environment.

6.2.5.3 ***Long-Term Effectiveness and Permanence.*** Excavation of PCE-contaminated soils with off-site disposal will permanently remove the source of groundwater contamination at the site. Off-site treatment and landfilling will eliminate the potential for human contact with or release to the environment of contaminants in the soils at an off-site location. Groundwater remediation of the bedrock aquifer as included in Alternative 5 is estimated to be achieved within 10 (southeastern site recovery well) to 22 (western site recovery well) years, with achievement of groundwater cleanup objectives in the MPR area in 15 to 20 years. Remediation of the groundwater in the source area till is estimated to require 10 to 15 years. The on-site production well treatment system and POU treatment units at the MPR homes and Route 6 businesses have been effective to date in reducing contaminant levels to below detection limits; with continued maintenance and carbon replacement as required, these units are expected to be effective throughout the estimated time frame for groundwater remediation.

6.2.5.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** Alternative 5 will reduce the toxicity and volume of contamination in soils through excavation and off-site treatment, which will result in destruction of the volatile organic constituents present in the soils. PCE concentrations in groundwater will be reduced through extraction of the groundwater and treatment with GAC. Spent carbon will then be transported off site for regeneration using thermal destruction resulting in a reduction in toxicity of the remaining contaminants.

6.2.5.5 *Short-Term Effectiveness*. During the time required for excavation and off-site transport of the source area soils (approximately two weeks), increased truck traffic and other disruptions may be expected at the site. Potential health risks may be posed to workers and the surrounding public during excavation of the contaminated source area soils, however, these risks will be minimized through use of personal protective equipment for workers and engineering controls to minimize dust generation and contaminant volatilization.

Increased truck traffic and disruption of site activities will also result from the construction activities associated with installing the source area, southeastern site, and western site recovery wells and treatment system, which are estimated to require approximately 10 weeks for completion. As with excavation of the source area, installation of the source area recovery wells poses a potential human health risk to workers, however, use of personal protective equipment is expected to minimize the risks. Installation of the other recovery wells and treatment system are expected to pose minimal risks to human health and the environment.

6.2.5.6 *Implementability*. Alternative 5 is readily implemented using available services and equipment. Excavation of source area soils will be conducted using conventional equipment, however, dewatering and sheeting of the excavation will be required for removal of saturated zone soils. Disposal of the excavated soils and dewatering water will require acceptance by an appropriate TSDF. Installation of recovery wells and construction of a recovery well treatment system are also readily implementable. The discharge of treated recovery well water will require that the technical requirements for a SPDES permit be met; due to the location of the site within a New York City water supply system watershed, the NYCDEP will also review the discharge requirements and may require more stringent monitoring or effluent requirements.

6.2.5.7 *Cost*. The estimated costs for Alternative 5 as described in Chapter 5 are shown in Table 6-4 and are accurate within a range of -30% to +50%. The capital costs for this alternative are $768,000, with annual O&M costs of $179,000 for years 1-5, $133,000 for years 6-15, $100,000 for years 16-20, and $39,000 for years 21-30. Based on a 5% interest rate and a 30-yr life, the present worth is $2,616,000.

6.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

6.3.1 Protection of Human Health and the Environment

Alternative 1 provides the least protection of human health and the environment of the four remedial alternatives as unremediated soils will remain on site and may continue to leach contaminants to the groundwater. In addition, Alternative 1 does not include any groundwater

TABLE 6-4 (Page 1 of 3)

COST ESTIMATE FOR ALTERNATIVE 5: SOURCE AREA EXCAVATION WITH SOURCE AREA/WESTERN SITE/SOUTHEASTERN SITE RECOVERY WELLS

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
CAPITAL COSTS:			
A. Direct Costs:			
Excavation of 95 yd³ of Soils with Off-Site Treatment and Disposal (see Table 4-5):			340,000
Recovery Wells and Treatment System:			
Installation of shallow till recovery well:	3,000/well	1 well	3,000
Installation of deeper till recovery well:	4,500/well	1 well	5,000
Installation of southeastern site recovery well:	15,000/well	1 well	15,000
Installation of western site recovery well:	7,000/well	1 well	7,000
Submersible well pumps and appurtenances:	1,700/well	4 wells	7,000
Piping to recovery well treatment system:	15/ft	1,500 ft	23,000
Treatment system including housing:	LS	-	112,000
		Subtotal:	512,000
B. Indirect Costs:			
Engineering and Design @ 15%:			77,000
Legal and Administrative @ 10%:			51,000
Contingency @ 25%:			128,000
		TOTAL:	768,000
O&M COSTS:			
POU Treatment Unit Maintenance-Route 6 Businesses (Years 1-20): Same as Alternative 1:			1,000/yr
POU Treatment Unit Maintenance-MPR Homes (Years 1-20) Same as Alternative 1:			2,000/yr
Recovery Wells and Treatment System Maintenance (Years 1-15):			
Inspection and maintenance of well pumps:	1,120/pump	4 pumps	4,000/yr
Replacement of well pumps every 5 years:	1,700/pump	12 pumps	20,000
		Annual Cost:	1,000/yr
Treatment plant maintenance:			5,000/yr
Carbon replacement:			18,000/yr
Treatment plant discharge sampling and analyses:	400 samples	12/sample[b]	5,000/yr

a - Costs rounded to nearest $1000.
b - Assumes monthly sampling of treatment system discharge.
LS - Lump sum.

COST ESTIMATE FOR ALTERNATIVE 5: SOURCE AREA EXCAVATION WITH SOURCE AREA/WESTERN SITE/SOUTHEASTERN SITE RECOVERY WELLS

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
Long-Term Monitoring Program:			
On-Site Monitoring Wells (Years 1-5):			
Well sampling cost for quarterly collection of samples:	600/well	32 wells	19,000/yr
Quarterly analyses for HVOCs:	200/sample	32 samples	6,000/yr
Semiannual analyses for AVOCs and MTBE:	200/sample	16 samples	3,000/yr
Replacement of 2 wells being monitored every 5 years:	10,500/cluster	1 cluster	11,000
		Annual Cost:	2,000/yr
On-Site Monitoring Wells (Years 6-30):			
Well sampling cost for annual collection of samples:	600/well	8 wells	5,000/yr
Annual analyses for HVOCs or AVOCs and MTBE:	200/sample	8 samples	2,000/yr
Replacement of 2 wells being monitored every 5 years:	10,500/cluster	5 clusters	53,000
		Annual Cost:	2,000/yr
Water Supply Wells-Residential (Years 1-20):			
Well sampling cost for quarterly collection of samples:	600/well	72 wells	43,000/yr
Quarterly analyses for HVOCs:	200/sample	168 samples[c]	34,000/yr
Water Supply Wells-Residential (Years 21-30):			
Well sampling for annual collection of samples:	600/well	18 wells	11,000/yr
Annual analyses for HVOCs:	200/sample	42 samples[c]	8,000/yr

a - Costs rounded to nearest $1000.
c - Includes collection of 3 samples/well; one each from before, between, and after the two carbon filters for all wells with treatment units (see Table 5-3).

COST ESTIMATE FOR ALTERNATIVE 5: SOURCE AREA EXCAVATION WITH SOURCE AREA/WESTERN SITE/SOUTHEASTERN SITE RECOVERY WELLS

Baldwin Place Mall

ITEM	UNIT COST ($)	QUANTITY	COST (1994 $)[a]
Water Supply Wells-Commercial and Production (Years 1-5):			
Well sampling cost for quarterly collection of samples:	600/well	24 wells	14,000/yr
Quarterly analyses for HVOCs, AVOCs and total coliforms:	420/sample	24 samples[c]	10,000/yr
Quarterly analyses of commercial well samples for HVOCs and MTBE:	200/sample	48 samples[c]	10,000/yr
Semiannual sampling of CW-25 for HVOCs and MTBE:	800/sample[d]	2 samples	2,000/yr
Water Supply Wells-Production (Years 6-30):			
Well sampling costs for semiannual collection of samples:	600/well	4 wells	2,000/yr
Semiannual analyses for HVOCs, AVOCs, and total coliforms:	420/sample	12 samples[c]	5,000/yr
Water Supply Wells-Commercial (Years 6-30):			
Well sampling costs for annual collection of samples:	600/well	4 wells	2,000/yr
Annual analyses for HVOCs and MTBE:	200/sample	12 samples[c]	2,000/yr
		Annual Cost for Monitoring Program (Years 1-5):	143,000/yr
		Annual Cost for Monitoring Program (Years 6-20):	97,000/yr
		Annual Costs for Monitoring Program (Years 21-30):	39,000/yr
	TOTAL O&M COSTS:	**Years 1-5:**	179,000/yr
		Years 6-15:	133,000/yr
		Years 16-20:	100,000/yr
		Years 21-30:	39,000/yr
PRESENT WORTH:			
Based on a 30-yr life and a 5% interest rate:			2,616,000

a - Costs rounded to nearest $1000.
c - Includes collection of 3 samples/well; one each from before, between, and after the two carbon filters for all wells with treatment units (see Table 5-3).
d - Includes well sampling costs and analytical cost.

plume containment but does include some minimal remediation of groundwater through continued pumping of the BPM production wells at a low rate (4 gpm). Alternatives 3, 4, and 5 provide a similar degree of protection of human health and the environment as all three alternatives include excavation of 95 yd^3 of contaminated soils from the source area with off-site treatment and disposal of the soils.

Alternatives 3, 4, and 5 also include active groundwater remediation through pumping and treatment; the difference among them is the inclusion of source area recovery wells in Alternative 4 and source area/western site/southeastern site recovery wells in Alternative 5 to expedite groundwater remediation. Alternatives 3, 4, and 5 all achieve bedrock groundwater remediation on site (i.e., at the BPM production wells) and in the MPR area bedrock groundwater within an estimated range of 15 to 20 years (Table 6-5). Alternative 3 will achieve cleanup objectives in the source area groundwater (i.e., shallow till) in an estimated 20 to 25 years, while Alternatives 4 and 5 achieve source area groundwater remediation in an estimated 10 to 15 years through installation of source area recovery wells. Installation of a western site recovery well in Alternative 5 is estimated to achieve groundwater cleanup objectives in the western bedrock aquifer in 21 to 22 years.

Until bedrock groundwater remediation is achieved, Alternatives 3 and 4 are protective of human health by treating the extracted groundwater using the existing BPM production well treatment system for supply to the BPM and MPR homes. Assuming continued maintenance of the existing POU treatment units at the MPR homes, Alternative 5 is also protective of human health during the period of groundwater remediation.

6.3.2 Compliance with ARARs and TBCs

In Alternative 1, the NYSDOH MCLs are currently being achieved by the existing BPM production well treatment system and the individual POU treatment units for extracted groundwater used as potable supply. No other site-specific ARARs or TBCs are achieved by Alternative 1. Alternatives 3, 4, and 5 are similar in their compliance with all identified chemical-, location- and action-specific ARARs and TBCs for the site. Alternatives 3 and 4 will also comply with the requirements for community water systems in the design, construction, maintenance, and monitoring of the distribution system to supply treated water to Meadow Park Road. Alternatives 4 and 5 will comply with the technical requirements for a SPDES permit for discharge of treated recovery well water to the eastern stream.

TABLE 6-5

SUMMARY OF GROUNDWATER REMEDIATION TIME FRAMES [a]

Baldwin Place Mall

ALTERNATIVE	SHALLOW TILL GROUNDWATER IN SOURCE AREA (Years)	ON-SITE BEDROCK GROUNDWATER AT BPM PRODUCTION WELLS (Years)	MEADOW PARK ROAD BEDROCK GROUNDWATER (Years)	WESTERN SITE BEDROCK GROUNDWATER (Years)
1	NS	40	> 40	NS
3	25-30	17-18	20	NS
4	10-15	15-17	20	NS
5	10-15	15-17	15-20	21-22

a - Based on a 11 year half-life for PCE in aquifer (see Appendix A for discussion).
NS - Not simulated.

6.3.3 Long-Term Effectiveness and Permanence

Alternative 1 provides the least long-term effectiveness and permanence as contaminated soils will remain on site and may continue to leach contaminants to groundwater. Alternatives 3, 4, and 5 all include excavation of 95 yd^3 of contaminated source area soils and therefore provide comparable long-term effectiveness for the source area soil remediation.

The time to effect groundwater remediation is the point of comparison between Alternatives 3, 4, and 5 (Table 6-5). Alternatives 4 and 5 achieve remediation of the shallow till groundwater within the source area in an estimated time frame of 10 to 15 years through pumping of the source area recovery wells. Alternative 3, which does not include source area recovery wells, will require an estimated 20 to 25 years for groundwater remediation within the till.

Alternative 3, which includes pumping of the BPM production wells only, is estimated to achieve bedrock groundwater cleanup objectives (i.e., 5 $\mu g/l$ PCE) at the on-site production wells in 17 to 18 years and in the MPR area in 20 years. Addition of two source area recovery wells as included in Alternative 4 is estimated to slightly reduce the time frame for on-site bedrock groundwater remediation to 15 to 17 years, however, the estimated time to meet groundwater cleanup objectives in the MPR area remains at 20 years. Alternative 5 has estimated time frames for bedrock groundwater remediation of 10 years for the southeastern site well, 15 to 17 years for the BPM production wells, and 15 to 20 years in the MPR area. Similar to Alternative 4, pumping of the source area recovery wells as included in Alternative 5 does not substantially reduce the time estimated to achieve groundwater cleanup objectives at the BPM production wells. Installation of a southeastern site recovery well downgradient of the source area is estimated to slightly reduce the time to achieve groundwater remediation in the MPR area. Alternative 5 also includes pumping of a western site recovery well; remediation of the bedrock aquifer at this location is estimated to require 21 to 22 years to achieve site remedial action objectives.

Given the uncertainties associated with estimating groundwater remediation times, the differences in time to clean up the bedrock groundwater beyond the immediate vicinity of the source area are not substantial and therefore all three alternatives are assumed to have a similar degree of long-term effectiveness with respect to bedrock groundwater remediation outside the source area. Alternatives 4 and 5 appear to provide greater effectiveness for till remediation through installation of source area recovery wells.

The distribution system included in Alternatives 3 and 4 to convey treated water from the BPM production wells to the MPR homes has a greater degree of long-term effectiveness and permanence than continued use of the POU treatment units as included in Alternative 5. Construction of a distribution system allows for potential future connection of the MPR homes and BPM to a public water supply source should one become available. In addition, the POU treatment units require frequent monitoring and maintenance to ensure that contaminant breakthrough does not occur.

6.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternatives 3, 4, and 5 result in the same reduction in toxicity and volume of contamination at the site through excavation and off-site treatment of contaminated soils. The volume of contaminated groundwater will also be reduced in all three alternatives through pumping and treatment, either at the BPM production well treatment system, a newly installed recovery well treatment system, or at the POU treatment units. Spent carbon with PCE contamination removed from the pumped groundwater will ultimately be transported off site where the toxicity of the contaminants will be reduced through thermal destruction. As groundwater remediation will continue in Alternatives 3, 4, and 5 until groundwater contaminant levels are reduced to below the drinking water standard of 5 μg/l PCE, it is assumed that the total reduction in the volume of contamination is the same for each alternative. Alternative 1 does not achieve a substantial reduction in the toxicity or volume of contamination present as contaminated soils will remain on site and the BPM production wells will be pumped at a low rate (4 gpm).

6.3.5 Short-Term Effectiveness

No short-term impacts will result from implementation of Alternative 1 as this alternative does not include any active remediation of contaminated soils or groundwater. Excavation of 95 yd^3 of contaminated source area soils is common to Alternatives 3, 4, and 5, therefore, the potential health risks posed to workers and the site disruptions (i.e., increased truck traffic and noise) will be the same. Alternatives 3 and 4 result in the greatest off-site short-term impacts resulting from construction of the water distribution system to the MPR area. Alternative 4 also includes installation of two source area recovery wells and construction of a new recovery well treatment system and therefore has greater on-site impacts than Alternative 3. Although Alternative 5 includes addition of two recovery wells besides the two source area recovery wells and construction of a larger recovery well treatment facility, this alternative does not include a distribution system to the MPR homes and has less off-site construction impacts but somewhat greater on-site construction impacts. Alternative 5 therefore requires a somewhat shorter time frame for implementation (approximately 10 weeks) as compared to Alternatives 3 and 4 (approximately 12 weeks each).

6.3.6 Implementability

Alternative 1 is the easiest alternative to implement as it maintains the current status quo of maintenance and monitoring of the POU units and adds on-site groundwater monitoring. Alternatives 3, 4, and 5 are all readily implementable with available vendors and equipment. The technologies included in all three alternatives, i.e., excavation of soils, off-site transport, recovery well installation, treatment system modification/construction, and installation of a distribution system, are all commonly applied and are not expected to pose any technical difficulties to implementation of the alternatives. Several administrative difficulties, including the need to create a new water district or incorporate the MPR area into an existing district such as the ASWD and the requirements for approval of the distribution system plans by the NYSDOH, WCDOH, and the Town of Somers, may limit the implementability of Alternatives 3 and 4. Alternative 5 does not require such approvals as no distribution system is included, however, both Alternatives 4 and 5 will require compliance with the technical requirements of a SPDES permit for discharge of the treated recovery well water to the eastern stream. The NYCDEP will also need to review the discharge requirements as appropriate for a new point-source discharge within a New York City water supply watershed.

6.3.7 Cost

Alternative 1 has the lowest capital cost of the four alternatives, however, the present worth cost ($2,075,000) for Alternative 1 is within the range of present worths ($1,781,000-2,616,000) for the three alternatives which include active soil and groundwater remediation (Table 6-6). Therefore, no substantial cost savings result from maintaining the status quo at the site. Alternative 5 has the lowest capital costs of the three active remediation alternatives (Alternatives 3, 4, and 5) as this alternative does not include construction of a distribution system to supply treated BPM production well water to the MPR homes. The present worth of Alternative 5 ($2,616,000) is however higher than the present worths of Alternatives 3 and 4 ($1,781,000 and $2,081,000, respectively); the continued use of the POU treatment units included in Alternative 5 requires continued monitoring of the MPR residential wells resulting in higher O&M costs for Alternative 5 as compared to Alternatives 3 and 4. Alternative 4 has a higher capital cost and present worth than Alternative 3 ($940,000 and $2,081,000, respectively) as Alternative 4 includes installation of source area recovery wells and treatment system in addition to construction of a water distribution system as included in Alternative 3.

TABLE 6-6

SUMMARY OF REMEDIAL ALTERNATIVE COSTS
Baldwin Place Mall

ALTERNATIVE	CAPITAL COST ($)		O&M COSTS ($)	PRESENT WORTH ($)
1	-[a]		135,000/yr	2,075,000
3	828,000	Year 1:	170,000/yr	1,781,000
		Years 2-5:	93,000/yr	
		Years 6-20:	47,000/yr	
		Years 21-30:	46,000/yr	
4	940,000	Year 1:	189,000/yr	2,081,000
		Years 2-5:	112,000/yr	
		Years 6-15:	66,000/yr	
		Years 16-20:	47,000/yr	
		Years 21-30:	46,000/yr	
5	768,000	Years 1-5:	179,000/yr	2,616,000
		Years 6-15:	133,000/yr	
		Years 16-20:	100,000/yr	
		Years 21-30:	39,000/yr	

a - Cost cannot be determined at this time.

CHAPTER 7

SELECTION OF RECOMMENDED REMEDIAL PLAN

7.1 INTRODUCTION

The recommended remedial plan for the BPM site is derived from Alternative 4 as described in the previous FS chapters and includes excavation of source area soils, installation of two source area recovery wells, increased pumping of the BPM production wells, and construction of a water distribution system to provide treated production well water to the residents on Meadow Park Road (when the administrative details allowing for its implementation have been finalized).

7.2 COMPARISON OF ALTERNATIVES

Alternative 1 (continuation of status quo), which includes continued use of the POU treatment units, pumping of the BPM production wells for mall water supply, and groundwater monitoring, was not selected for remediation of the site as it provides the least degree of protection of human health and the environment and does not provide a substantial cost savings compared to the other alternatives (i.e., present worth of $2,075,000 as compared to $1,781,000-2,616,000 for Alternatives 3, 4, and 5). Remediation of on-site bedrock groundwater in Alternative 1 is estimated to require 40 years assuming pumping of the BPM production wells at the existing rate (4 gpm).

Alternatives 3, 4, and 5 all include excavation of 95 yd^3 of source area soils and therefore do not differ in their degree of effectiveness for source area soil remediation. The excavated soils will be transported to an off-site TSDF for incineration or thermal desorption treatment and landfilling; further evaluation of the off-site treatment options will be conducted during the remedial design (RD). Remediation of the source area shallow groundwater in the till following excavation of 95 yd^3 of soils, as modelled for Alternative 3, is estimated to require 25 to 30 years. Installation of source area recovery wells (one till well and one well immediately below the till in the bedrock), as included in Alternatives 4 and 5, is estimated to reduce the time to achieve groundwater cleanup objectives within the source area till to 10 to 15 years. Implementation of either Alternative 4 or 5, therefore, provide greater long-term effectiveness than Alternative 3 for the shallow till groundwater at the site through source area recovery wells and an associated treatment system, at an estimated capital cost of $74,000.

Alternatives 3 and 4 both include construction of a distribution system to provide treated water from the BPM production wells to the MPR residents when the administrative details allowing for its implementation have been approved. The estimated capital cost of the distribution system and associated modifications to the BPM production well treatment system is $212,000, however, provision of a potable water supply to the MPR residents results in estimated savings of $77,000 per year in the annual O&M costs for the first 14 years after installation of the distribution system as quarterly sampling of the residential wells along Meadow Park Road will no longer be required as stipulated in the Order on Consent.

