PREPARED FOR

MILLER BREWING COMPANY

Reynolds Can Plant Site
Fulton, New York

FEASIBILITY STUDY REPORT

MALCOLM PIRNIE

JULY 1994

FEASIBILITY STUDY REPORT

REYNOLDS CAN PLANT
FULTON, NEW YORK
NYSDEC SITE NO. 7-38-029

Prepared For: Miller Brewing Company

JULY 1994

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1028-258

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1.0 INTRODUCTION

This report describes the performance and results of the Feasibility Study (FS) undertaken by Malcolm Pirnie, Inc. (MPI) for the Miller Brewing Company (Miller) at the Reynolds Can Plant site (Registry No. 7-38-029), formerly the Miller Container Division site, located in Fulton, New York. The terms for the development and preparation of the FS were set forth in Order on Consent #A7-0227-90-04. The methodology followed is outlined in the USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final, October 1988, and the New York State Department of Environmental Conservation (NYSDEC) Technical and Administrative Guidance Memorandum (TAGM) "Selection of Remedial Actions at Inactive Hazardous Waste Sites", dated May 15, 1990.

The FS is intended as a companion volume to the July 1993 Remedial Investigation (RI) Report - Miller Brewing Company, Container Division and the July 1994 RI Report Addendum. The RI Report and RI Report Addendum describe the results of field investigations and sampling conducted at the site and identify the extent of contamination at the site. In the FS, a determination is made as to what actions, if any, should be taken to address the contamination. Remedial alternatives for the clean-up of the contaminated media identified at the Reynolds Can Plant site are formulated and screened on a preliminary basis. The alternatives surviving the preliminary screening are then combined to address the site as a whole. These combined alternatives are analyzed in detail, and a final combined alternative is recommended for implementation.

This FS Report is divided into six sections, including Section 1.0, the Introduction. Site background information is provided in Section 2.0, as are the conclusions reached during the RI conducted at the site. Section 3.0 describes the first phase of the FS, in which the areas of contamination are defined and the framework within which each area will be addressed is developed. Through a thorough screening of applicable remedial technologies, remedial action alternatives are formulated. In Section 4.0, or the second phase of the FS, the alternatives are screened to reduce the number to be subjected to detailed analysis. Alternatives to be carried through the detailed analysis are summarized. In Section 5.0, the alternatives surviving the preliminary screening are incorporated into combined alternatives to address the site as a whole. Aspects of some of the alternatives are also better defined, and a conceptual design is provided for each combined alternative. The third phase of the FS, in which the combined remedial alternatives are analyzed in detail and a recommendation is made, is contained in Section 6.0.