As a result, Alternative 5, which includes continued use of the POU treatment units, has a lower capital cost than Alternatives 3 and 4 but a higher present worth due to the higher O&M costs associated with residential well sampling and POU maintenance. Installation of a water distribution system also allows for connection of both the MPR homes and the BPM to an off-site public water source (the WCWD No. 2 via the ASWD distribution system) at some time in the future, as discussed below.

Alternative 5 includes southeastern and western site recovery wells for groundwater pumping in addition to the source area and BPM production wells included in Alternative 4 at an additional capital cost of $96,000. The groundwater modelling conducted indicates that these two additional recovery wells do not substantially impact the estimated time required to achieve groundwater cleanup objectives in the bedrock aquifer at the BPM production wells or in the MPR area.

Therefore, Alternative 4 was initially selected as the basis of the preferred remedial option for the BPM site and presented to the State since it includes the most effective technical components; source area excavation, source area recovery wells, on-site containment of contaminated groundwater, and a water distribution system to the MPR homes. Since State acceptance of the remedial alternative is one of the nine NCP criteria for evaluation of the alternatives, the final recommended plan presented in this chapter reflects the State's comments on the originally proposed remedial alternative, Alternative 4. As discussed in Chapter 4, excavation of 95 yd^3 of soils based on a cleanup goal of 50 mg/kg PCE was retained in the FS as the optimum excavation scenario for this site as it meets the criteria of removing the most substantial contamination (i.e., 99% of the estimated total mass of PCE in soils) while minimizing the quantity of excavated material. The State did not feel that a cleanup goal of 50 mg/kg PCE was adequately protective of groundwater quality at the site and requested that the source area be excavated based on a cleanup goal of 10 mg/kg PCE as delineated in Chapter 4, resulting in an additional soil volume of 40 yd^3 (for a total of 135 yd^3). Excavation based on the 10 mg/kg PCE cleanup level has therefore been included in the recommended plan, with the understanding that no additional excavation of the source area will be conducted based on the results of any post-excavation sampling. Post-excavation samples will be collected from the bottom of the excavation and the excavation will be immediately backfilled due to the engineering difficulties and health and safety issues associated with holding open the excavation.

7.3 RECOMMENDED PLAN

The recommended remedial plan for the BPM site includes the following major components:

- Excavation of 135 yd^3 of source area soils with off-site treatment and disposal
- Increased pumping of the BPM production wells
- Installation and pumping of two source area recovery wells
- Provision of treated BPM production well water to the MPR residents
- Future connection of the MPR area and BPM to the WCWD No. 2 public water supply if such an alternative becomes implementable
- Groundwater monitoring

The two source area recovery wells in the recommended plan include one recovery well in the shallow till deposits to contain contaminant migration to the west (which is primarily horizontally in the till) and one well in the underlying weathered bedrock to capture/contain vertical leakage from the source area into the underlying bedrock system as well as lateral flow passing under the source area. The deeper source area recovery well will be screened in the weathered zone to the top of the competent bedrock. To ensure optimal functioning of the source area recovery wells, the exact placement of the screen intervals will be determined during the drilling process.

Following installation of two source area recovery wells and increased pumping of the BPM production wells, monitoring will be conducted of on-site wells to evaluate the effectiveness of the groundwater remedial program. A performance specification will be established during the RD that will include both a hydraulic capture/containment evaluation and a groundwater quality evaluation. A containment pumping test will be conducted during the initial months of the groundwater remediation to determine the appropriate pumping rate for the BPM production wells to achieve containment of site groundwater. In addition, numerical groundwater quality goals will be established to evaluate the effectiveness of the remediation on a yearly basis. If the reduction in contaminant concentrations at the State-specified wells (MW-9S and RW-05) falls significantly short of the numerical criteria to be established, reevaluation of the groundwater pump and treat system will be conducted, including the potential need for increased pumping of the BPM production wells, installation of a southeastern recovery well, and/or a western site recovery well.

The recommended plan includes connection of the MPR homes and BPM to the WCWD No. 2 via the ASWD distribution system at such a time as this connection becomes implementable. Connection of the MPR residents to the WCWD No. 2 is considered the preferred long-term water supply option, however, implementation requires several actions by governmental entities. First, the ASWD will need to be expanded to include the MPR area. Second, the WCWD No. 2 will have to be expanded to include the newly enlarged ASWD. Third, the Somers Town Board must vote to incorporate into the WCWD No. 2 extensions. Fourth, the County legislature must approve these extensions. Due to these administrative and legislative complexities, a time frame of at least two to five years is estimated for implementation of this option. The recommended plan therefore includes provision of treated BPM production well water to the MPR homes until connection to the WCWD No. 2 can be implemented. (POU treatment units are provided for specific Route 6 businesses.) Provision of treated BPM production water to the MPR homes results in greater initial capital costs but reduced annual O&M costs as the monitoring and maintenance of the POU treatment units is no longer required. As a result, the present worth of providing treated BPM production well water is less that the present worth of continuing the POU treatment units until connection of the MPR area to the WCWD No. 2 becomes implementable.

Implementation of the recommended remedial plan will be staged; the on-site activities that may be more readily implemented (i.e., excavation of source area soils, source area recovery wells and treatment system installation, and increased pumping of the BPM production wells) will be initiated immediately, while the installation of the distribution system to the MPR homes from the BPM production wells will subsequently be performed when the relevant administrative issues have been resolved. Prompt implementation of the on-site remedial actions will prevent additional migration of contaminants to and within the groundwater during the time frame which may be required to obtain the necessary approvals to implement the off-site portion of the remedy. For costing purposes, it was assumed that the distribution system to the MPR area would be completed approximately one year after the on-site remedial activities have been initiated, however, the actual time required to obtain the necessary distribution system approvals is unknown at this time. Treated groundwater from the BPM production wells not used by the mall will be discharged to the eastern stream until the MPR distribution system is complete. Use of the treated BPM production well water to supply the MPR homes will be discontinued when connection with the WCWD No. 2 becomes implementable. For costing purposes, it was assumed that connection to the WCWD No. 2 will occur in year five.

Table 7-1 presents a summary of the estimated costs for implementation of the recommended remedial plan; detailed unit costs for each line item are included in the cost estimate for Alternative 4 (Table 6-3) in Chapter 6. The estimated O&M costs for years 1-5 only have been included as it was assumed that a decision concerning the implementability of connection of the MPR area and BPM to the WCWD No. 2 will be reached by that time. O&M costs beyond year five are therefore not included as they are unknown at this time.

Upon issuance of the ROD for the site, the RD for the preferred remedy will be prepared. Although actual implementation of the remedial action will be phased, preparation of the RD will include both the initial, on-site remediation and the subsequent, off-site water supply. The RD will include additional evaluations of off-site soil treatment and disposal options and options for disposal of the dewatering water. The RD will also define monitoring and contingent responses (i.e., a Remedial Effectiveness Monitoring Plan) to evaluate the effectiveness of the groundwater pumping and treatment in achieving site remedial objectives including the hydraulic containment and numerical groundwater contaminant criteria previously discussed.

TABLE 7-1

SUMMARY OF COSTS FOR RECOMMENDED REMEDIAL PLAN[a]

Baldwin Place Mall

ITEM		TOTAL COST ($)[b]
CAPITAL COST:		
A. Direct Costs:		
Excavation of 95 yd^3 of Soils with Off-Site Treatment and Disposal:		430,000
BPM Treatment System Modifications:		1,000
Distribution System:		211,000
Source Area Recovery Wells and Treatment System:		74,000
	Subtotal:	716,000
B. Indirect Costs:		
Engineering and Design @ 15%:		107,000
Legal and Administrative @ 10%:		72,000
Contingency @ 25%		179,000
	Total:	1,074,000
O&M COSTS:[c]		
BPM Treatment System Maintenance:		22,000 /yr
Distribution System Maintenance:		4,000 /yr
POU Treatment Unit Maintenance - Route 6 Businesses:		1,000 /yr
Recovery Wells and Treatment System Maintenance:		19,000 /yr
Long-Term Monitoring Program:	Year 1:	143,000 /yr
	Years 2-5:	66,000 /yr
Total O&M Costs:	Year 1:	189,000 /yr
	Years 2-5:	112,000 /yr
PRESENT WORTH:		
Based on a 5-yr life and a 5% interest rate:		1,614,000

a - Line item cost summaries are presented here; detailed unit costs for each line item are included in Table 6-3 in Chapter 6.
b - Costs rounded to nearest $1000.
c - Estimated costs for years 1-5 only as a decision concerning connection to WCWD No. 2 is anticipated in year 5; costs beyond year 5 are therefore unknown.

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APPENDIX A

HYDROGEOLOGIC APPENDIX
IN SUPPORT OF
REMEDIAL ALTERNATIVES EVALUATION
BALDWIN PLACE MALL, SOMERS, NEW YORK

APPENDIX A

HYDROGEOLOGIC APPENDIX
IN SUPPORT OF
REMEDIAL ALTERNATIVES EVALUATION
BALDWIN PLACE MALL, SOMERS, NEW YORK

TABLES

FIGURES

APPENDIX A

HYDROGEOLOGIC ANALYSIS IN SUPPORT OF REMEDIAL ALTERNATIVES EVALUATION BALDWIN PLACE MALL, SOMERS, NEW YORK

1.0 INTRODUCTION

The principal objectives of the Hydrogeologic Analysis were to:

1. Determine the rate of natural flux in (a) the bedrock aquifer system in the southeastern and western site areas, and (b) from the source area till to the underlying bedrock aquifer system to the southeast (vertical flow component) and from the source area till to the west (horizontal flow component).

2. Conduct a capture zone analysis to determine the pumping rates necessary to (a) contain groundwater and contaminant migration over the southeastern and western site areas for the bedrock aquifer system, and (b) contain contaminant migration from the source area till to the underlying bedrock system to the southeast (vertical flow component) and from the source area till to the west (horizontal flow component).

3. Through the application of a mass (solute) transport model, develop estimates of the timeframes for remediation of PCE concentrations in groundwater with respect to the Site-Wide Remedial Alternatives.

The principal technical basis for the analysis includes: (a) the characterization of aquifer hydraulic characteristics derived from the 48-hour aquifer pumping test on BPM bedrock Production Well PW-1 and the short duration pumping test on shallow source area till Monitoring Well MW-11S; and (b) the characterization of groundwater flow conditions developed during the RI field investigation under different production well pumping conditions.

2.0 GROUNDWATER FLUX CALCULATIONS

2.1 Bedrock Aquifer

Flux calculations for the bedrock aquifer in the southeastern and western site areas were made using the equation:

$$Q = TIL \quad (1)$$

where: Q = Natural Flux in gallons per day (gpd)
T = Transmissivity in gallons per day per foot (gpd/ft)
I = Hydraulic Gradient under non-pumping conditions (ft/ft)
L = Width of impacted area in feet (ft)

2.1.1 Southeastern Site Area

Groundwater flux for the southeastern site area was determined using: (1) the average transmissivity for the bedrock aquifer determined from the aquifer pumping test on PW-1 (1,000 gpd/ft); (2) the hydraulic gradient from the regional water-level contour map (RI Figure 4-16); and (3) the width of the affected area of 1,200 feet.

Using the equation Q = TIL: (1)

Q = 1,000 gpd/ft x 0.0158 x 1,200 ft
Q = 19,000 gpd
Q = 13.2 gpm

In summary, the natural groundwater flux over the southeastern site area is on the order of 13 gallons per minute (gpm).

2.1.2 Western Site Area

Groundwater flux for the western site area was determined using: (1) estimated transmissivities of 1,000 gpd/ft (from the aquifer pumping test on PW-1) and 2,000 gpd/ft (based on short-term pumping tests on MW-9S/9D); (2) a hydraulic gradient determined between MW-4D and MW-9D (RI Figure 4-16); and (3) the width of the affected area of 500 feet. In contrast to the southeastern site area, there is less certainty over the western site area in regard to aquifer transmissivity as a longer term pumping test was not conducted on MW-9S or MW-9D.

Using the equation Q = TIL: (1)

Q = 1,000 to 2,000 gpd/ft x 0.014 x 500 ft.
Q = 7,000 to14,000 gpd
Q = 5 to10 gpm

In summary, the natural groundwater flux over the western site area is on the order of 5 to 10 gpm.

2.2 Source Area Till

The flux from the source area shallow till to the underlying bedrock aquifer was determined for (a) the vertical component of flow contributing to the bedrock plume in the southeastern site area, and (b) the horizontal component of flow contributing to the western plume in the bedrock aquifer, using the equation:

$$Q = KIA \qquad (2)$$

where: Q = Natural Flux in gallons per day (gpd)
K = Vertical/horizontal hydraulic conductivity of the till deposits (gpd/ft2)
I = Vertical/horizontal hydraulic gradient in the till deposits (ft/ft)
A = Area in the till (a) through which leakage is taking place from the source area in the shallow till to the underlying bedrock aquifer, and (b) cross sectional area in shallow till through which contaminant flux is moving to the west (ft2)

2.2.1 Vertical Flow Component To Underlying Bedrock Aquifer

Groundwater flux from the shallow source area in the till to the underlying bedrock aquifer was determined using: (1) a vertical hydraulic conductivity of 0.050 gpd/ft2 determined from analysis of the aquifer pumping test on PW-1; (2) a vertical hydraulic gradient of 13ft/50ft determined from water-level measurements on MW-11S (shallow till monitoring well in source area) and MW-5D (deeper monitoring well completed in weathered bedrock underlying till), and the thickness of saturated till (50 feet) in the source area; and (3) the dimensions which encompass the area from which contaminated groundwater would be migrating vertically through the till into the underlying bedrock (this was conservatively estimated at 50 ft x 50 ft).

Using the equation Q = KIA: (2)

Q = 0.050 gpd/ft2 x 13ft/50ft x 50 ft x 50 ft
Q = 32.5 gpd
Q = 0.022 gpm

In summary, the natural groundwater flux from the shallow saturated source area to the underlying bedrock aquifer is less than 0.1 gpm.

2.2.2 Horizontal Flow Component to the West

Groundwater flux from the shallow source area in the till to the west was determined using: (1) a horizontal hydraulic conductivity of 4 gpd/ft2 determined from the short-term pumping test on MW-11S and slug test on MW-11D, (2) a horizontal hydraulic gradient of 0.023 ft/ft determined between MW-5S and MW-7S (RI Figure 4-7), and (3) a cross sectional area of 50 feet wide by 30 feet deep.

Using the equation Q = KIA: (2)

Q = 4 gpd/ft2 x 0.023 x 50 ft x 30 ft
Q = 138 gpd
Q = 0.10 gpm

2.3 Summary of Flux Calculations

A summary of the natural flux calculations is provided below:

Bedrock Aquifer: Southeastern Site Area:	13 gpm
B^edrock Aquifer: Western Site Area:	5 to10 gpm
Source Area Till: Vertical Leakage to Bedrock:	0.022 gpm
Source Area Till: Horizontal Flux to West:	0.10 gpm

3.0 CAPTURE ZONE ANALYSIS

3.1 Bedrock Aquifer

The analytical equations used to develop estimates of capture zones for the bedrock aquifer in the southeast and western site areas are presented in "Groundwater Contamination; Optimal Capture and Containment" (Gorelick et. al., 1993). The basic equations as shown on Figure A-1 include:

$$Xo = Q/2\pi TI \quad (3)$$

$$Yi = Q/2TI \quad (4)$$

$$Y = Q/TI \quad (5)$$

where: Xo=Downgradient distance to stagnation point at center point of capture zone (ft)
Q = Pumping rate (gpd)
T = Transmissivity (gpd/ft)
I = Hydraulic Gradient (ft/ft)
Yi = Distance between dividing streamlines at line of well (ft)
Y = Distance between dividing streamlines far upgradient of wells (ft)

Capture zone determinations were made for the following alternatives:

Alternative 1: (No Action) BPM production wells pumping at current rates (4 gpm).

Alternatives 3 and 4: BPM production wells pumping at rates to: (a) supply fully operative mall and Meadow Park Road (20 gpm); and (b) supply fully operative mall, Meadow Park Road, and to contain contaminant migration to southeast.

Alternative 5: BPM production wells pumping at rate (15 gpm) to supply fully operative mall; with the inclusion of a western plume recovery well and a recovery well downgradient of the source area near the eastern property boundary.

Figure A-2 shows the extent of capture for Alternatives 1, 3, and 4. The capture zone analysis indicated that the BPM production wells would need to be pumped in the range from 20 to 30 gpm to contain contaminant migration to the southeast in the bedrock aquifer.

Figure A-3 shows the extent of capture in the bedrock aquifer for Alternative 5 wherein the BPM production wells serve to supply a fully operative mall (15 gpm); a western recovery well is operating in the range from 5 to 10 gpm, and a recovery well is operating from 15 to 20 gpm downgradient of the source area near the southeastern property boundary.

Table A-1 provides a summary of the capture zone calculations.

3.2 Source Area

Groundwater in and underlying the source area in the till has a significant downward flow component that serves to recharge the underlying bedrock aquifer system and is the principal contaminant migration pathway to the bedrock aquifer to the southeast. Further, groundwater in the source area has a westerly horizontal groundwater flow component in the till that is the principal contaminant migration pathway to the bedrock aquifer to the west (Refer to RI Figure 4-17; Vertical Flow Net). Given these conditions, the optimal configuration of a recovery well system in the source area would be two recovery wells; one completed in the upper portion of the bedrock aquifer to contain vertical leakage into and migration in the bedrock aquifer to the southeast; and the second completed in the shallow till deposits to contain migration in the till to the west. As such, the capture zone analysis for the source area included:

(1) Determining the rate at which a deeper recovery well, completed in the upper portion of the bedrock aquifer, would need to be pumped to contain contaminant migration to the southeast in the bedrock aquifer.

(2) Determining the rate at which a shallow recovery well, completed in the shallow till, would need to be pumped to contain contaminant migration from the source area to the west.

3.2.1 Recovery Well in Upper Portion Of Bedrock Underlying Source Area

The analysis for the recovery well in the upper portion of the bedrock aquifer took into consideration (a) the rate of natural flux through the bedrock aquifer in the vicinity of the source area, and (b) the vertical leakage from the source area till to the bedrock aquifer. Using a conservative estimate of the bedrock aquifer width (50 feet) underlying the source area and a transmissivity of 500 gpd/ft (assumed to be half of the total transmissivity of the bedrock aquifer), the rate of natural flux through the bedrock aquifer underlying the source area was calculated using the following equation:

$$Q = TIL \qquad (1)$$
$$Q = 500 \text{ gpd/ft} \times 0.0158 \times 50 \text{ ft}$$
$$Q = 395 \text{ gpd}$$
$$Q = 0.27 \text{ gpm}$$

The flux calculations in Section 2.2.1 above showed the vertical leakage from the source area till to the bedrock aquifer to be less than 0.1 gpm. This analysis indicates that a pumping rate on the order of 0.25 to 0.50 gpm will be sufficient to contain contaminant migration emanating from the source area and leaking into the bedrock aquifer.

3.2.2 Recovery Well in Glacial Till To West Of Source Area

The rate of flux in the shallow till (upper 30 feet) from the source area to the west is on the order of 138 gpd for a 50 ft by 30 ft cross sectional area (see Section 2.2.2). The capture zone equations presented above are not valid for materials such as till that are characterized by very low hydraulic conductivities. As such, an analysis was made of the sustained pumping rate for a recovery well completed in the shallow till. A sustained rate of approximately 0.40 gpm or 600 gpd was calculated which will be more than sufficient to contain contaminant flux (approximately 0.10 gpm or 150 gpd) to the west in the shallow till.

4.0 SOLUTE TRANSPORT MODELING

The Random-Walk analytical mass-transport model (Prickett 1994) was used to simulate the Baldwin Place Mall (BPM) PCE plume in groundwater. The Random-Walk technique represents the chemical concentration of a constituent by a discrete number of particles which are moved and dispersed by groundwater flow. The Random-Walk analytical model includes the capabilities of both steady state and non-steady state conditions, and multiple pumping or injection wells at time-variable rates. The mass transport capabilities are accomplished by the random-walk theory given by Prickett, et. al. (1981) and includes mapping of the concentrations of chemical constituents as they advect and disperse in the aquifer. Chemical retardation and first-order decay are included in the capabilities of the model.

The first phase of the modeling effort was to calibrate the model by simulating the historical (where available) and present PCE distribution in the groundwater. The model was calibrated for (a) the glacial till in the source area, (b) the bedrock aquifer to the east/southeast of the source area, and (c) the bedrock aquifer to the west of the source area.

The bedrock aquifer models were calibrated using a site-specific 11-year PCE half life calculated on the relative onsite concentration of PCE and its breakdown products. As requested by the New York State Department of Environmental Conservation (NYSDEC), the bedrock aquifer models were also calibrated using a 1,000-year half life to simulate no degradation of PCE in the aquifer. The no degradation scenario is felt to be exceedingly conservative with respect to actual site conditions. Relative onsite concentrations were also used to calculate a 4.6-year PCE half life in the glacial till.

The calibrated models were then used to predict future PCE concentration distribution under different remedial alternatives for the following areas:

1) The glacial till materials in and beneath the source area behind the dry cleaner.

2) The bedrock aquifer east/southeast of the source area (BPM production wells and residential wells along Meadow Park Road).

3) The bedrock aquifer west of the source area.

4.1 Conceptual Model

The BPM is located in Somers, New York and was constructed in 1965. A dry cleaning establishment has always been present at the mall and, until November 1991, dry cleaning processing was performed on the mall property. In 1979, the Westchester County Health Department discovered dry cleaning chemicals in the mall water supply. The mall water supply is comprised of two bedrock production wells on the southern part of the property. These wells (PW-1 and PW-2) can reportedly provide a combined capacity of 115 gpm. The water supply is treated by a granular activated carbon filter system that was installed in April 1989. During the height of the mall operations, the BPM supply wells were operating at a combined capacity of 20,000 gpd (14 gpm). By 1984 (19 years after opening) the mall operations had declined and the water consumption decreased to approximately 11,500 gpd (based on a discussion with the mall waste water treatment plant operator). In 1993/1994 the BPM supply wells were supplying the remaining mall tenants with approximately 5,700 gpd.

The geologic characteristics of the site and surrounding areas consist of glacial till overburden underlain by a thin mantle of weathered saprolitic granitic gneiss. The bedrock is fractured granitic gneiss. The glacial till is approximately 50 feet thick at the source area. These till materials thicken to the east-southeast and are thinnest in the western site areas near Monitoring Wells MW-9S/9D.

The till is the uppermost water-bearing unit over most of the site area. The bottom of the till lies near the top of the water table in the western site area near MW-9S/9D. The till in the eastern site area serves to recharge the underlying bedrock, as evidenced by the hydraulic head differences between shallow till monitoring wells and deeper bedrock monitoring wells in well clusters. Beneath the till/weathered saprolitic bedrock horizon is a fractured partially weathered bedrock horizon in which groundwater circulation is relatively significant as indicated by water strikes and yields measured during drilling. The bedrock system is unconfined over the western portion of the site and semi-confined (leaky artesian) over the eastern/southeastern portion of the site (characterized during the 48-hour pumping test conducted on PW-1 in June 1993). The vertical hydraulic conductivity of the till is approximately 0.050 gpd/ft2. The transmissivity of the bedrock in the eastern site area is 1,000 gpd/ft, and storativity is 0.005. The transmissivity of the bedrock in the western site area is less certain although a transmissivity of approximately 2,000 gpd/ft was calculated from short-term pumping tests on individual monitoring wells in this area. The storativity of the bedrock in this area, where the bedrock is unconfined, is assumed to be 0.10.

A groundwater divide is present in the shallow water table system (saturated till). The groundwater divide is orientated in a northeast to southwest direction with a component of flow to the southeast and a component of flow to the west. The groundwater divide is also present in the bedrock system under non-pumping conditions. The hydraulic gradient of the bedrock system over the east/southeastern portion of the site is on the order of 0.0158 ft/ft. The regional groundwater velocity in this area using a hydraulic conductivity of 10 gpd/ft2 (T=1,000 gpd/ft, b=100 feet, n=0.1) was calculated at 0.21 ft/day.

The hydraulic gradient for the bedrock over the western site area is on the order of 0.014 ft/ft. The regional groundwater velocity in this area using a hydraulic conductivity of 10 gpd/ft2 (T=2,000 gpd/ft, b=200 feet, n=0.1) is 0.187 ft/day.

4.2 Source Area Till

The Prickett Model was applied to the saturated till materials at and underlying the source area. The predominant component of groundwater flow in these materials is vertical as a result of the significant head (water level) differences between wells completed in the till materials and underlying bedrock. Thus, the Y axis represents ground surface or the top of the zone of saturation and the X axis represents the saturated till in the vertical direction.

The modeling provides a comparison of remediation timeframes for the following source area alternatives:

Alternative 3: Source area soil excavation with three different volume options:

Volume 1: 95 cubic yards: soils > 50 ppm PCE
Volume 2: 135 cubic yards: soils > 10 ppm PCE
Volume 3: 185 cubic yards: soils > 1.4 ppm PCE

Alternatives 4 and 5: Source area soil excavation with the same three excavation volume options and the addition of two recovery wells (a shallow till well and a deeper well in the underlying bedrock aquifer) in the source area.

4.2.1 Mass Calculations

The analytical results from the test boring and soil sampling programs in the source area (April and November 1993, and September/October 1994) were utilized to develop estimates of the total mass of PCE which would be removed for the three excavation volume options discussed above. Table A-2 provides these calculations which are summarized below:

Volume 1: 95 cubic yards: soils > 50 ppm: PCE MASS = 203.54 lbs.
Volume 2: 135 cubic yards: soils > 10 ppm: PCE MASS = 204.13 lbs.
Volume 3: 185 cubic yards: soils > 1.4 ppm:PCE MASS = 204.32 lbs.

In summary, removal of soil at concentrations less than 50 ppm results in approximately 0.78 lbs. of additional PCE mass removal.

4.2.2 Calibration to Existing Conditions

Three monitoring wells, MW-11S, MW-11D and MW-5D, are located within and proximate to the source area. The model was calibrated to provide a simulation wherein the modeled concentrations in these wells were reasonably similar to the actual concentrations detected in the RI samples collected in 1993.

The input parameters for the till model are discussed below and provided in Table A-3. Transmissivity was determined as the product of the saturated till thickness (50 feet) and vertical hydraulic conductivity (0.050 gpd/ft2) determined from analysis of the aquifer pumping test on PW-1. Aquifer storage coefficient and effective porosity were assumed at 5 percent. A retardation coefficient of 2.5 was determined for PCE. The vertical (X) component of velocity was determined to be 0.034 ft/day on the basis of hydraulic conductivity of 0.050 gpd/ft2, a vertical gradient of 13ft/50ft and an effective porosity of 5 percent.

The PCE half life for the till materials was calculated using the equations:

$$C_t/C_o = e^{(-\lambda t)} \quad (6)$$

$$\lambda = 0.693/\text{Half Life} \quad (7)$$

where:

C_t = PCE concentration at time t (ug/L)
C_o = Initial concentration (ug/L)
λ = Decay constant (year -1)
t = Time (years)

The VOC data from shallow till Monitoring Well MW-5S located 75 feet from the source area was used to calculate the half life for PCE in the till materials. This well exhibited a PCE concentration of 300 ug/L, TCE of 190 ug/L and 1,2-DCE of 61 ug/L in the 1993 RI sample. The initial PCE concentration (Co) is assumed to be the sum of PCE and its breakdown products which is 551 ug/L. The calculated travel time in the till from the source area to Monitoring Well MW-5S was determined to be on the order of 4 years. Thus, the concentration at time t = 4 years (Ct) is the PCE concentration detected in MW-5S of 300 ug/L. Using Equation 6 above, the decay constant (λ) was calculated to have a value of 0.152/year. This yields a PCE half life of 4.6 years from Equation 7.

The asymptotic dispersivity model was used and a dispersivity of 70 feet for the glacial till was chosen (Walton, 1984) with a corresponding mean travel distance of 200 feet. Table A-4 provides a comparison between actual and modeled PCE concentrations in Monitoring Wells MW-11S, MW-11D and MW-5D.

4.2.3 Alternative 3: Source Area Excavation

The Feasibility Study outlines the three soil excavation volume options discussed previously. The modeling effort for Alternative 3 involved two simulations. The first simulation involved removing soils with PCE concentrations > 1.4 ppm (Volume 3). In this most conservative scenario, after calibration to present conditions, no additional mass was added to the model. The second simulation involved removing soils with PCE concentrations > 50 ppm (Volume 1). An additional 0.78 lbs of mass, which represents the calculated difference in PCE mass that would be left in place (see Section 4.2.1), was added to the till model over a five year period. The intermediate scenario of removing soils with > 10 ppm (Volume 2) was not modeled because of the negligible difference in mass remaining from Volume 3 (about 0.2 lbs.).

The model runs indicate that the timeframe for remediation of PCE concentrations in groundwater in the saturated till to approach 500 ug/L is on the order of 15 years, and to approach 5 ug/L, 25 to 30 years, for both excavation scenarios. The modeling indicates that leaving soils in place with concentrations < 50 ppm will not change the timeframe within which groundwater in the till will be restored.

4.2.4 Alternatives 4 and 5: Source Area Excavation with Two Source Area Recovery Wells

Alternatives 4 and 5 incorporate the same soil excavation volume options as Alternative 3 with the inclusion of two source area recovery wells. The modelling effort involved the same two simulations with regard to Volumes 1 and 3, with the addition of a shallow recovery well (30 foot depth in till) and a deeper recovery well (60 foot depth in the upper portion of bedrock aquifer). The simulations were run using pumping rates (RW-1 shallow recovery well at 0.15 gpm and RW-2 deeper recovery well at 0.40 gpm) that were greater than the calculated natural flux (see Sections 2.2.2 and 3.2.1).

The model runs indicate that the timeframe for PCE concentrations in the source area recovery wells to approach 5 ug/L is on the order of 10 to 15 years for both soil excavation volume simulations.

Table A-5 summarizes simulated PCE concentrations over time in the two source area recovery wells. Overall, there is little improvement noted by excavating soils with concentrations < 50 ppm.

4.2.5 Comparison of Source Area Alternatives

Table A-6 provides a comparison of the alternatives for the source area for the two simulated soil excavation options (Volumes 1 and 3) with (Alternatives 4 and 5) and without (Alternative 3) recovery wells. The timeframes for source area groundwater remediation do not significantly change with the different soil excavation options. The timeframe for remediation of PCE concentrations in source area groundwater is shortened by approximately 10 to 15 years by the inclusion of the two source area recovery wells.

4.3 Southeastern Site Area: Bedrock Aquifer

The model for the bedrock system over the southeastern site area was calibrated to the PCE concentrations detected historically in the BPM production wells from 1979 to 1994 and to the relative PCE concentrations detected along Meadow Park Road in 1994. These data are:

Year	**Average Historical PCE Concentration in BPM Production Wells (ug/L)**
1979	37
1984	37
1989	43
1990	77
1991	93
1992	77
1993	71
1994	55

Location	May 1994 PCE Concentrations in Meadow Park Road Wells (ug/L)
RW-7	14
RW-8	43
RW-9	38
RW-10	18
RW-11	6.6
RW-12	1.3
RW-14	3
RW-15	13
RW-16	20
RW-17	27

The input parameters, their effect in the calibration process and the calculation of the mass input to the model are discussed below.

4.3.1 Mass Calculation (Southeastern Site Area Model)

The first step in the modeling process was to develop a grid for the southeastern site area which took into account the plume geometry over the on-site and off-site areas (Figure A-4A). The grid was constructed extending 2,000 feet downgradient from the source area in the X direction and 1,000 feet in the + Y and - Y directions. The PCE concentrations detected in the on-site monitoring wells, the BPM production wells and the off-site Meadow Park Road residential wells were then placed onto the grid and contoured. The mass within each grid block was then calculated by the following equation:

$$M_B = (C_B * CDX * CDY * b * n * W * R) / 10^9 \quad (8)$$

where: M_B = total mass or weight of constituent in grid block (lbs)

C_B = average concentration of water in the grid block (ug/L)

CDX = grid block dimension in X direction (ft)

CDY = grid block dimension in Y direction (ft)

b = aquifer thickness (ft)

n_e = effective porosity

W = weight or mass of water (62.4 lbs/ft^3)

R = retardation coefficient

The retardation coefficient used in the mass calculations ranged from 1.056 to 1.615 as calculated from the following equation:

$$R = (1 + K_d p/n) \qquad (9)$$

where: K_d = soil/water partition coefficient = 0.63 * F_{oc} * K_{ow}

p = aquifer bulk density (2.24 to 2.46 grams/cubic cm for granites)

F_{oc} = Fraction of organic carbon (1×10^{-5} to 1×10^{-4} for granites)

K_{ow} = octonal/water partition coefficient for PCE = 398 (USEPA, 1990)

The calculated total mass (a summation of the mass in all the grid blocks) ranged from 223 lbs to 341 lbs for the southeastern modeled area.

4.3.2 Calibration to Existing Conditions

The final calibrated input parameters to the model for the southeastern site area are:

Transmissivity (T) = 1000 gpd/ft
Storativity (S) = 0.005
Hydraulic Conductivity (K) = 10 gpd/ft^2
Effective Porosity (n_e) = 0.10
Retardation Coefficient = 1.34
Regional Aquifer Pore Velocity = 0.21 ft/day
X Component of Aquifer Pore Velocity = 0.204 ft/day
Y Component of Aquifer Pore Velocity = - 0.05 ft/day
Particle Mass (no degradation model) = 0.0205 lbs/Particle
Particle Mass (site-specific degradation model) = 0.0341 lbs/Particle
Species Half Life (no degradation model) = 1000 Years
Species Half Life (site-specific degradation model) = 11 Years
Dispersivity Model = Asymptotic
Asymptotic Dispersivity (AD) = 85 ft
Mean Travel Distance Corresponding to AD/2 = 850 ft
Ratio of Longitudinal to Transverse Dispersivity = 1

Transmissivity and storativity were derived from the 48-hour aquifer pumping test conducted during the RI on BPM Production Well PW-1. The aquifer hydraulic conductivity was calculated from the aquifer transmissivity and an assumed aquifer thickness of 100 feet. The effective porosity of 10% was literature derived (Walton 1984; Freeze and Cherry 1979).

As previously discussed, two degradation scenarios were modeled. The first scenario utilized a PCE half life of 1,000 years to simulate no degradation of PCE in the aquifer. The second scenario utilized a site-specific PCE half life based on the VOC data from Monitoring Well MW-5D. This well exhibited a PCE concentration of 910 ug/L, TCE of 57 ug/L and non-detectable (ND) 1,2-DCE in the 1993 RI sample. The initial PCE concentration is assumed to be the sum of PCE and its breakdown products which is 967 ug/L. The calculated travel time in the bedrock system to this well was determined to be on the order of 1 year. Using Equations (6) and (7) shown in Section 4.2.2, the decay constant was calculated to have a value of 0.0618/year, yielding a PCE half life in the bedrock aquifer of 11 years.

A range of retardation values and total mass were calculated and used in the model calibration process; values of R = 1.34 and Total Mass = 205 Lbs were required to calibrate the model to existing conditions for the no degradation (1,000 year half life) model scenario. In order to calibrate the model with the site-specific degradation (11 year half life), a total mass of 341 lbs was required.

An asymptotic dispersivity model was used to simulate the PCE plume. A maximum longitudinal dispersivity of 85 feet was derived based on the actual half distance of the PCE plume of 850 feet (mean travel distance) over the southeastern portion of the site. A range of longitudinal to transverse dispersivities were used in the calibration process. A ratio of 1:1 was required to calibrate the model to existing conditions with respect to PCE concentrations in the BPM production wells and along Meadow Park Road.

Figure A-4A is the model grid used for the southeastern site model. In the modeling process, a sink was used at grid coordinates 500,-370 to represent a single general location of the two BPM production wells pumping at 20,000 gallons per day (gpd) for years 1965 to 1984 (19 years), and 11,520 gpd for years 1984 to 1994 (10 years).

A source location was used in the model at grid coordinates 10,5, to represent leakage to the bedrock from the overlying saturated till materials at the source area. This leakage through the till was calculated to be 2.4 gpd over a rectangular source area of approximately 20 feet by 10 feet. This source (leakage) remained unchanged over the course of the model simulation.

The maximum number of particles allowed by the model of 10,000 was used to represent the total mass. It was assumed that the source "operated" for approximately 24 years (1970 to 1994) at 417 particles/year. The mass input to the model simulations were entered in a continuous mode at the source area rectangle with the grid coordinates: x,y = 0,0 (lower left corner of rectangle); x,y = 20,10 (upper right corner of rectangle).

The simulated PCE concentration for the modeled BPM production well versus the actual (average) PCE detected in the BPM production wells are summarized below. Plots of simulated versus actual (average) PCE concentrations for the BPM production well(s) are shown on Figures A-5 and A-6.

BPM PRODUCTION WELLS

Year	Simulated PCE Concentrations 1000 Year Half Life (ug/L)	11 Year Half Life (ug/L)	Actual Average PCE Concentration (ug/L)
1975	0.067	0.40	
1979	31.5	32	37
1984	66	57.2	37
1989	76	60.9	43
1990	87	71	77
1991	90.6	82.6	93
1992	86	72.9	77
1993	83	76.8	71
1994	91.7	70	55

The calibrated simulations for both of the modeled scenarios show a reasonable and conservative correlation with respect to the concentrations in the BPM production well(s) (see Figures A-5 and A-6), and with respect to the range of concentrations along Meadow Park Road. The modeled plume length and width versus the actual are summarized below:

Length of Plume in X direction

<u>Modeled</u>	<u>Actual</u>
2000 feet	1700 feet

Width of Plume in +Y and -Y directions

<u>Modeled</u>	<u>Actual</u>
+ 300 to + 500 feet	+ 600 feet
-1000 feet	-1000 feet

4.3.3 Modeling of FS Alternatives

4.3.3.1 Alternative 1: No Action

The No Action alternative was simulated in 5-year increments with the BPM production wells pumping at 4 gpm utilizing the site-specific PCE degradation scenario (11 year half life). In this model run, additional PCE mass was input in a continuous mode over a period of 20 years. The quantity of PCE mass input over this timeframe was equivalent to the calculated PCE mass in the source area (204 lbs, refer to Section 4.2.1).

Figure A-7 is a plot of the simulated PCE concentration in the BPM production wells versus years of pumping at 4 gpm. This analysis indicates a projected timeframe of approximately 40 years for PCE concentrations to approach 5 ug/L onsite and at the BPM production wells. At 40 years, simulated PCE concentrations along Meadow Park Road are still greater than 5 ug/L.

4.3.3.2 Alternative 3: BPM Production Wells to Supply Mall and Meadow Park Road; Plus Containment with Excavation of Source Area

Four simulations were made for this alternative: Pumping the BPM production wells at the rate sufficient to supply the Mall and Meadow Park Road (20 gpm), and pumping the BPM production wells at 30 gpm to enhance containment over the southeastern site area with both the no degradation (1,000 year half life) and site-specific degradation (11-year half life) scenarios. All four simulations were made on the basis of the excavation of soils containing PCE concentrations > 50 mg/Kg (Volume 1). The remaining PCE mass entering the bedrock aquifer (after excavation in the source area) was calculated to be 2.8 lbs; this included the residual 0.78 lbs in the source area soils and the PCE mass in groundwater at and underlying the source area that eventually migrates to the bedrock system (determined from the till model for this alternative). This mass was input into the bedrock simulations over a 20-year timeframe.

Figures A-8 and A-9 are plots of simulated PCE concentration in the BPM production wells pumping at 20 gpm and 30 gpm versus time for the no degradation (1,000 year half life) scenario. The projected timeframe for cleanup onsite and at the BPM production wells is similar (on the order of 24 to 25 years) for both the 20 gpm and 30 gpm pumping rates.

Figures A-10 and A-11 are similar plots for the site-specific degradation (11-year half life) scenario. The projected timeframe for cleanup onsite and at the BPM production wells for both the 20 and 30 gpm pumping rates are likewise similar and on the order of 17 to 18 years.

For the Meadow Park Road area, the 11-year half life simulations indicate that PCE concentrations are less than 5 ug/L after 20 years of pumping at the BPM production wells for both the 20 and 30 gpm pumping rates. The simulations using the 1,000 year half life indicate that within the same 20 year timeframe there are modeled concentrations that exceed 5 ug/L.

4.3.3.3 Alternative 4: BPM Production Wells to Supply Mall and Meadow Park Road; Plus Containment with Excavation of Source Area and Source Area Recovery Wells.

In this alternative, the remaining mass at the source area after excavation is assumed to be captured by the source area recovery wells. Therefore no mass was input to the bedrock model from the till in the simulations for this alternative. The BPM production wells were modeled at 20 and 30 gpm for the 1000 year and 11 year half life scenarios as discussed in Section 4.3.3.2. Figures A-12 through A-15 are plots of simulated PCE concentrations in the BPM production wells versus time.

For the no degradation (1,000 year half life) scenario, a projected timeframe of approximately 23 to 25 years (similar to the timeframe for Alternative 3) was required for the concentrations onsite and at the BPM production wells to decline below 5 ug/L for both the 20 and 30 gpm simulations (Figures A-12 and A-13).

For the site-specific degradation (11 year half life) scenario, a projected timeframe of approximately 15 to 17 years was necessary to reach 5 ug/L onsite and in the BPM production wells pumping at 20 and 30 gpm (Figures A-14 and A-15).

For the Meadow Park Road area, the simulations with the 11 year half life indicate that PCE concentrations are less than 5 ug/L for both the 20 and 30 gpm pumping rates after 20 years of pumping. The simulations using the 1,000 year half life indicate that within the same 20 year timeframe, there are modeled concentrations that exceed 5 ug/L.

Overall, the simulations indicate little difference in the time required for on and offsite groundwater remediation with Alternative 3 (source area excavation) and Alternative 4 (source area excavation with source area recovery wells).

4.3.3.4 Alternative 5: BPM Wells to Supply Mall; Recovery Wells Downgradient of Plume to Southeast and West; with Excavation of Source Area and Source Area Recovery Wells

For Alternative 5 (southeast area model), a recovery well was placed at grid coordinates 340,0 (near existing well LBG-1) to simulate an onsite downgradient recovery well near the eastern property boundary. Model runs were made with this recovery well pumping at 15 and 20 gpm. In these simulations, the BPM production wells were pumping at a rate of 15 gpm (rate to supply fully operative mall).