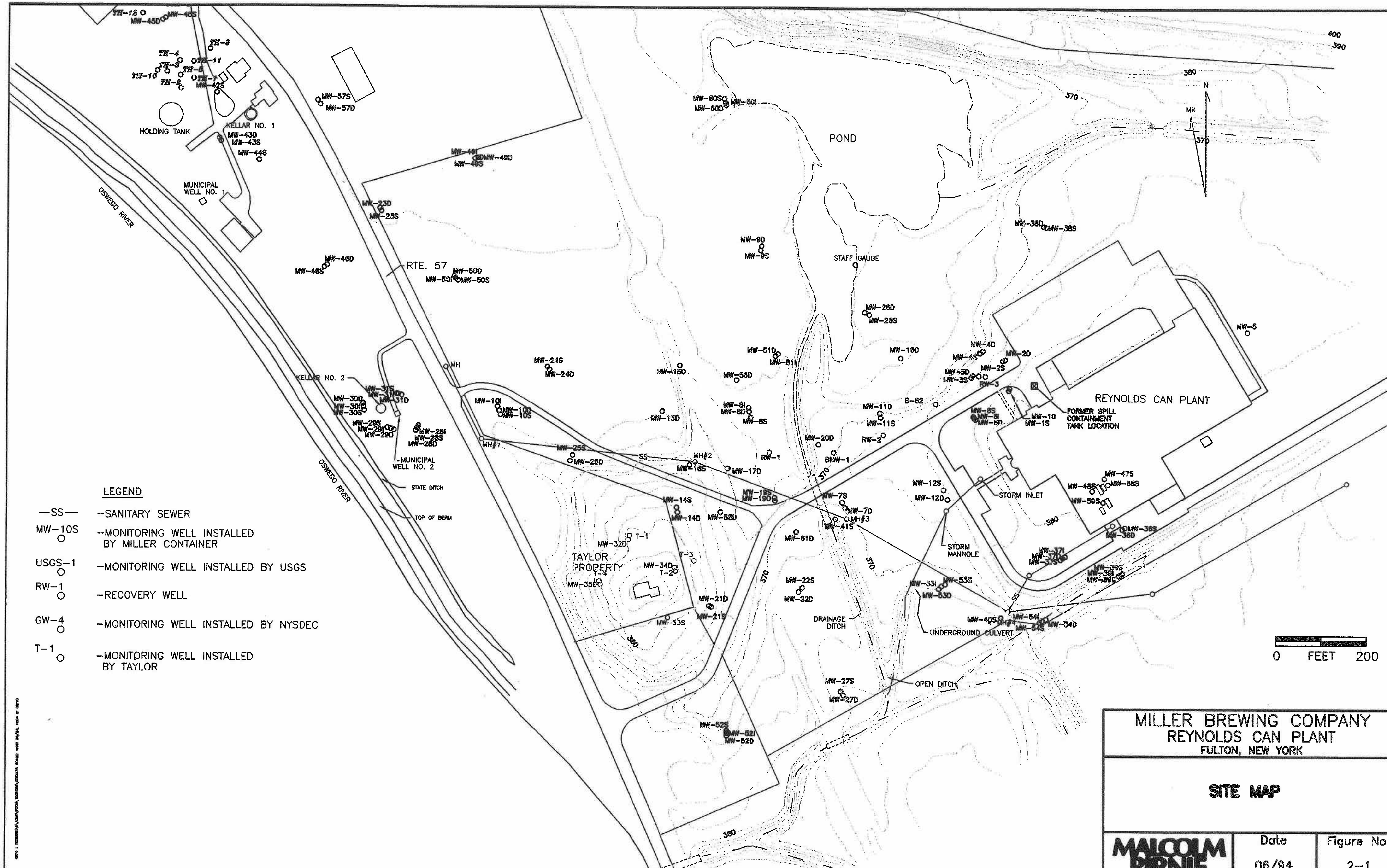
2.0 BACKGROUND INFORMATION

2.1 SITE BACKGROUND

Miller formerly operated a can-making facility (the "Can Plant") in the Town of Volney, Oswego County, New York. The Can Plant was sold to Reynolds Metals Company in November 1993, and Miller retained responsibility for environmental contamination that emanates from identified sources on the property. Through the performance of detailed site investigations, several source areas of volatile organic compound (VOC) contamination have been identified.

The Can Plant is located about 1200 feet southeast of the City of Fulton municipal boundary and approximately 1500 feet east of the Oswego River. The Can Plant is situated on approximately 40 acres of land (the "site"). The Oswego River is located hydraulically downgradient of the Can Plant and the site. Situated adjacent to the Oswego River are three City of Fulton municipal wells. Two of the municipal wells, Municipal Well No. 2 (M-2) and Kellar Well No. 2 (K-2), are located between the Can Plant and the river. The third municipal well, Kellar Well No. 1 (K-1), is located about 700 feet north of the other two municipal wells. Details of the site and part of the surrounding area are shown in Figure 2-1.