Figures A-16 through A-19 are plots of simulated PCE concentrations in the BPM production wells and the onsite downgradient recovery well versus time. For the 1,000 year half life scenario, simulated PCE concentration in the BPM production wells approached 5 ug/L in an appro..mate 25 year time frame (similar to Alternative 4). Simulated PCE concentration in the onsite downgradient recovery well declined to below 5 ug/L in approximately 14 years for both the 15 and 20 gpm pumping rates. For the 11 year half life scenario, simulated PCE concentration in the BPM production wells declined to 5 ug/L in 15 to 17 years (similar to Alternative 4). PCE in the on-site downgradient recovery well declined to 5 ug/l in approximately 10 years for both the 15 and 20 gpm simulated pumping rates.

For the Meadow Park Road area, the simulations with the 11 year half life indicate that PCE concentrations are less than 5 ug/L for both the 15 and 20 gpm recovery well pumping rates after 15 to 20 years of pumping. The simulations using the 1,000 year half life indicate that within the same timeframe, there are modeled concentrations that exceed 5 ug/L.

4.4 Western Site Area: Bedrock Aquifer

The model for the bedrock system over the western site area was calibrated to the PCE concentrations detected in the western onsite bedrock monitoring wells sampled during the Remedial Investigation in 1993. The concentrations detected in these monitoring wells are summarized below:

Monitoring Well Cluster	Maximum PCE Concentration (ug/L)
MW-9S/9D	850
MW-7D	3
MW-1S/1D	2
MW-10S/10D	37

4.4.1 Mass Calculation (Western Site Area)

As discussed in Section 4.3.1, a grid was also constructed for the western site area which took into account the plume geometry over the onsite and offsite areas (see Figure A-4B). The PCE concentrations detected in the onsite monitoring wells during the RI and the concentrations detected in the Route 6 commercial wells (May 1994 sampling event) were placed onto the grid and contoured. The mass was then calculated using Equation 8 (see Section 4.3.1) with a range of retardation coefficients of 1.056 to 1.615. The calculated total mass ranged from 394 lbs to 602 lbs.

4.4.2 Calibration to Existing Conditions

The final calibrated input parameters to the model for the western site area are:

Transmissivity (T) = 2000 gpd/ft
Storativity (S) = 0.10
Hydraulic Conductivity (K) = 10 gpd/ft2
Effective Porosity (n_e) = 0.10
Retardation Coefficient = 1.34
Regional Aquifer Pore Velocity = 0.187 ft/day
X Component of Aquifer Pore Velocity = 0.182 ft/day
Y Component of Aquifer Pore Velocity = 0.042 ft/day
Particle Mass (no degradation model) = 0.050 Lbs/Particle
Particle Mass (site specific degradation model) = 0.1377 Lbs/Particle
Species Half Life (no degradation model) = 1000 Years
Species Half Life (site specific degradation model) = 11 Years
Dispersivity Model = Asymptotic
Asymptotic Dispersivity (AD) = 90 ft
Mean Travel Distance Corresponding to AD/2 = 900 ft
Ratio of Longitudinal to Transverse Dispersivity= 10

Transmissivity was estimated from short-term pumping tests on Monitoring Wells MW-9S/9D in the western site area. The storativity of the bedrock was assumed to be 0.10. The aquifer hydraulic conductivity was calculated from the aquifer transmissivity and an assumed aquifer thickness in this area of 200 feet. As discussed in the southeastern site area bedrock model, the effective porosity of 10% was literature derived (Walton 1984; Freeze and Cherry 1979).

The no degradation scenario (1,000 year half life) and the site-specific degradation scenario (11 year half life) were simulated. A retardation coefficient of 1.34 was used throughout the calibration process.

Due to the change in the groundwater flow component toward the western stream and the change in the hydraulic gradient near Route 6, the model was not calibrated to the offsite

(Route 6 wells) concentrations. The objective in the western area was to calibrate the model to the concentration detected in the bedrock monitoring well MW-9S (850 ug/L) ensuring that Monitoring Wells MW-1S/1D and MW-10S/10D were at the fringes of the simulated PCE plume. Also, attention was given to calibrating the general plume geometry (length and width) to known existing conditions.

The maximum number of particles allowed by the model of 10,000 was used to represent the total mass. Again it was assumed that the source operated for approximately 24 years (1970 to 1994) at the grid location corresponding to the alleyway behind the dry cleaner.. One single simulation time of 8760 days was used for calibration.

The simulated PCE concentrations for MW-9S/9D are summarized below:

MONITORING WELL MW-9D

Simulated PCE Concentration 1000 Year Half Life (ug/L)	Simulated PCE Concentration 11 Year Half Life (ug/L)	Actual PCE Concentration (ug/L)
900	883	850

The final calibrated simulations show reasonable correlation with respect to the concentration at MW-9S/9D. Monitoring Wells MW-1S/1D and MW-10S/10D are simulated at the fringe of the PCE plume and the modeled plume length and width are similar to the known existing conditions. The modeled plume length and width versus the actual are summarized below:

Length of Plume in X direction

Modeled	Actual
2000 feet	1900 feet

Width of Plume in +Y and -Y directions

Modeled	Actual
+400 to 500 feet	+400 feet
-200 feet	-200 feet

4.4.3 Modeling of FS Alternative 5: Recovery Wells Downgradient of Plume to Southeast and West; with Excavation of Source Area and Source Area Recovery Wells

Alternative 5 for the western site area was modeled by simulating a recovery well at the location of the MW-9S/9D monitoring well cluster pumping at 5 to 20 gpm. Figures A-20 and A-21 are plots of simulated PCE concentrations versus time in the recovery well for the 1000 year half life and 11 year half life scenarios, respectively. The projected timeframes to reach 5 ug/L onsite and in the western recovery well are summarized on Table A-9. For the 1,000-year half life scenario, simulated PCE concentration in the western recovery well approaches 5 ug/L in a 25 (20 gpm) to 30 (5 gpm) year timeframe. For the 11-year half life scenario, simulated PCE concentration in the western recovery well approaches 5 ug/L in a 22 (20 gpm) to 27 (5 gpm) year timeframe

5.0 COMPARISON OF ALTERNATIVES

Table A-6 summarizes the projected timeframes for cleanup of the groundwater in and beneath the source area. The projected timeframes for restoration of groundwater in the bedrock aquifer with respect to the site-wide remedial alternatives are summarized on Tables A-7, A-8 and A-9 for the southeastern and western site areas.

No Action

Under Alternative 1, the no action alternative with the BPM production wells pumping at 4 gpm, a timeframe of approximately 40 years would be required for concentrations in the bedrock aquifer to approach 5 ug/L. This is at least twice the time as compared to the other alternatives.

Groundwater In and Beneath the Source Area

Alternatives 3,4, and 5 incorporate excavation of the source area soils. The timeframes for groundwater remediation in the source area (with and without source area recovery wells) do not significantly differ with excavating soils >50 ppm (Volume 1) as compared to excavating soils >1.4 ppm (Volume 3). This is because the difference in PCE mass remaining in the source area between the two soil excavation volume options is very small (0.78 lbs).

Alternative 3 involves source area soils excavation only, while Alternatives 4 and 5 incorporate source area recovery wells. The projected timeframe for groundwater remediation in the source area is shortened by approximately 10 to 15 years by inclusion of two source area recovery wells (a shallow well in the till and a deeper well in the upper portion of the underlying bedrock).

Bedrock Aquifer

Although the two source area recovery wells provide faster cleanup in the source area (Alternatives 4 and 5), they do not significantly decrease the projected timeframes for restoration of the bedrock aquifer. This is due to the small mass of PCE remaining in the source area soils and groundwater after excavation (with either soil excavation volume option), and dilution of the vertical leakage from the source area till in the underlying bedrock aquifer.

Alternatives 3 and 4 involve pumping the BPM production wells. No significant advantage in the projected timeframe for groundwater restoration is obtained by pumping at 30 gpm compared to the 20 gpm required to supply a fully operative mall and Meadow Park Road.

Alternative 5 involves pumping the BPM production wells at 15 gpm (to supply mall) plus a southeast downgradient onsite recovery well. This well (pumping at 15 to 20 gpm) provides a somewhat shorter projected timeframe for restoration of groundwater in its area near the eastern property boundary and on Meadow Park Road. This recovery well does not affect the projected timeframe for groundwater restoration at the BPM production wells.

The projected timeframe for overall onsite and offsite groundwater restoration under Alternatives 3, 4, and 5 is on the order of 20 years for the southeastern area, with the most marked reduction in concentrations achieved in the first 10 years of pumping.

Alternative 5 also incorporates a western downgradient onsite recovery well. The projected timeframe for groundwater remediation in the western site area is shortened by approximately 5 years by increasing the recovery well pumping rate from 5 gpm to 20 gpm.

6.0 DISCUSSION OF ANALYSIS AND RELATED ISSUES

The capture analysis provided above has been based on field derived values for aquifer transmissivity and hydraulic gradient which comprise the two variable inputs into the analysis. It is recognized that these estimates and the theoretical basis assume that the aquifer system being studied is homogeneous, isotropic, etc. In most aquifer systems, such assumptions are often simplistic.

It should be recognized in the implementation of pumping remedial alternatives, that adjustments will in all likelihood need to be made to pumping rates to ensure that capture/containment is effectuated. This will be accomplished by synoptic water-level measurement events during sustained pumping and the development of field-derived water-level contour maps and flow nets that will be used to document the extent of recovery well capture. For example, as stated in the RI, attaining capture on the western part of the site by BPM production wells pumping (Alternatives 3 and 4) is likely but less certain than in the southeastern area. Under these alternatives, in the event that containment of contaminated groundwater onsite in the western area is not evident by the field-derived flow nets, then such contingent steps as increasing the pumping rate of the BPM production wells or a western recovery well could be considered.

In this regard, the use of the mall production well system for groundwater recovery provides flexibility in terms of both the rates at which the wells can be pumped as well as the capacity of the treatment system. If a western recovery well is used, such flexibility should be provided for the pumping system.

The analytical solution in the Prickett model for groundwater flow is premised on homogeneous and isotropic aquifer conditions. The inherent uncertainties in contaminant transport modeling are principally associated with assumptions that are made for model input parameters such as retardation coefficients and dispersivity. In addition, for the western site area, hydraulic characteristics were not as clearly defined as for the southeastern site area. Further, the modeling effort for the southeast site area was calibrated to 15 years of PCE data for the BPM production wells whereas the western site model could only be calibrated to 1993/1994 RI monitoring data. As such, the southeastern site model is considered to have a more reliable basis for prediction than the western site model. The solute transport modeling provided a reasonable basis for comparing the different remedial alternatives with respect to relative timeframes for PCE concentrations to approach 5 ug/L onsite and offsite and at the recovery wells.

7.0 REFERENCES

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TABLE A-1: SUMMARY OF CAPTURE ZONE CALCULATIONS

Alternatives 1,3, and 4: BPM Production Wells Pumping.

Southeastern Site Area: Bedrock Aquifer

(BPM Production Wells)

T = 1,000 gpd/ft
I = 0.0158 ft/ft

Q	4 GPM	20 GPM	30 GPM
Xo	60 ft.	300 ft.	450 ft.
Yi	190 ft.	940 ft.	1400 ft.
Y	370 ft.	1850 ft.	2800 ft.

Alternative 5: BPM Production Wells at 15 GPM (Mall Demand); Recovery Well Near LBG-1; and Recovery Well in Western Site Area.

•BPM Production Wells

T = 1,000 gpd/ft
I = 0.0158 ft/ft

Q	15 GPM
Xo	225
Yi	700
Y	1400

•Recovery Well Near LBG-1

T = 1,000 gpd/ft
I = 0.0158 ft/ft

Q	15 GPM	20 GPM
Xo	225 ft.	300 ft.
Yi	700 ft.	940 ft.
Y	1400 ft.	1850 ft.

•Recovery Well: Western Site Area

T = 1,000/2,000 gpd/ft
I = 0.014 ft/ft

T = 1,000 gpd/ft

Q	5 GPM	10 GPM	15 GPM
Xo	80 ft.	160 ft.	250 ft.
Yi	250 ft.	500 ft.	780 ft.
Y	500 ft.	1000 ft.	1560 ft.

T = 2,000 gpd/ft

Q	5 GPM	10 GPM	15 GPM
Xo	40 ft.	80 ft.	120 ft.
Yi	125 ft.	250 ft.	390 ft.
Y	250 ft.	500 ft.	780 ft.

TABLE A-2. PCE MASS CALCULATIONS: SOURCE AREA
REMOVAL OF SOIL WITH PCE CONCENTRATION GREATER THAN 50 PPM.
(VOLUME 1)

AREA 1: 7 X 15 FT TO DEPTH OF 15 FT

AREA 2: 14 X 8 FT TO DEPTH OF 8 FT

AREA 1: INTERIOR OF ALLEYWAY

NORTHERN PORTION 7 X 10 FT. (TB-1 & TB-16)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
0 to 2	140	14,000	Assume 1,200	16.8
2 to 4	140	14,000	1,200	16.8
4 to 6	140	14,000	Assume 2,850	39.9
6 to 8	140	14,000	4,500	63.0
8 to 10	140	14,000	0.160	0.00224
10 to 12	140	14,000	500	7.0
12 to 14	140	14,000	270	3.78
14 to 15	70	7,000	1,300	9.1
	1,050	105,000		156.38

SOUTHERN PORTION 7 X 5 FT. (TB-25)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
0 to 2	70	7,000	0.036	0.00025
2 to 4	70	7,000	0.094	0.00066
4 to 6	70	7,000	0.015	0.00011
6 to 8	70	7,000	Assume 0.018	0.00013
8 to 10	70	7,000	0.021	0.00015
10 to 12	70	7,000	Assume 550	3.85
12 to 14	70	7,000	1,100	7.7
14 to 15	35	3,500	Assume 550	1.93
	525	52,500		13.48

AREA 2: NORTH SIDE OF ALLEYWAY

EAST OF AREA 1 14 X 8 FT. (TB-2, TB-8 & TB-23)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
0 to 2	224	22,400	295	6.61
2 to 4	224	22,400	660	14.78
4 to 6	224	22,400	139	3.11
6 to 8	224	22,400	410	9.18
	896	89,600		33.68

TOTAL VOLUME OF SOIL = 2,471 cu ft =92 cu yds
TOTAL MASS PCE = 203.54 lbs

TABLE A-2. PCE MASS CALCULATIONS: SOURCE AREA REMOVAL OF SOIL WITH PCE CONCENTRATION GREATER THAN 10 PPM. (VOLUME 2)

AREA 1: 7 X 15 FT TO DEPTH OF 15 FT
AREA 2: 14 X 8 FT TO DEPTH OF 10 FT
AREA 3: 3 X 8 FT TO DEPTH OF 10 FT
AREA 4: 17 X 4 FT TO DEPTH OF 10 FT

AREA 3: EXTENSION ON NORTH SIDE OF ALLEYWAY

EXTENSION OUT EAST OF AREA 2 3 X 8 FT. (TB-17)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
0 to 2	48	4,800	0.130	0.00062
2 to 4	48	4,800	0.160	0.000768
4 to 8	96	9,600	Assume 22	0.21
8 to 10	48	4,800	43	0.21
	240	24,000		0.42

EXTENSION OF DEPTH OF AREA 2 14 X 8 FT. (TB-2, TB-8 & TB-23)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS OF PCE (lbs)
8 to 10	224	22,400	0.014	0.00031

AREA 4: EXTENSION TO SOUTH OF AREAS 2 AND 3 17 X 4 FT. (TB-7 & TB-9)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
0 to 2	136	13,600	12	0.163
2 to 4	136	13,600	0.008	0.000109
4 to 6	136	13,600	0.073	0.000993
6 to 10	272	27,200	Assume 0.073	0.001990
	680	68,000		0.166

TOTAL VOLUME OF SOIL = 2,741+1,144= 3,615 cu ft = 134 cu yds
TOTAL MASS PCE = 204.13 lbs

TABLE A-2. PCE MASS CALCULATIONS: SOURCE AREA

CONSERVATIVE REMOVAL INCLUDING SOIL WITH PCE CONCENTRATION GREATER THAN 1.4 PPM.

(VOLUME 3)

AREA 1: 7 X 15 FT TO DEPTH OF 16 FT

AREA 2: 14 X 8 FT TO DEPTH OF 15 FT

AREA 3: 3 X 8 FT TO DEPTH OF 22 FT

AREA 4: 17 X 4 FT TO DEPTH OF 15 FT

EXTENSION OF DEPTH OF AREA 1 7 X 15 FT. (TB-1, TB-16 & TB-25)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
15 to 16	105	10,500	1.8	0.0189

EXTENSION OF DEPTH OF AREA 2 14 X 8 FT. (TB-2, TB-8 & TB-23)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
10 to 12	224	22,400	0.020	0.00045
12 to 14	224	22,400	0.018	0.00040
14 to 15	112	11,200	Assume 0.009	0.00010
	560	56,000		0.00095

EXTENSION OF DEPTH OF AREA 3 3 X 8 FT. (TB-17)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
10 to 14	96	9,600	Assume < 10	0.096
14 to 16	48	4,800	0.190	0.00091
16 to 18	48	4,800	2.2	0.0106
18 to 20	48	4,800	1.7	0.0082
20 to 22	48	4,800	6.1	0.029
	288	28,800		0.145

EXTENSION OF DEPTH OF AREA 4 17 X 4 FT. (TB-7 & TB-9)

DEPTH INTERVAL (feet)	VOLUME OF SOIL (cubic feet)	MASS OF SOIL (lbs)	PCE CONCENTRATION (ppm)	MASS of PCE (lbs)
10 to 14	272	27,200	Assume 0.5165	0.0140
14 to 15	68	6,800	0.960	0.00653
	340	34,000		0.0205

TOTAL VOLUME OF SOIL = 3,615+1,293= 4,908 cu ft = 182 cu yds
TOTAL MASS PCE = 204.32 lbs

TABLE A-3: MODEL INPUT PARAMETERS; TILL MODEL

Present Mass Transport Coefficients	
Transmissivity	2.5 gpd/ft
Storage Coefficient	0.05
Hydraulic Conductivity	0.05 gpd/ft^2
Effective Aquifer Porosity	0.05
Retardation Coefficient	2.5
X Component of Aquifer Pore Velocity	0.034 ft/day
Y Component of Aquifer Pore Velocity	0 ft/day
Particle Mass	0.009 Weight in Lbs./Particle
Species Half Life	5 years
Dispersivity Model is ASYMPTOTIC	
Asymptotic Dispersivity (AD)	70 feet
Mean Travel Distance Corresponding to AD/2	200 feet
Ratio of Longitudinal to Transverse Dispersivity	5

Table A - 4: Actual and Modeled PCE Concentrations in MW-11S, MW-11D, and MW-5D

Monitoring Well	Actual Concentration (ug/L)	Modeled Concentration (ug/L)
MW-11S	24,000	22,000
MW-11D	3,200	~4000
MW-5D	1,000	1,000

Table A-5: Simulated PCE Concentrations in Source Area Recovery Wells; Alternatives 4 and 5.

Source Area Volumes Removed	Recovery Well PCE Concentrations in ug/L							
	5 Years Recovery Wells		10 Years Recovery Wells		15 Years Recovery Wells		20 Years Recovery Wells	
	RW-1	RW-2	RW-1	RW-2	RW-1	RW-2	RW-1	RW-2
Volume 1 (> 50 ppm)	183	92	3	16	0	8	0	1
Volume 3 (> 10 & 1.4 ppm)	168	92	3	14	0	3		

RW-1 = Shallow Till Recovery Well.
RW-2 = Deep Recovery Well

Table A-6 Comparison of Source Area Alternatives

Remedial Alternative		Approximate Time Periods For Groundwater Remediation in Till Underlying Source Area. < 500 μg/L PCE	< 5 μg/L PCE
3. Excavate Source Area			
	3.1 Volume 1 (> 50 ppm)	15 Years	25 - 30 Years
	3.2 Volume 3 (> 10 & 1.4 ppm)	15 Years	25 - 30 Years
4. & 5. Excavate Source Area and Source Area Recovery Wells			
	4.1 Volume 1 (> 50 ppm)	< 5 Years	10 - 15 Years
	4.2 Volume 3 (>10 & 1.4 ppm)	< 5 Years	10 - 15 Years

Table A-7. Timeframe for Groundwater Restoration to 5 ug/L; Bedrock Aquifer Southeastern Site Area: 1,000 Year Half-Life Model.

FS Alternative	BPM Wells at 4 gpm	BPM Wells at 15 gpm	BPM Wells at 20 gpm	BPM Wells at 30 gpm	On-Site Downgradient Recovery Well at 15 gpm	On-Site Downgradient Recovery Well at 20 gpm	On-Site Groundwater	Meadow Park Road
1	NS	NS	NS	NS	NS	NS	NS	NS
3	NS	NS	24 to 25 yrs.	24 to 25 yrs.	NS	NS	~24 to 25 yrs.	>20 yrs.
4	NS	NS	24 to 25 yrs.	23 to 25 yrs.	NS	NS	~24 to 25 yrs.	>20 yrs.
5	NS	~25 yrs.	NS	NS	14 yrs.	14 yrs.	~14 to 25 yrs.	>20 yrs.

NS = Not Simulated

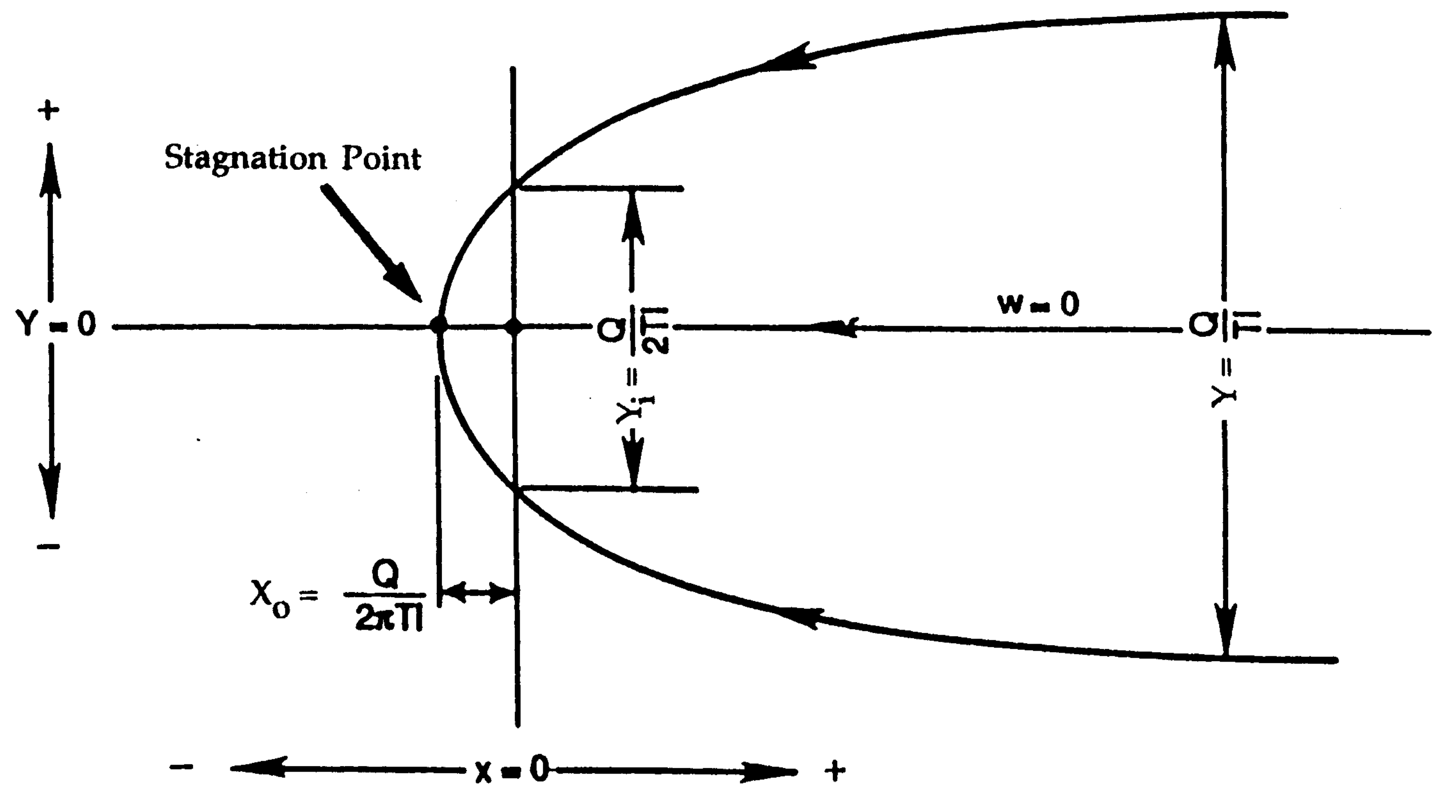
Table A-8. Timeframe for Groundwater Restoration to 5 ug/L; Bedrock Aquifer Southeastern Site Area: 11 Year Half-Life Model.

FS Alternative	BPM Wells at 4 gpm	BPM Wells at 15 gpm	BPM Wells at 20 gpm	BPM Wells at 30 gpm	On-Site Downgradient Recovery Well at 15 gpm	On-Site Downgradient Recovery Well at 20 gpm	On-Site Groundwater	Meadow Park Road
1	40 yrs.	NS	NS	NS	NS	NS	~40 yrs.	>40 yrs.
3	NS	NS	17 to 18 yrs.	17 to 18 yrs.	NS	NS	~17 to 18 yrs.	~20 yrs.
4	NS	NS	15 to 17 yrs.	15 to 17 yrs.	NS	NS	~15 to 17 yrs.	~20 yrs.
5	NS	15 to 17 yrs.	NS	NS	~10 yrs.	~10 yrs.	~10 to 17 yrs.	~15 to 20 yrs.

NS = Not Simulated

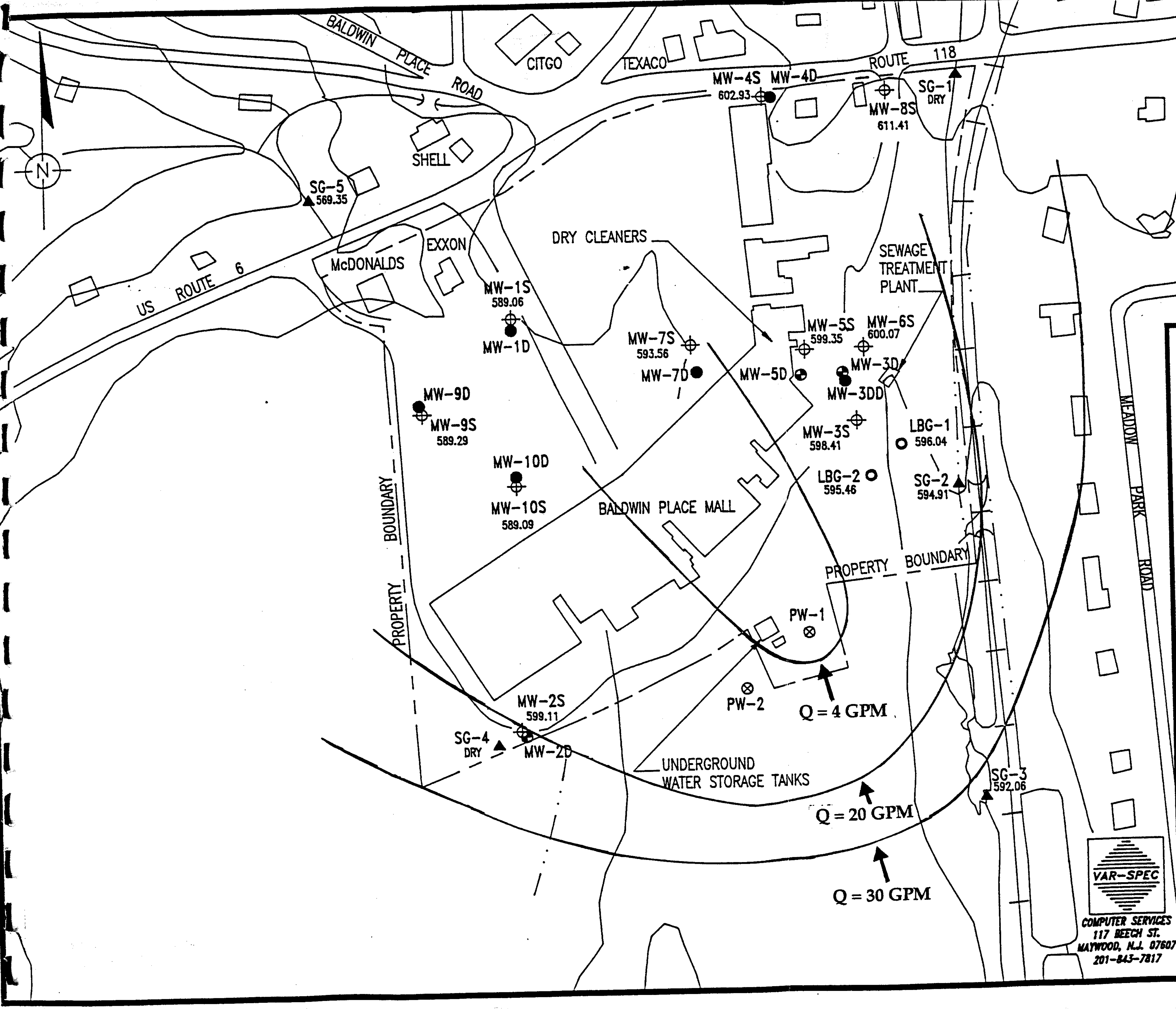
Table A-9. Timeframe for Groundwater Restoration to 5 ug/L; Bedrock Aquifer Western Recovery Well.

FS Alternative	at 5 gpm	at 10 gpm	at 15 gpm	at 20 gpm
1,000 Year Half-Life Model.				
5	29 to 30 yrs.	29 to 30 yrs.	26 to 27 yrs.	24 to 25 yrs.
11 Year Half-Life Model.				
5	26 to 27 yrs.	24 to 25 yrs.	23 to 24 yrs.	21 to 22 yrs.



Adapted From: Gorelick et. al. 1993. "Groundwater Contamination; Optimal Capture and Containment." Lewis Publishers. Page 127.

A - 1. Capture Zone Analysis Equations



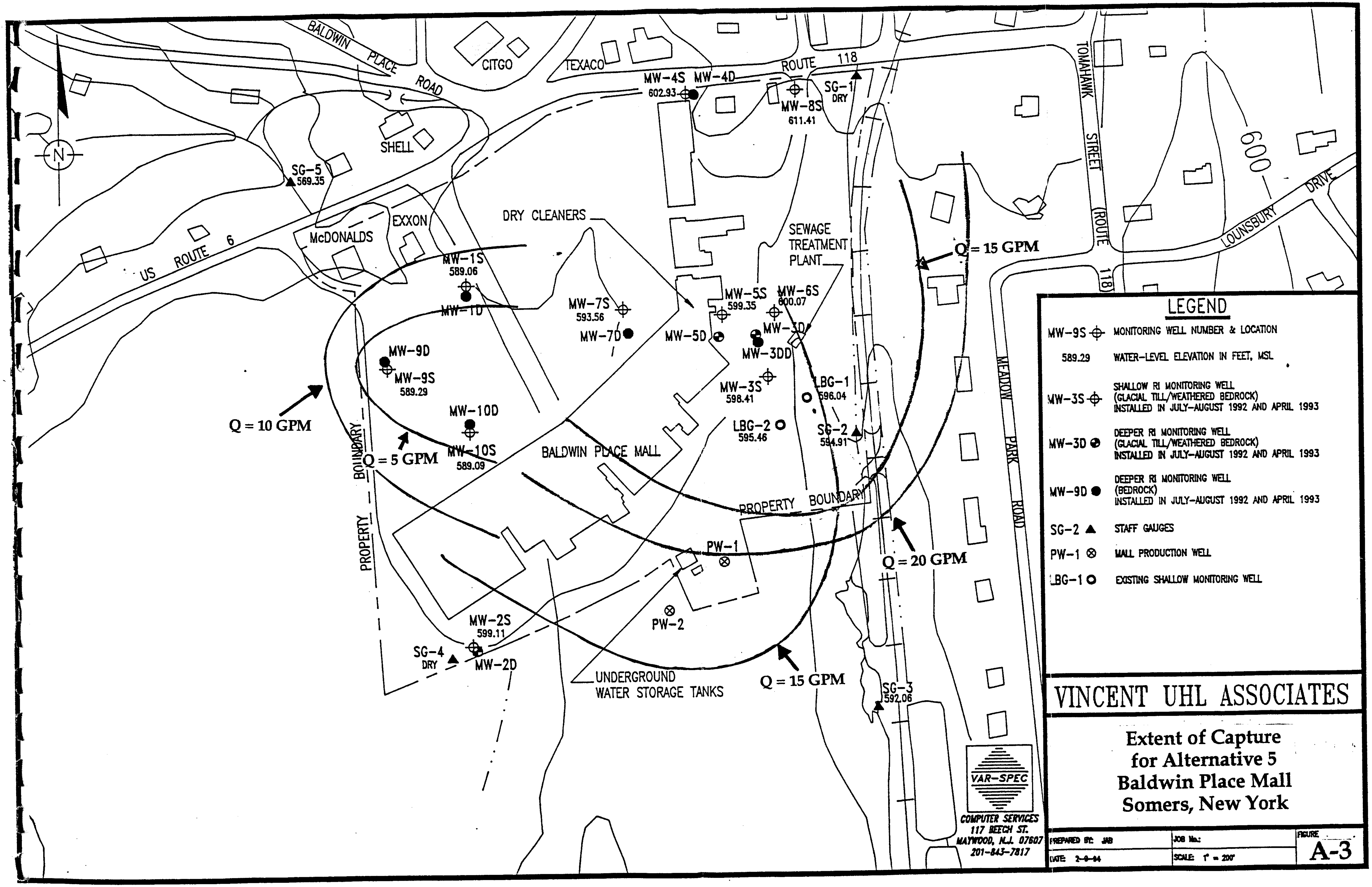
LEGEND

MW-9S ⌖	MONITORING WELL NUMBER & LOCATION
589.29	WATER-LEVEL ELEVATION IN FEET, MSL
MW-3S ⌖	SHALLOW RI MONITORING WELL (GLACIAL TILL/WEATHERED BEDROCK) INSTALLED IN JULY-AUGUST 1992 AND APRIL 1993
MW-3D ◉	DEEPER RI MONITORING WELL (GLACIAL TILL/WEATHERED BEDROCK) INSTALLED IN JULY-AUGUST 1992 AND APRIL 1993
MW-9D ●	DEEPER RI MONITORING WELL (BEDROCK) INSTALLED IN JULY-AUGUST 1992 AND APRIL 1993
SG-2 ▲	STAFF GAUGES
PW-1 ⊗	MALL PRODUCTION WELL
LBG-1 ○	EXISTING SHALLOW MONITORING WELL

VINCENT UHL ASSOCIATES

Extent of Capture for Alternatives 1, 3 & 4 Baldwin Place Mall Somers, New York

PREPARED BY: JAB	JOB No.:	FIGURE A-2
DATE: 2-8-94	SCALE: 1" = 200'	



BALDWIN PLACE ROAD
CITGO
TEXACO
SHELL
EXXON
McDONALDS
US ROUTE 6
ROUTE 118
TOMAHAWK STREET (ROUTE 118)
LOUNSBURY DRIVE
MEADOW PARK ROAD
600
N
SG-5 569.35
MW-4S MW-4D 602.93
MW-8S 611.41
SG-1 DRY
DRY CLEANERS
SEWAGE TREATMENT PLANT
MW-1S 589.06
MW-1D
MW-7S 593.56
MW-7D
MW-5D
MW-5S 599.35
MW-6S 600.07
MW-3D
MW-3DD
MW-3S 598.41
LBG-1 596.04
LBG-2 595.46
SG-2 594.91
MW-9D
MW-9S 589.29
MW-10D
MW-10S 589.09
Q = 10 GPM
Q = 5 GPM
Q = 15 GPM
Q = 20 GPM
Q = 15 GPM
BALDWIN PLACE MALL
PROPERTY BOUNDARY
PROPERTY BOUNDARY
PW-1
PW-2
MW-2S 599.11
MW-2D
SG-4 DRY
UNDERGROUND WATER STORAGE TANKS
SG-3 592.06
LEGEND
MW-9S MONITORING WELL NUMBER & LOCATION
589.29 WATER-LEVEL ELEVATION IN FEET, MSL
MW-3S SHALLOW RI MONITORING WELL (GLACIAL TILL/WEATHERED BEDROCK) INSTALLED IN JULY-AUGUST 1992 AND APRIL 1993
MW-3D DEEPER RI MONITORING WELL (GLACIAL TILL/WEATHERED BEDROCK) INSTALLED IN JULY-AUGUST 1992 AND APRIL 1993
MW-9D DEEPER RI MONITORING WELL (BEDROCK) INSTALLED IN JULY-AUGUST 1992 AND APRIL 1993
SG-2 STAFF GAUGES
PW-1 MALL PRODUCTION WELL
LBG-1 EXISTING SHALLOW MONITORING WELL
VAR-SPEC
COMPUTER SERVICES
117 BEECH ST.
MAYWOOD, N.J. 07607
201-843-7817
VINCENT UHL ASSOCIATES
Extent of Capture
for Alternative 5
Baldwin Place Mall
Somers, New York
PREPARED BY: JAB
DATE: 2-8-94
JOB No.:
SCALE: 1" = 200'
FIGURE
A-3

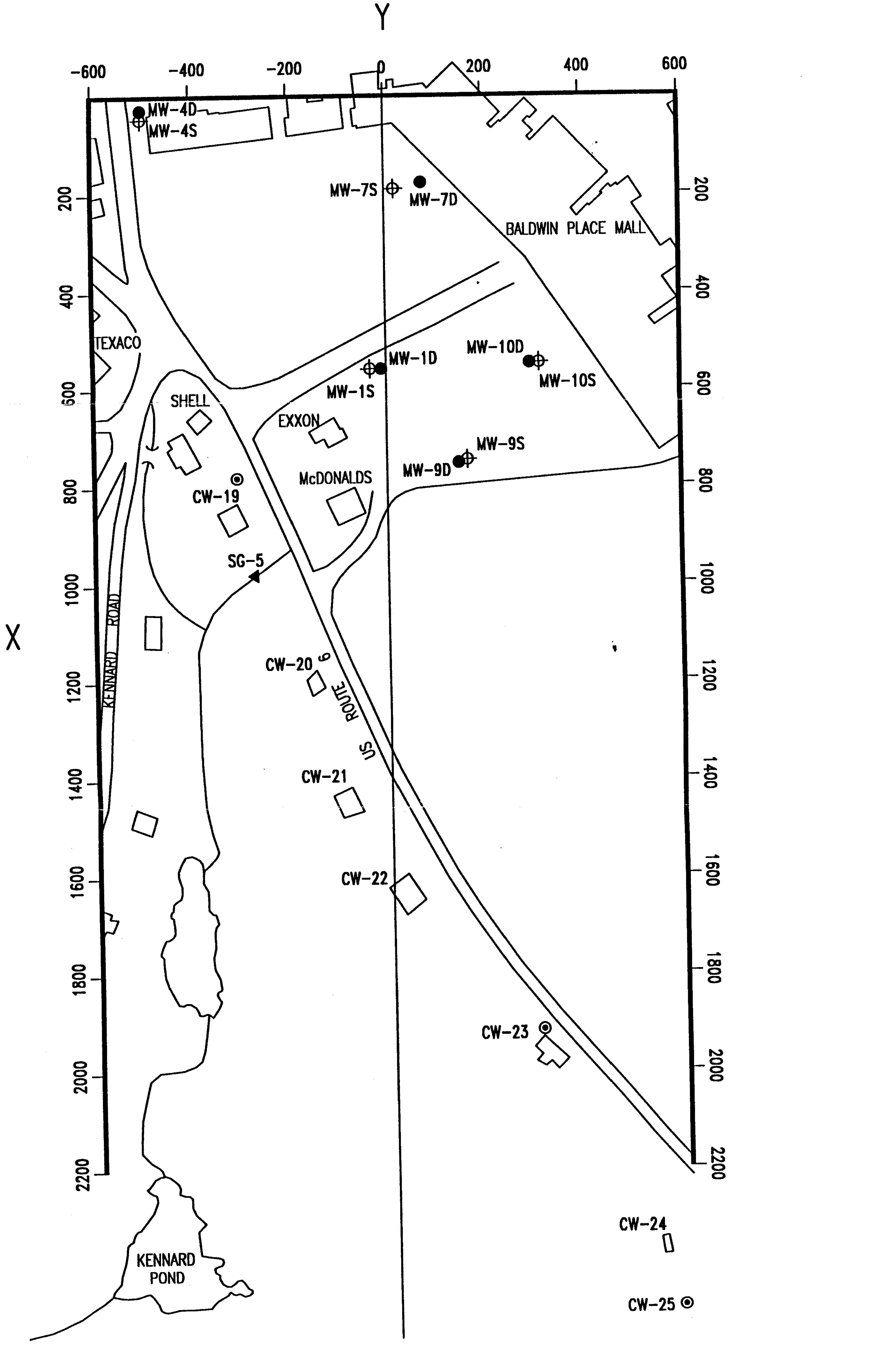


FIGURE A-4B
MODEL GRID: WESTERN SITE AREA: BEDROCK AQUIFER.