A 500-gallon steel underground storage tank (UST) known as the spill containment tank was installed on the north side of the Can Plant when the Can Plant was constructed in 1976. This tank was replaced with a 500-gallon concrete tank in 1978. No evidence of contamination was noticed when the steel tank was excavated and replaced; however, during the removal of the concrete tank and associated piping in 1986, relatively high levels of VOCs were detected in samples of soil and water collected from outside the tank. Miller notified the NYSDEC and hired an engineering firm to conduct a hydrogeologic investigation in the vicinity of the former tank. During this investigation, Miller discovered that some of the same VOCs detected near the spill containment tank had also been detected in M-2. Therefore, additional hydrogeologic investigations to determine the extent of contamination due to the leakage from the former spill containment tank followed. During 1987, an interim remedial measure (IRM) was designed to contain and treat



MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK

SITE MAP

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Date 06/94

Figure No. 2-1

contaminated ground water resulting from the spill containment tank leak. The IRM consisted of three ground water recovery wells and an air stripping treatment system which was designed to operate at a maximum flow of 20 gallons per minute (gpm). This system went on line during June 1988. The treatment system is housed in a small building located north of the plant's access road, near MW-19S,D.

After the air stripping treatment system began operating, the VOCs in M-2 dropped off; however, VOCs eventually reappeared at M-2 and began appearing at nearby K-2. Due to the occurrence of VOC contamination at the two downgradient municipal wells, the NYSDEC required a RI to: identify contaminant source areas at the site; define the extent, flow path, and rate of travel of downgradient contaminant plumes; and determine the relationship of identified contamination to the municipal wells.

Through the performance of RI work tasks, additional source areas of contamination and three additional plumes of ground water contamination were identified on the site. Contamination emanating from the site was linked to the contamination at the two downgradient municipal wells, M-2 and K-2. These wells were eventually taken out of service because VOC levels exceeded drinking water standards. VOC and gasoline-type ground water contamination were found in the vicinity of and at the third municipal well, K-1; however, the contaminant levels in this well have been below drinking water standards and the contamination does not appear to be attributable to sources on the site based on ground water flow patterns and the identity and occurrence of the contamination. While a long-term treatment system to treat the water pumped from the municipal wells was being designed and constructed, an IRM was implemented to treat water from M-2 and K-2 prior to discharge to the Oswego River. The IRM consisted of a 20,000-pound portable granular activated carbon (GAC) treatment system.

The long-term treatment system incorporated provisions for treatment of water from K-1, M-2 and K-2. This system went on line in July 1992 and consists of a one-million gallon per day (1 mgd) packed column air stripping unit with GAC treatment for the exhaust gases. The water is treated to below detection limits and is then used as part of the municipal supply.

The RI Report for the site was completed and submitted to the NYSDEC in July 1993. The NYSDEC approved the RI Report with reservations in October 1993, with the request for additional soil sampling and analysis to support the RI conclusion that three identified soil source areas did not require remediation. This conclusion was based on available soil analytical data which showed soil contaminant levels in the three areas to be below the soil clean-up goals calculated in accordance with the NYSDEC TAGM on the determination of soil clean-up goals.

The NYSDEC also requested additional investigation in the area east of the Taylor property to locate the source for the contamination found in the vicinity of MW-21S since it was concluded in the RI Report that the source for the contamination in this area was localized, but had not been pinpointed.

During the period February through June 1994, additional field work was performed at the site in accordance with NYSDEC requests. The investigation was summarized in the RI Report Addendum, dated July 1994. The conclusions presented in the RI Report were not altered by the data collected during 1994; however, the additional information was used to more accurately delineate the extent of ground water contamination along the southern edge of the northern ground water operable unit and to reduce the area of contaminated soil in the southern operable unit which was defined in the RI Report as requiring remediation.

2.2 RI REPORT AND RI REPORT ADDENDUM CONCLUSIONS

There follows a summary of the conclusions from the work performed as part of the RI. They are based on the discussions contained in the RI Report and RI Addendum.

2.2.1 RI Report Conclusions

1. There are two contaminated media at the site: soil and ground water. The types of contaminants detected in the soil and ground water consist predominantly of chlorinated hydrocarbons, although some petroleum hydrocarbons and ketones have also been detected.