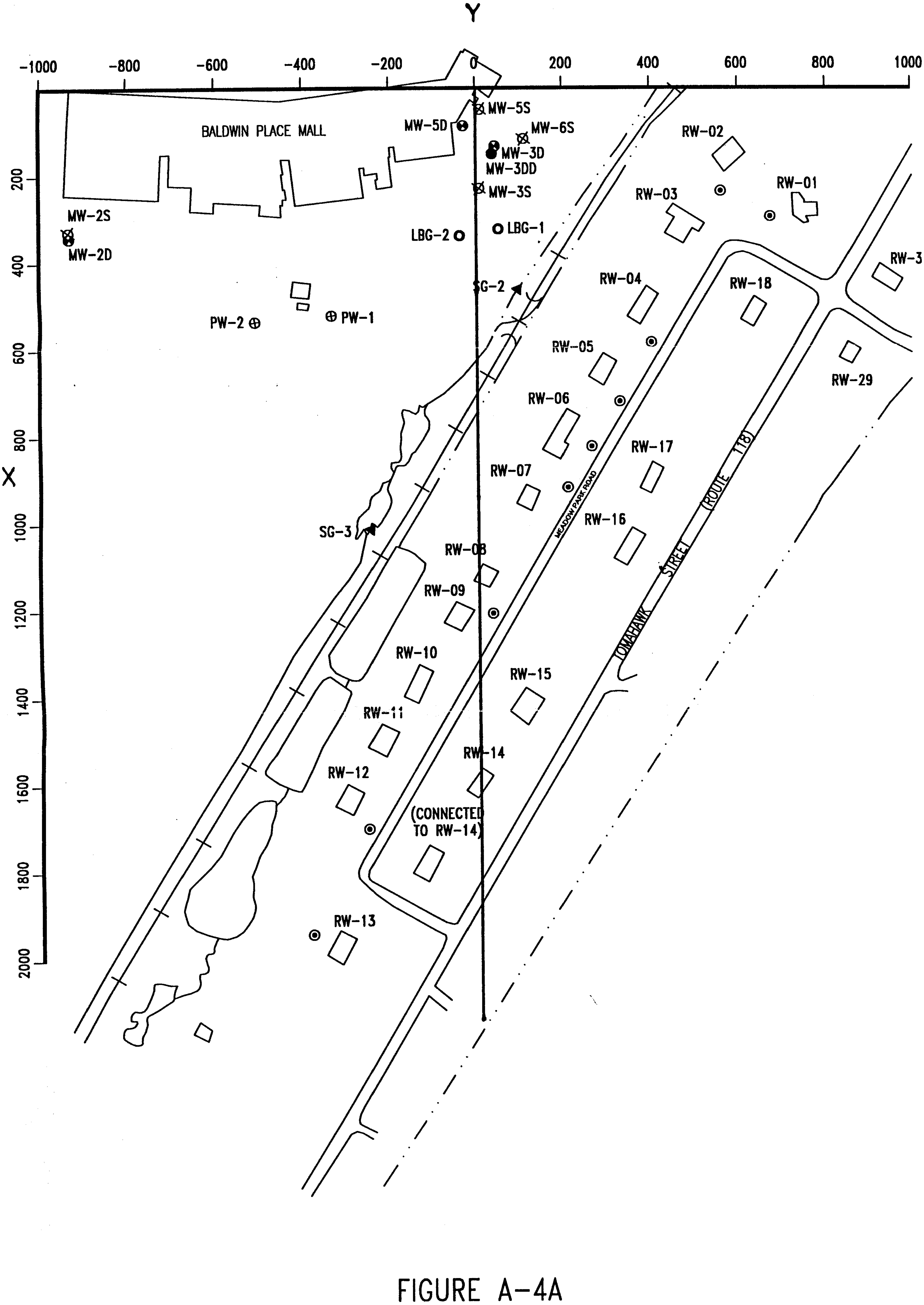


FIGURE A-4A
MODEL GRID: SOUTHEASTERN SITE AREA: BEDROCK AQUIFER.

Figure A-5
Modeled vs. Actual (1000 year HL)

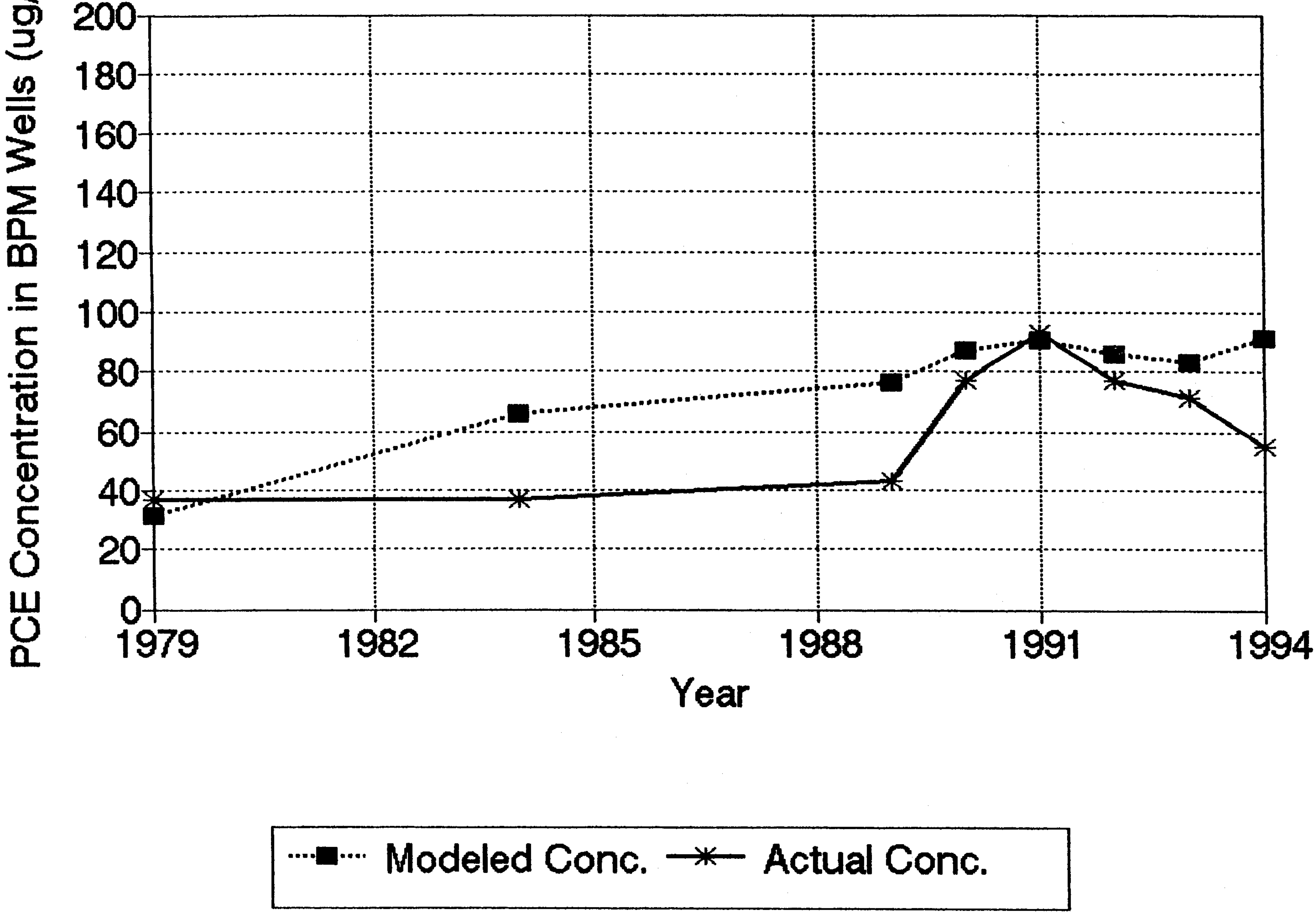


Figure A-6
Modeled vs. Actual (11 year HL)

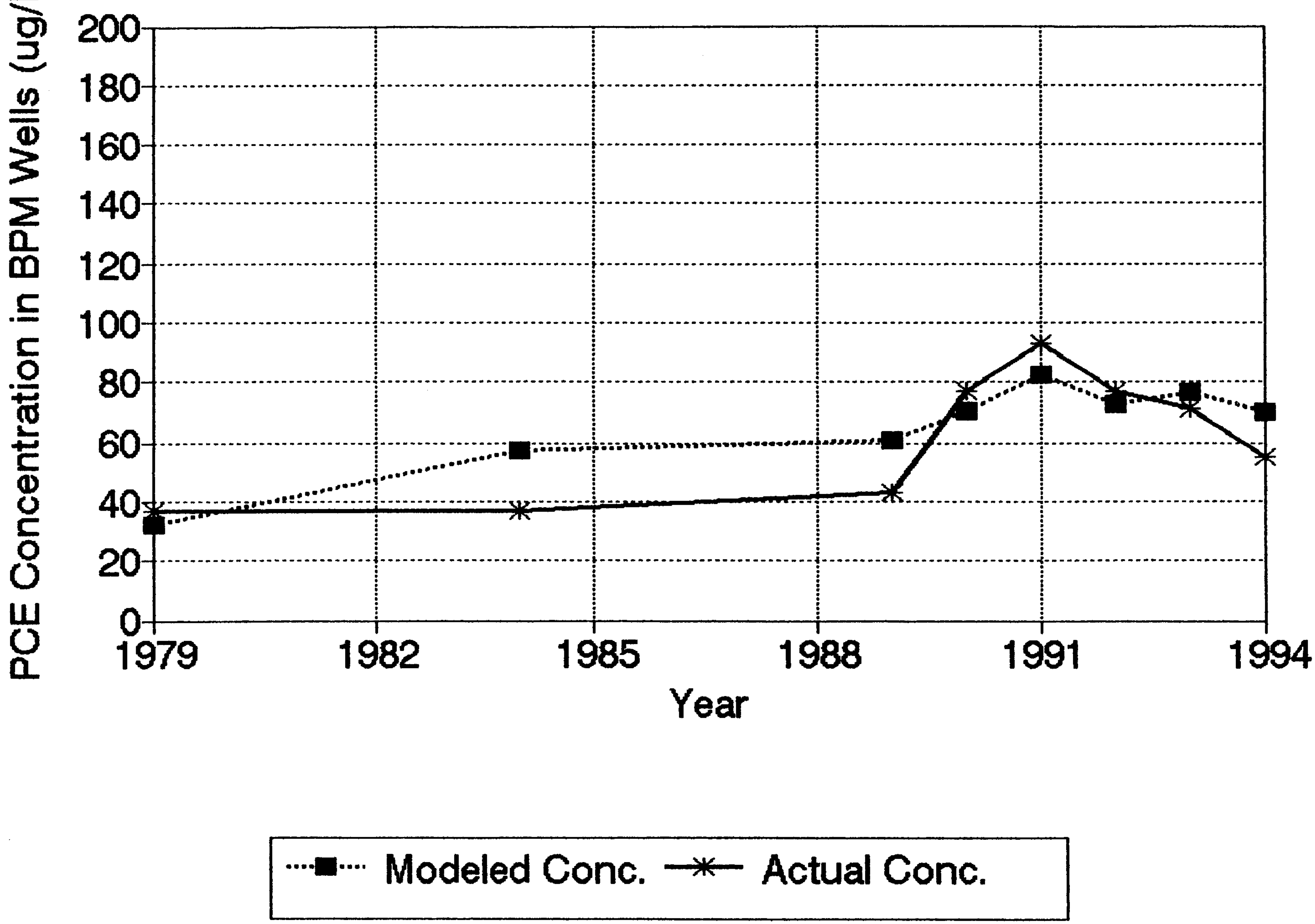


Figure A-7. Simulated PCE in BPM Wells FS Alternative 1 (No Action)

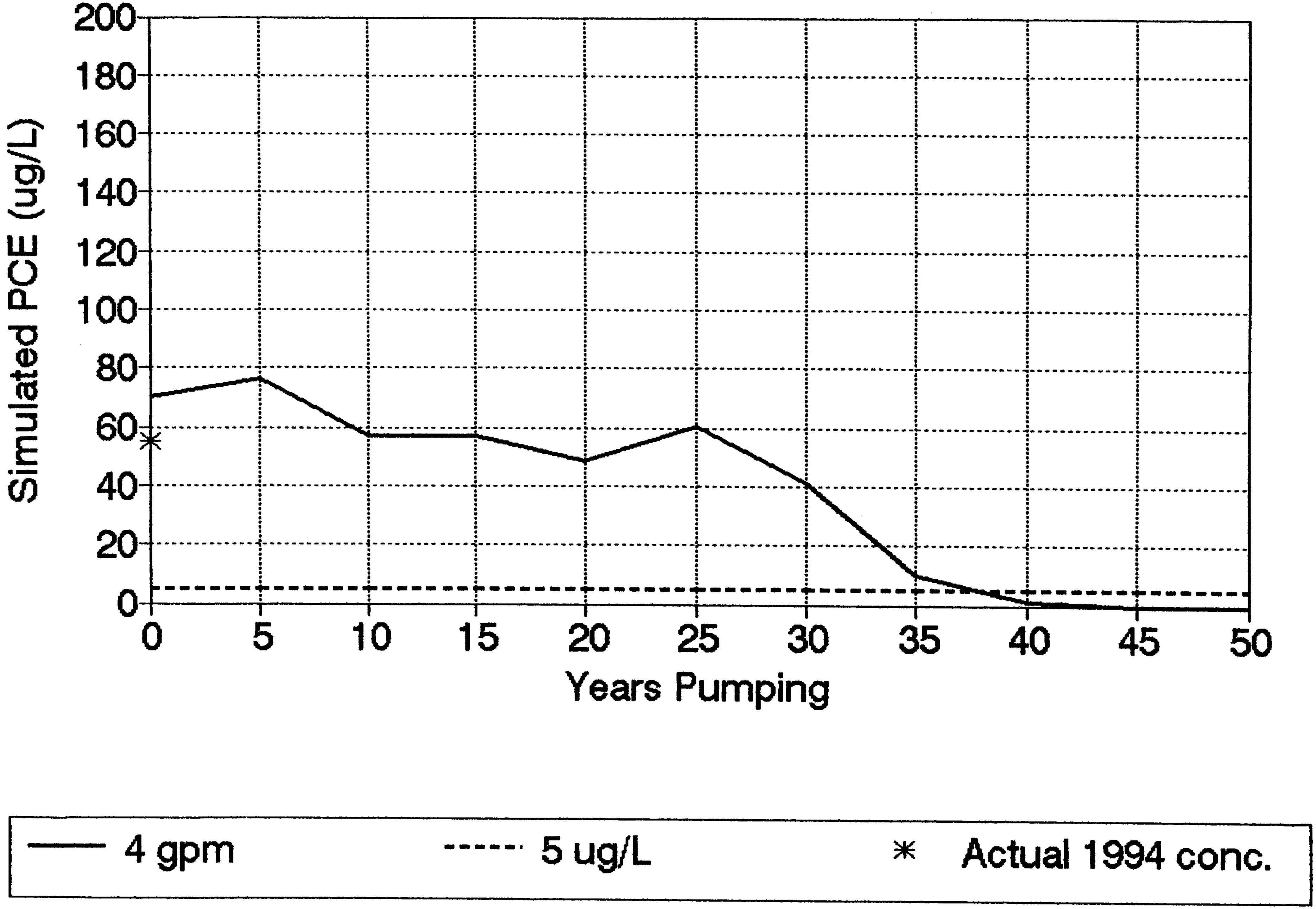


Figure A-8. Simulated PCE in BPM Wells
FS Alternative 3 (20 gpm)

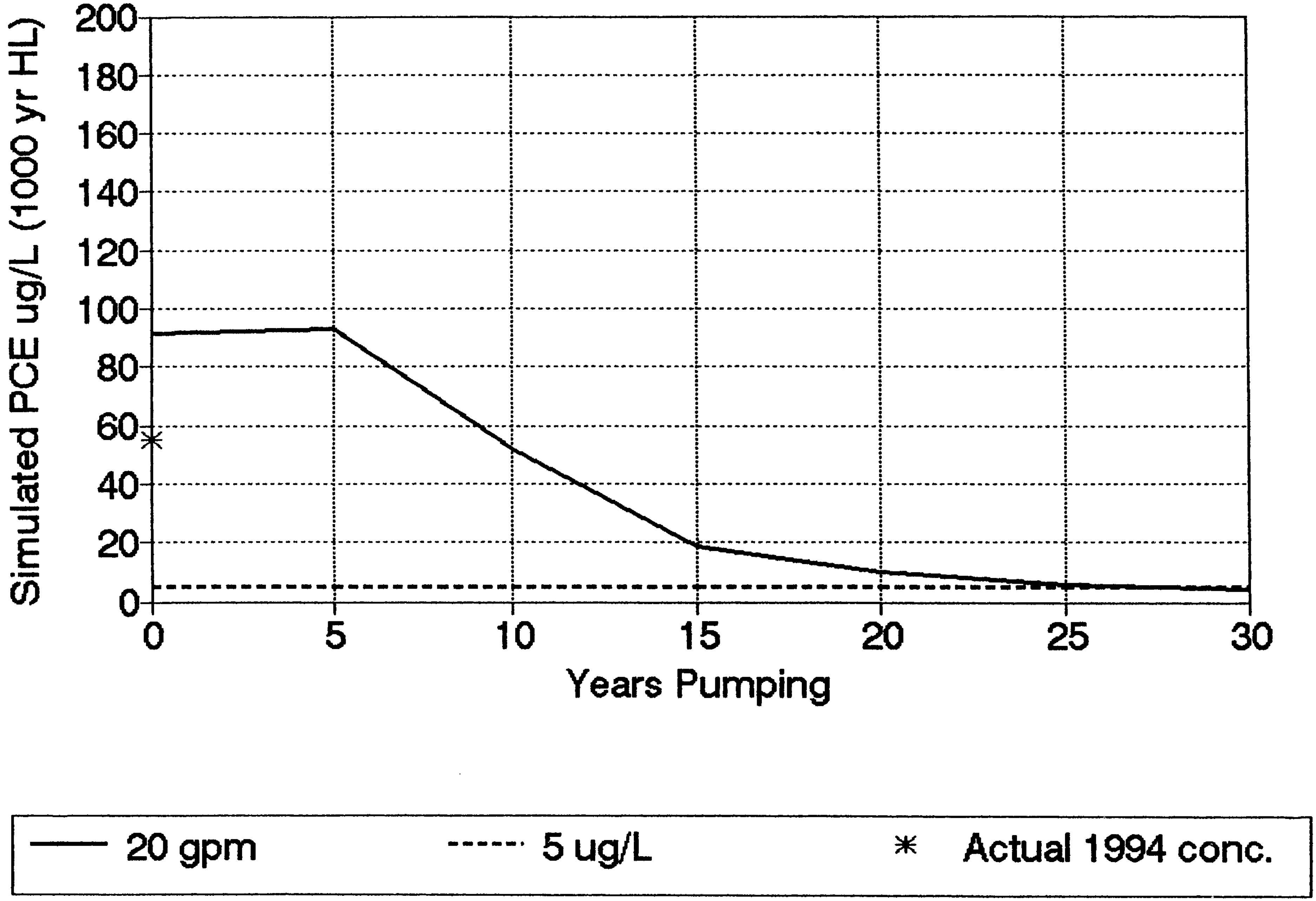


Figure A-9. Simulated PCE in BPM Wells
FS Alternative 3 (30 gpm)

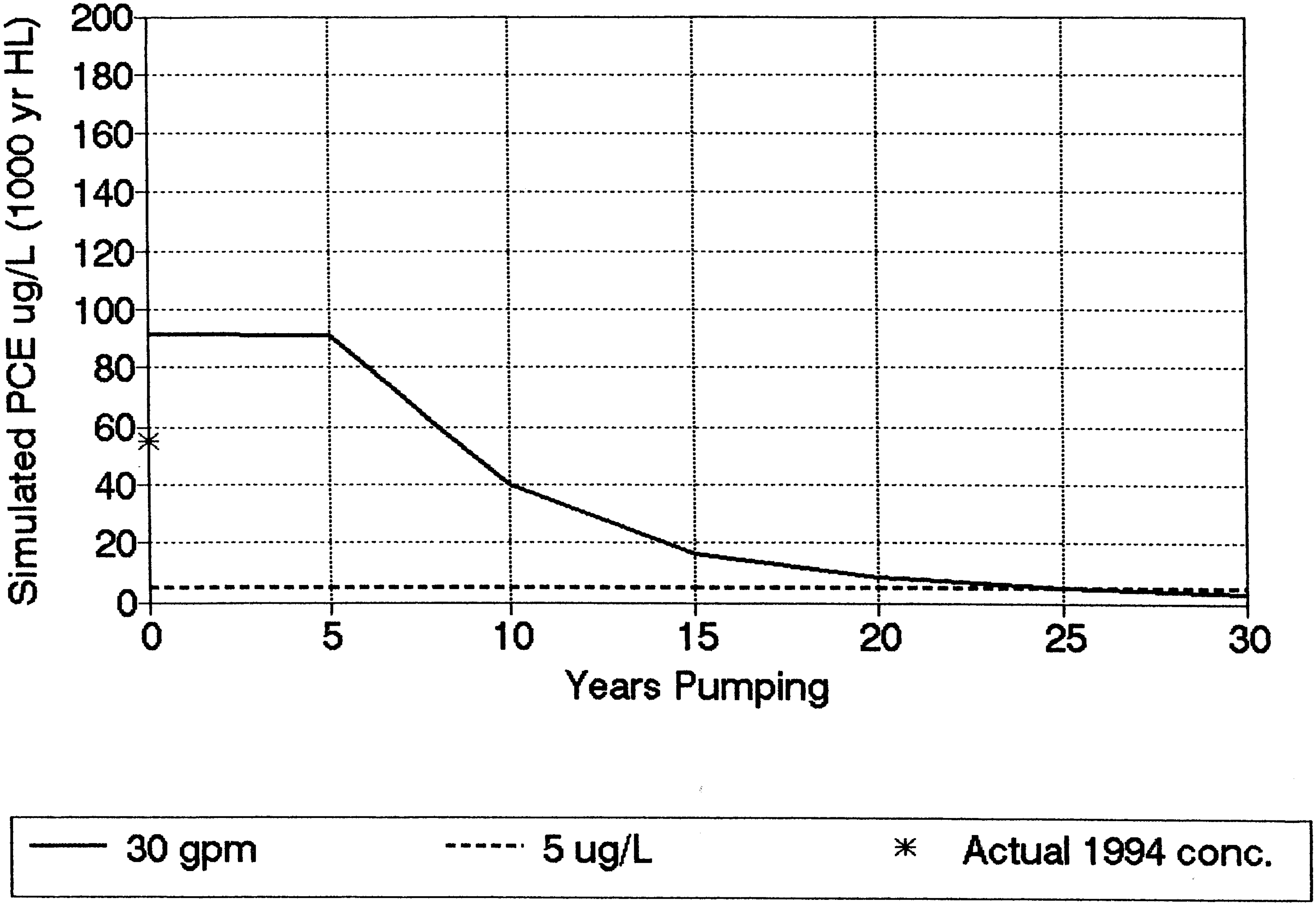


Figure A-10. Simulated PCE in BPM Wells
FS Alternative 3 (20 gpm)