2. One soil source area was known prior to performance of the RI: the former spill containment tank area. Performance of the RI verified three additional sources areas: the former drum washing and storage area in the area north of the Can Plant's northern parking area, the area south of the Can Plant where drums were also washed and stored, and the UST area located below the southwestern portion of the Can Plant near the Plant's wastewater treatment facility (WWTF).

3. The RI suggested two additional low-level source areas: in the vicinity of sanitary sewer manhole # 1 (MH#1); and east of the Taylor property (Figure 2-1) in the area of MW-14D and MW-21S.

4. The performance of the RI has allowed the delineation of the horizontal and vertical extent of contamination emanating from the source areas on the site. Ground water contaminant migration from the source areas is basically a function of the ground water flow patterns.

5. Contaminant concentrations in the shallow ground water are highest on the Can Plant's south side and below the Can Plant near the UST area. However, the relatively low horizontal hydraulic conductivity and hydraulic gradient in this area indicate that the contaminant migration rate is slow in the south and southeastern portions of the site. Ground water analytical data from wells installed in this area and to the west of the source area on the Can Plant's south side support this conclusion.

6. The sanitary sewer bedding was investigated as a potential contaminant migration pathway. The presence of shallow contamination near MW-18S, MW-40S, and MW-41S and an elevated water level near MW-41S would seem to indicate leakage from the sewer. However, the analytical data do not support the theory of high levels of contamination migrating in the sewer bedding from MW-36S and MW-37I across the site to the MW-18S area and beyond.

7. Monitoring wells installed during the RI along the south side of the site have provided analytical data that rule out the theory of a plume of contamination that originates on the south side of the Can Plant then migrates across the site and into the MW-21S, MW-14D and Taylor property area.

8. Shallow zone contamination is found in the former spill containment tank area and in the former northern drum storage area. The shallow contamination is absent across the middle of the site, but reappears near MW-21S and in the shallow wells on the Taylor property. These data are suggestive of a potential source area for ground water contamination east of MW-14D, MW-21S and the Taylor property.

9. The identified ground water contamination in the vicinity of the Taylor property and to the east near MW-14D and MW-21S is responsible for the majority of the contamination at municipal wells K-2 and M-2. A smaller, lower concentration plume from the MW-13D area joins this plume near MW-25S,D and then is pulled toward K-2 and M-2. A long-term treatment system to treat the K-2/M-2 ground water is currently in operation. Following treatment to below detection limits, the ground water is added to the City of Fulton municipal drinking water supply.

10. The most likely source of the contamination at MW-13D appears to be the migration of contaminated ground water from the shallow zone near MW-38S, into the deeper zone northeast of MW-16D, then north of MW-16D and MW-8D in the area near MW-56D. Drawdown was observed at MW-56D during the 1992 pumping test; however, contamination in this area appears to be out of the capture zone of RW-1 under the current pumping conditions.

11. The air stripping system in use at the site has operated efficiently with respect to the removal of VOCs from ground water collected downgradient of the former spill containment tank area, despite the occurrence of significantly higher levels of total VOCs than were originally estimated. The presence of the contamination in the MW-4D, MW-16D, and possibly MW-3D areas appears to be the result of contamination migrating from the former northern drum storage area and/or the former spill containment tank area.

12. Significant contamination has been detected at intermediate well MW-8I. This well is under the influence of pumping at RW-1. No contamination has been detected at intermediate well MW-51I, located to the northeast of MW-8I. No contamination has been found in intermediate wells located between MW-8I and K-1. The shallow and deep wells in the clusters between the MW-8S,I,D cluster and K-1 are also not contaminated.

13. VOC and gasoline-type ground water contamination has been found in the vicinity of and at K-1. However, the contaminant levels in this well have been below drinking water standards and the contamination does not appear to be attributable to Can Plant sources based on ground water flow patterns and the identity and occurrence of the contamination. The NYSDEC has installed a ground water treatment system northwest of K-1, in the vicinity of MW-45S,D, in response to the gasoline-type contamination in this area. The NYSDEC is currently investigating the contamination in order to identify the source and the responsible party for the contamination. Water from K-1 is also routed through the 1 MGD treatment facility operated by the City of Fulton.