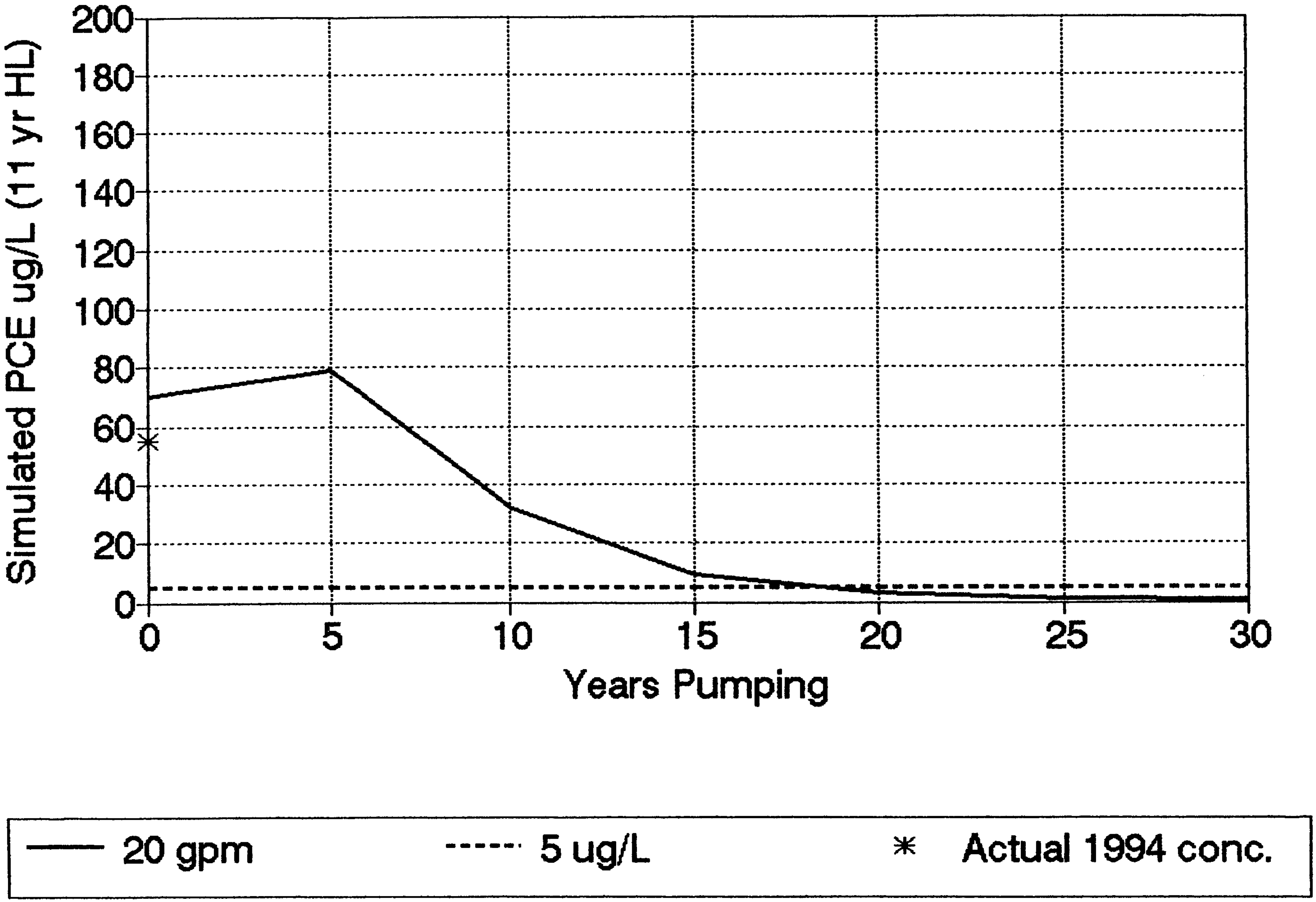


Figure A-11. Simulated PCE in BPM Wells
FS Alternative 3

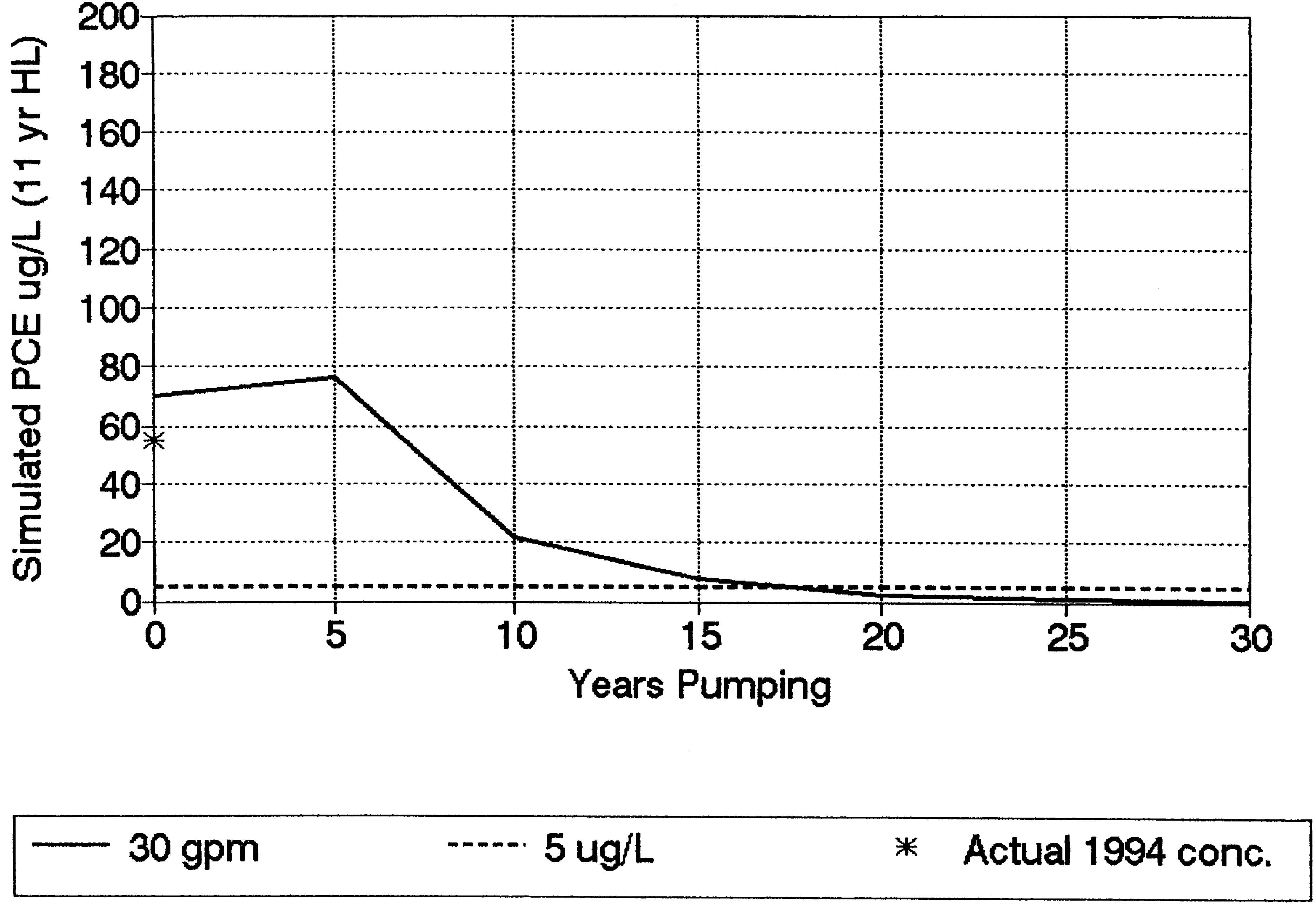


Figure A-12. Simulated PCE in BPM Wells
FS Alternative 4 (20 gpm)

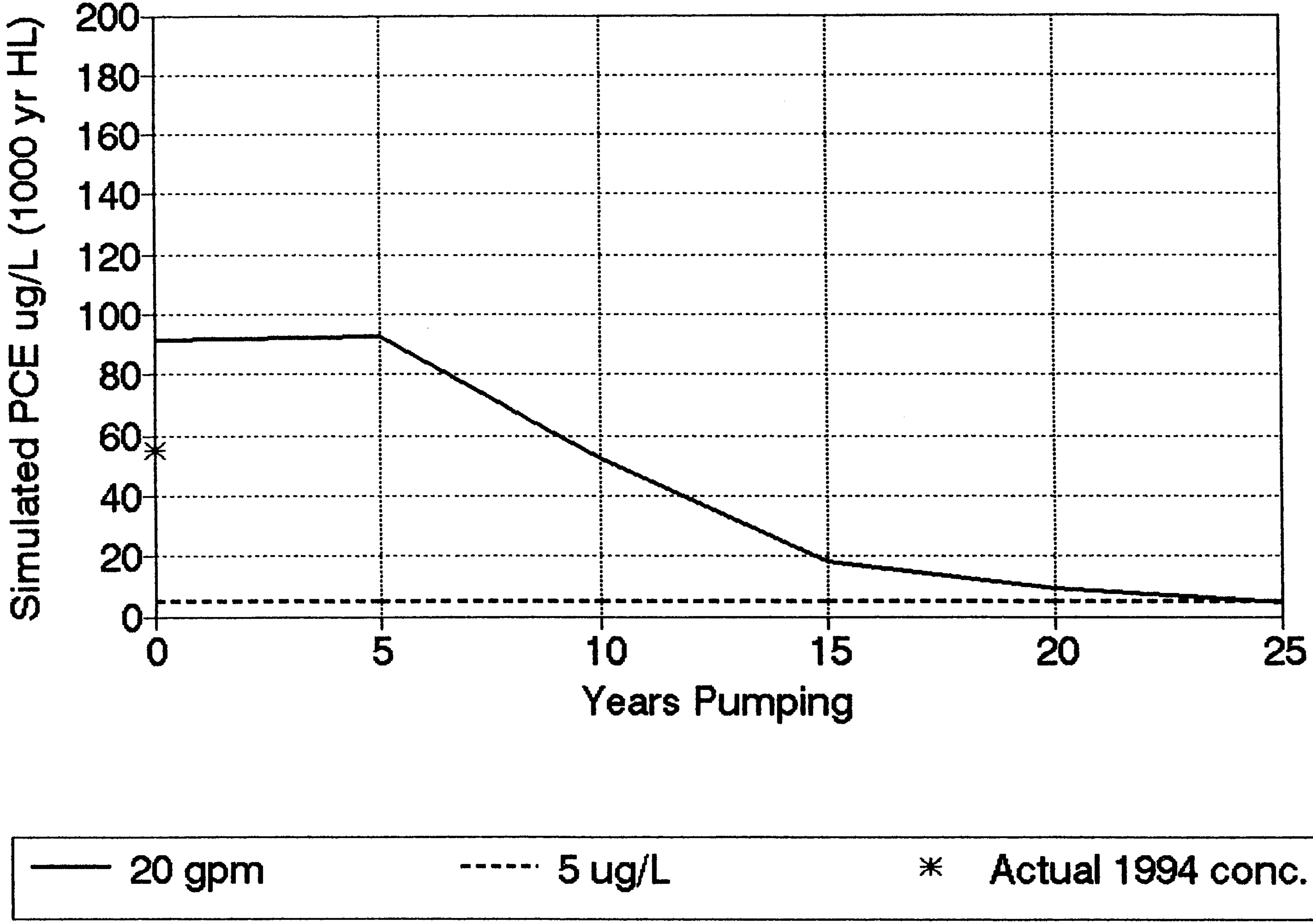


Figure A-13. Simulated PCE in BPM Wells
FS Alternative 4 (30 gpm)

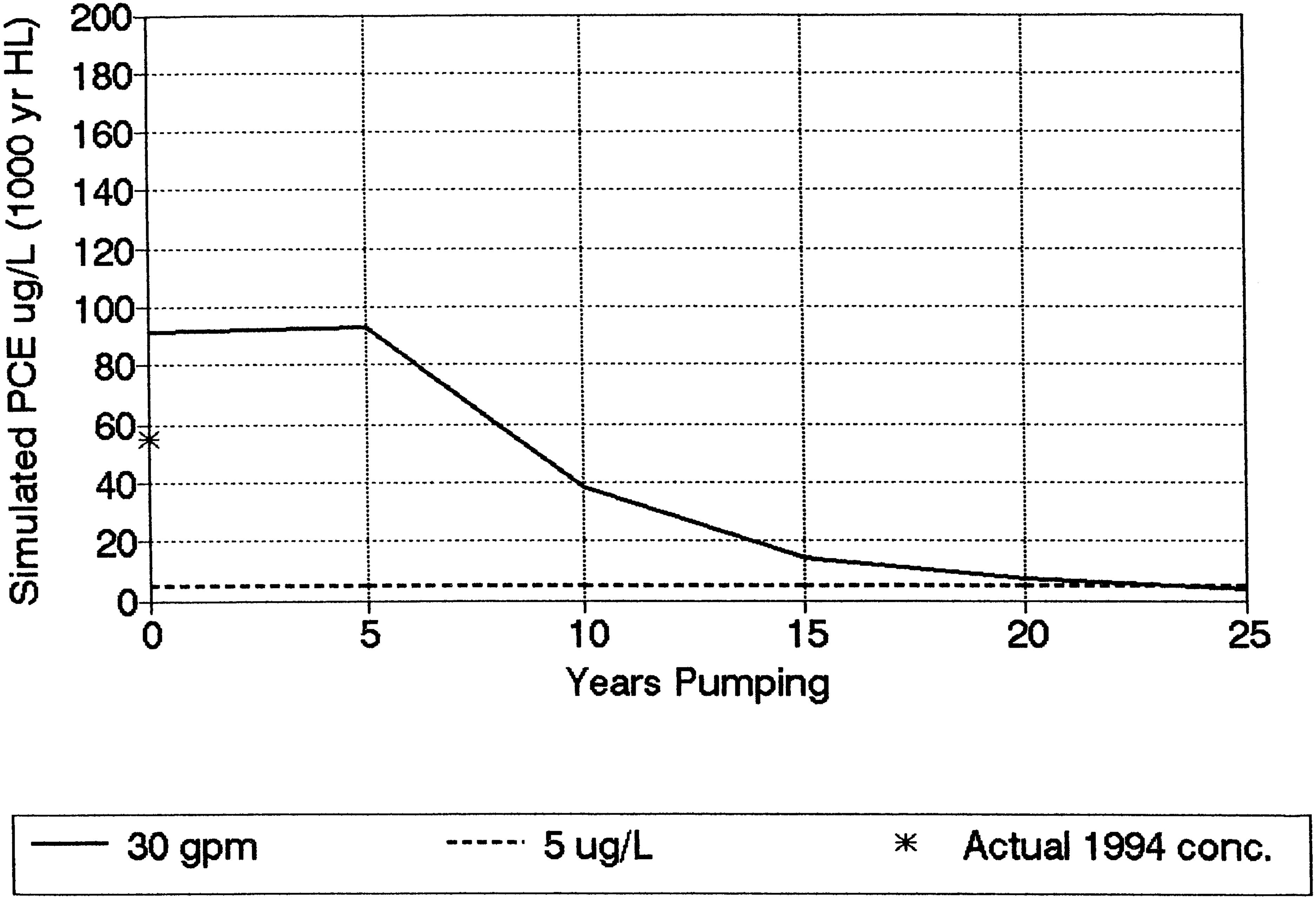


Figure A-14. Simulated PCE in BPM Wells
FS Alternative 4 (20 gpm)

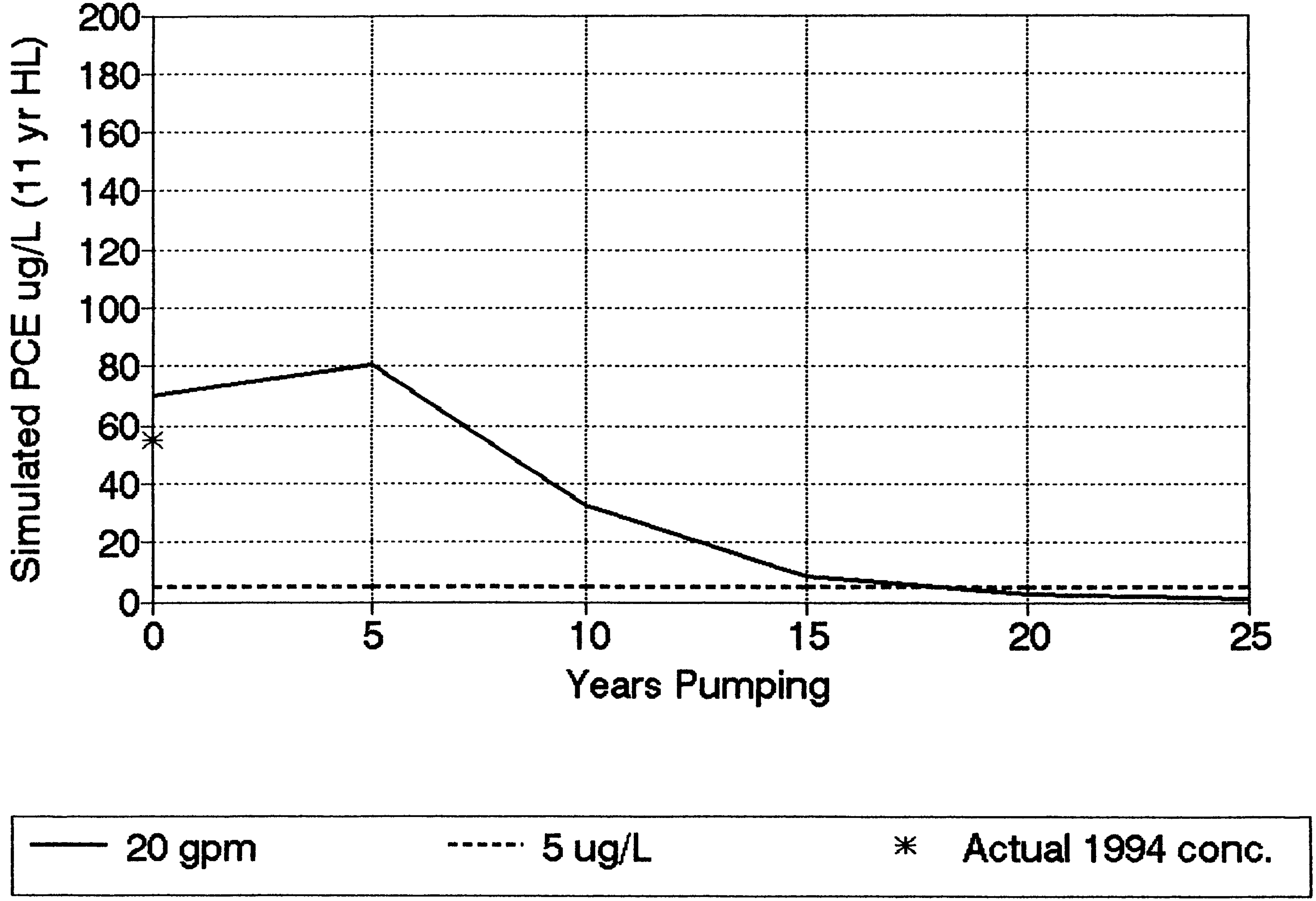


Figure A-15. Simulated PCE in BPM Wells
FS Alternative 4 (30 gpm)

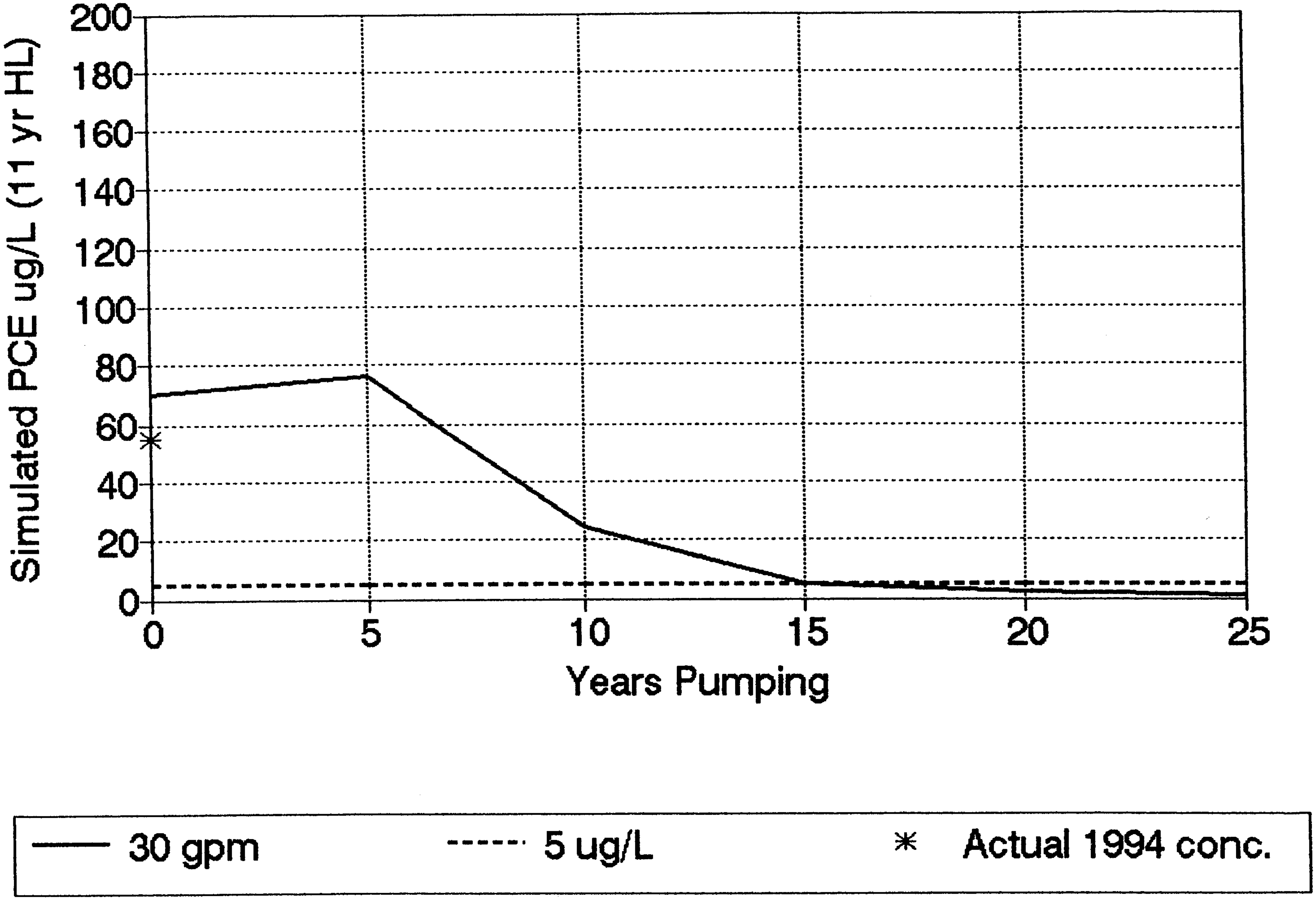


Figure A-16. Simulated PCE in BPM Wells And SE Recovery Well; FS Alternative 5

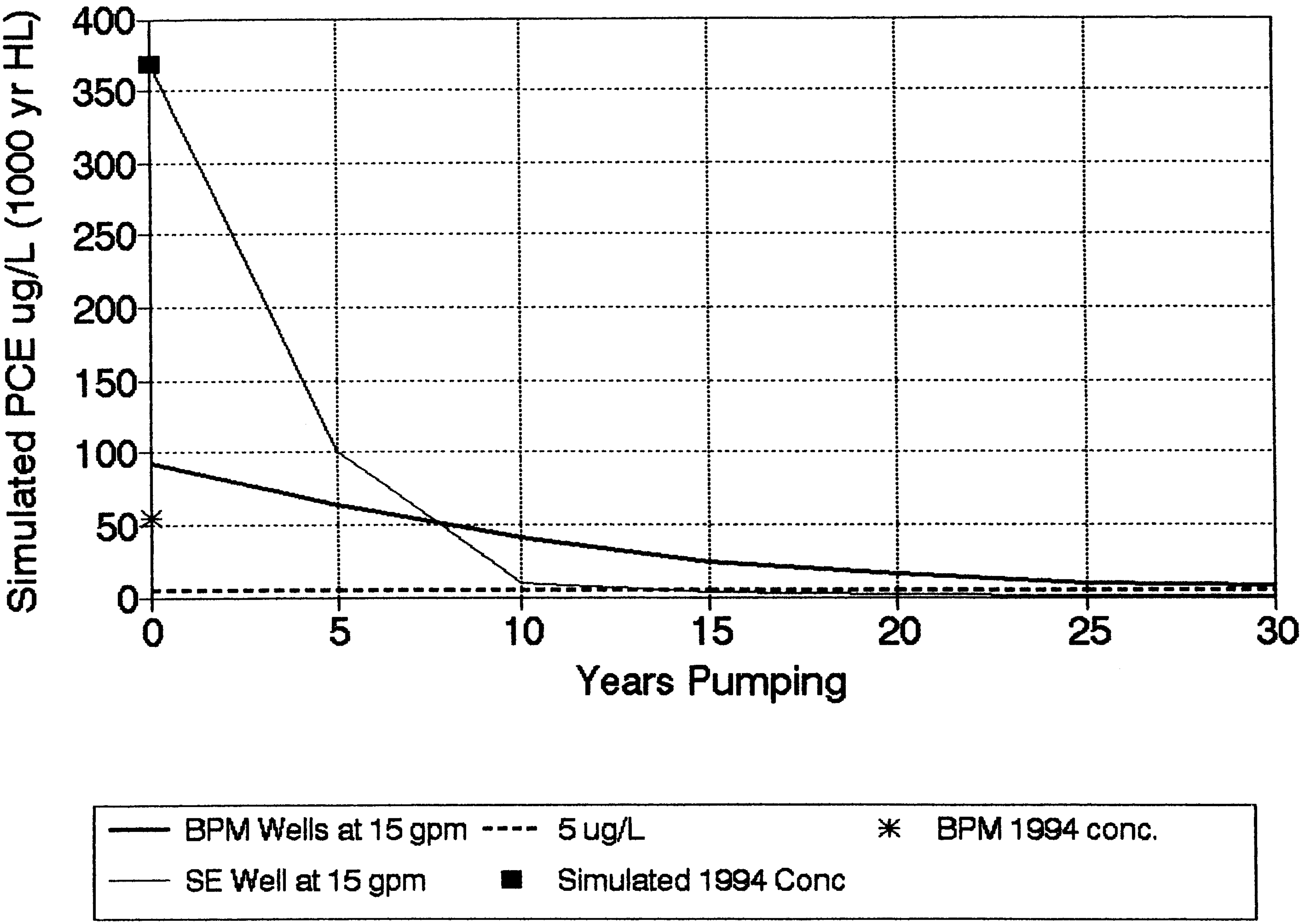


Figure A-17. Simulated PCE in BPM Wells And SE Recovery Well; FS Alternative 5

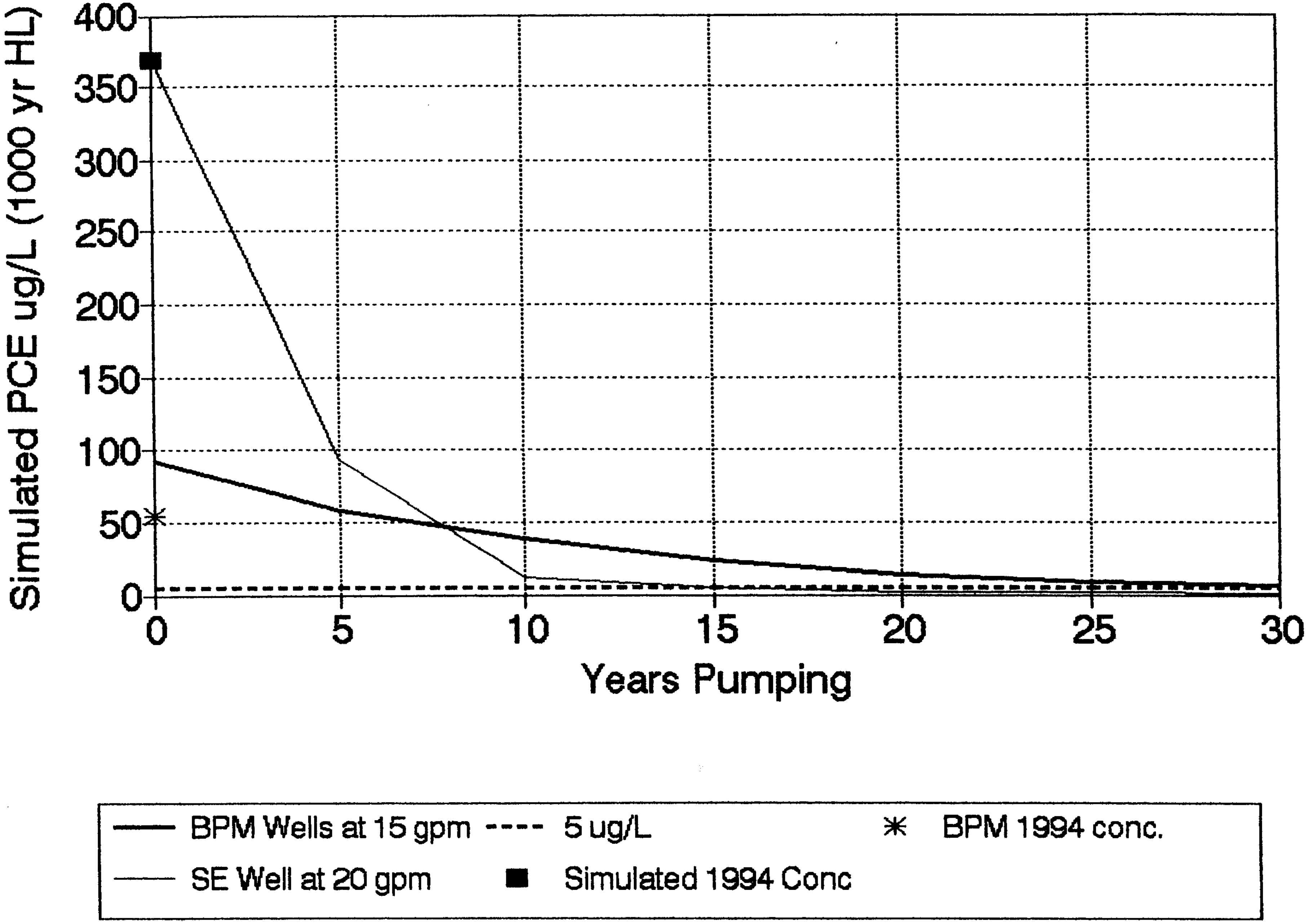


Figure A-18. Simulated PCE in BPM Wells And SE Recovery Well; FS Alternative 5

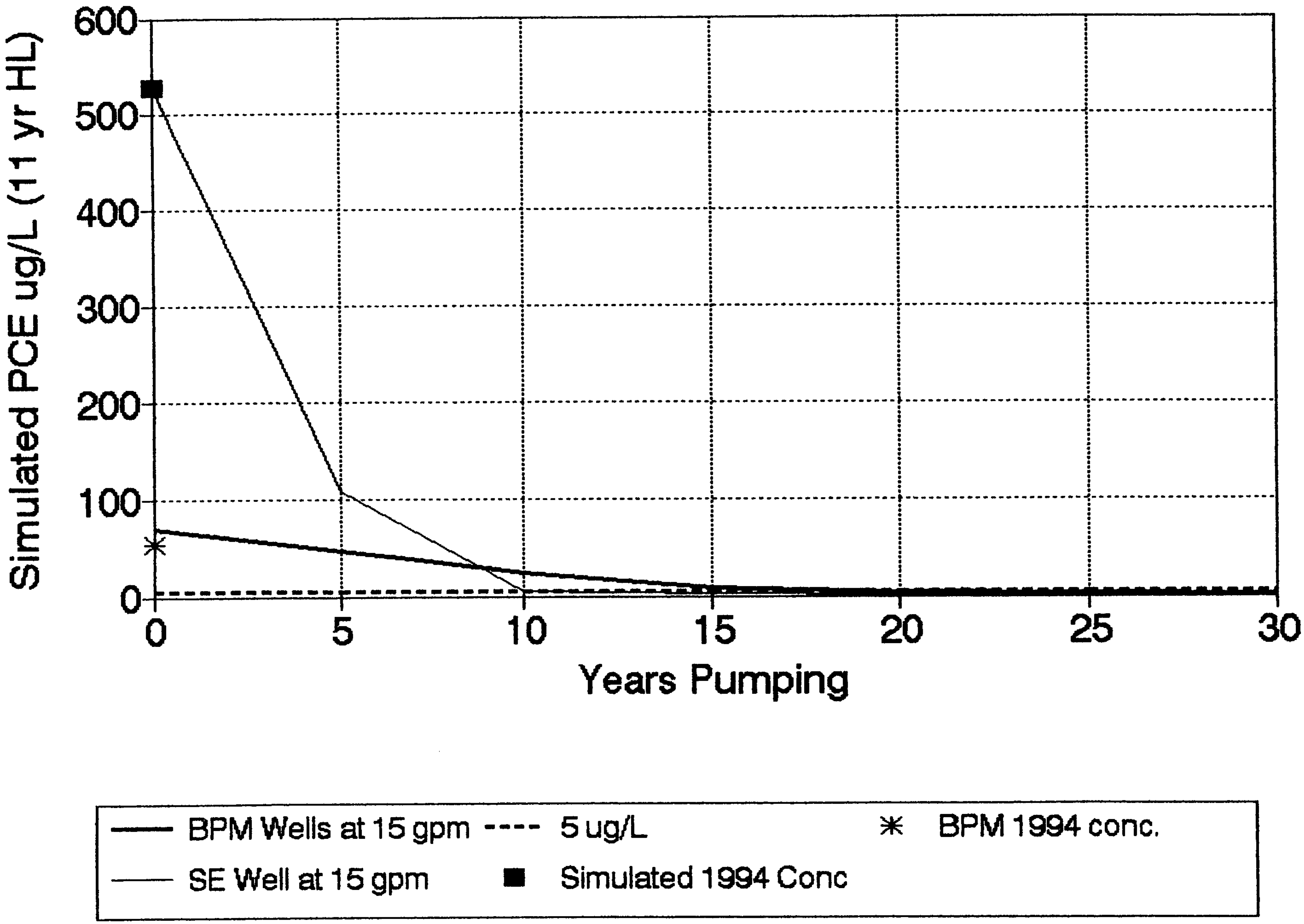


Figure A-19. Simulated PCE in BPM Wells And SE Recovery Well; FS Alternative 5

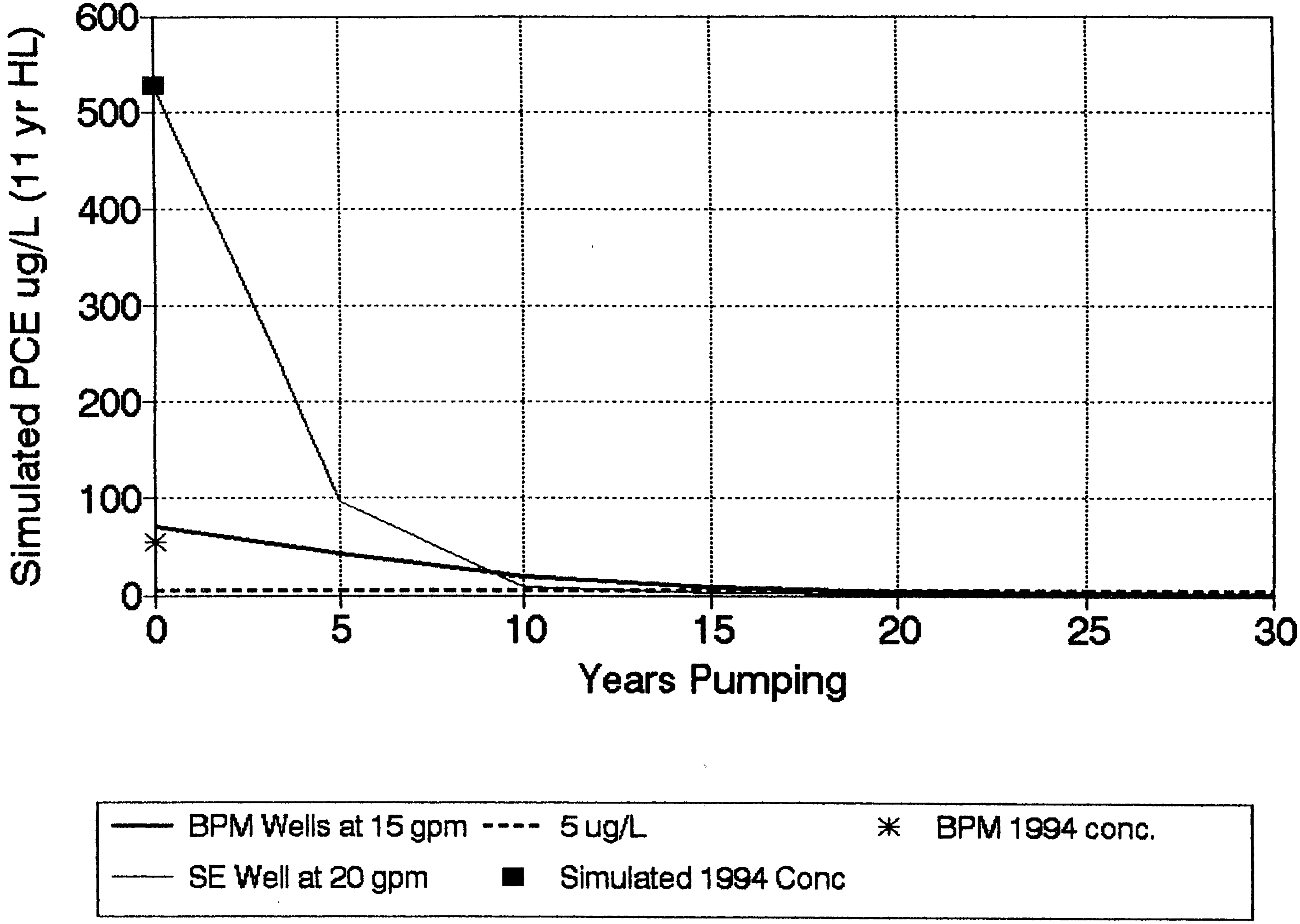


Figure A-20. Simulated PCE in Western Recovery Well; FS Alternative 5

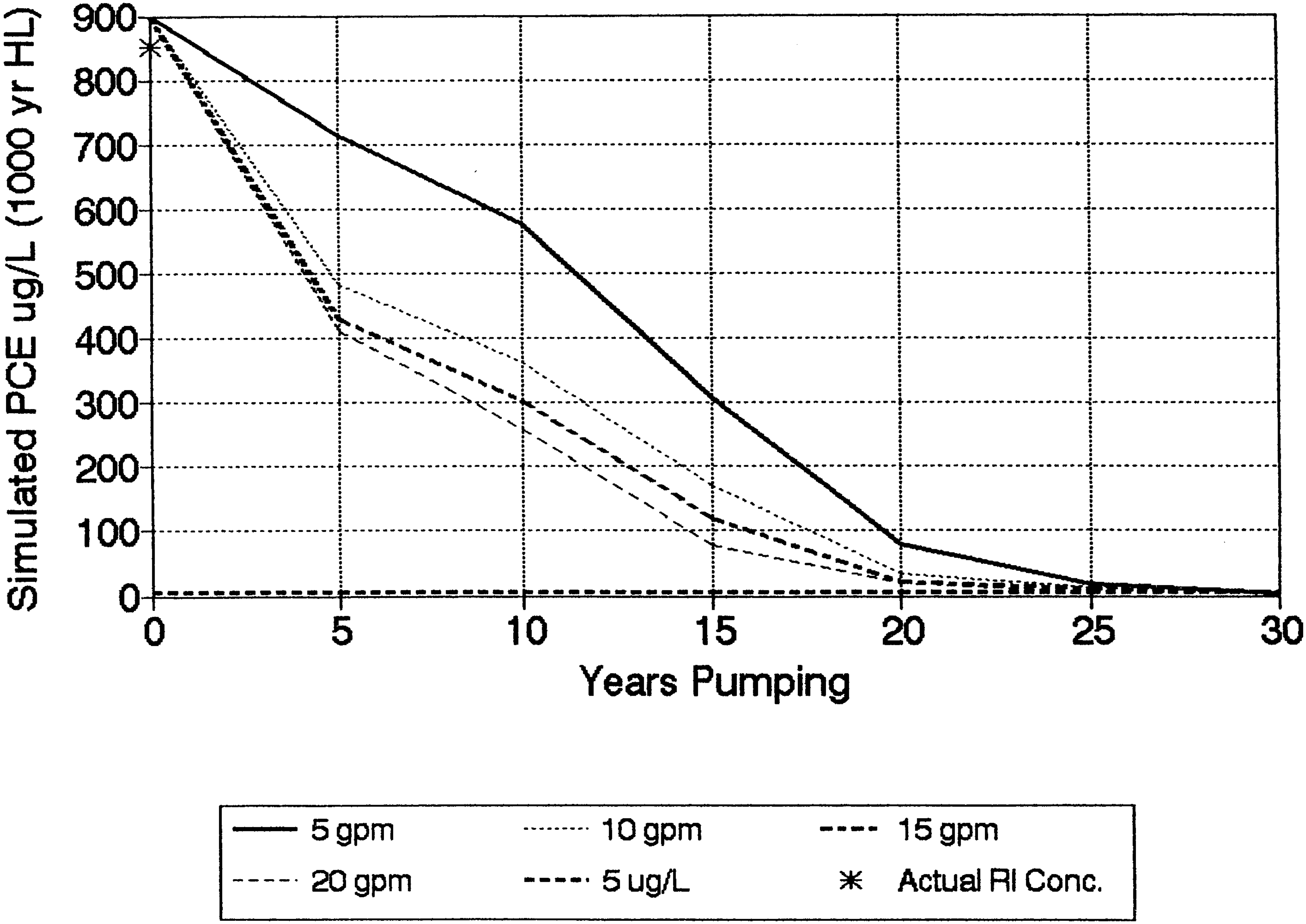


Figure A-21. Simulated PCE in Western Recovery Well; FS Alternative 5