14. Analytical data obtained from well cluster MW-60S,I,D, and additional data collected throughout the RI, do not indicate the presence of a ground water contaminant plume emanating from the MW-38S,D area and moving northwest across the site toward K-1.

15. The Oswego River is hydraulically connected to the municipal pumping wells and acts as a constant source of recharge. Consequently, it is estimated that about 60 percent of the shallow water entering K-1 originates at this recharge boundary and only about 10 percent is supplied from the direction of the Miller property; the remainder originates mostly from areas to the east and northeast of K-1. K-2 and M-2 are located closer to the Oswego River recharge boundary and receive nearly 75 percent of their combined shallow water supply from the River; about 25 percent of the water entering these wells originates from the northeast, east and southeast directions which include flow from the site and the Taylor property. The pumping from municipal well K-1

exerts a greater influence on the aquifer than the pumping from K-2 and M-2; however, operation of the K-1 and K-2/M-2 systems concurrently greatly reduces the rate of ground water movement from the K-2/M-2 area toward K-1. Wells located between K-2/M-2 and K-1 show no evidence of chlorinated hydrocarbon contamination. In addition, the most common contaminant detected at K-1, trichloroethylene (TCE), is not detected at M-2 or K-2.

2.2.2 RI Report Addendum Conclusions

The conclusions presented in the RI Report were not altered by the data collected during the investigations performed during 1994. Evaluation of the more recently collected data provided additional information with which to further delineate the extent of contamination at the site, and served to support the conclusions made in the RI Report. The conclusions presented below emanate from the data collected subsequent to the July 1993 RI Report.

1. Ground water quality data from MW-61D have been used to better define the lateral extent of the southern edge of the northern operable unit ground water.

2. Results of the soil gas/soil sampling investigation verify soil source areas identified in the RI Report: the former spill containment tank area (including the area beneath the Can Plant's drum storage room) and the area north of and below a portion of the Can Plant's northern parking area. Analytical results from soil samples collected from these areas show contaminant levels to be below the soil clean-up goals calculated using the January 24, 1994 NYSDEC TAGM on the determination of soil clean-up goals.

3. Soil gas results from the area adjacent to and west of the Can Plant indicated VOC levels below the quantitation limit, except at the sample point located at the southwestern corner of the Can Plant. One compound was detected at this location at a concentration of less than 1 mg/m^3. Due to the low soil gas concentrations detected, it was not necessary to collect soil samples in this area. Soil gas results from two additional points located near the southern drum storage area and the Can Plant's WWTF showed non-detect levels at the southwestern-most location, and total VOCs at 95 mg/m^3 at the location adjacent to MW-36S,D.

4. Soil samples collected from the southern drum storage area outside the Can Plant, and near MW-36S,D, verified previous soil analytical data which showed soil contaminant levels (outside the Can Plant) to be below the soil clean-up goals calculated from the NYSDEC TAGM on the determination of soil clean-up goals. Soil located beneath the Can Plant in the vicinity of the USTs is the only soil at the site that will require remediation.

5. Soil headspace data and ground water quality data (including concentrations and the types of compounds detected) from MW-61D do not support the theory of contamination originating from the former spill containment tank area, migrating within the intermediate-depth and deep sand and gravel deposits along a pathway coincident with the location of the roadway, then over the till ridge and into the intermediate-depth sand and gravel deposits that occur in the MW-21S area.

6. Soil gas results from the area east of the Taylor property indicate low levels of shallow VOC contamination (primarily 1,1,1-trichloroethane (TCA) and 1,1-dichloroethylene (DCE) at concentrations of less than 10 ug/l) isolated in the vicinity of MW-21S,D; however, the detected soil contaminant concentrations in this area are not of sufficient magnitude to require remediation. In fact, the analytical results from soil sampled in this area showed all parameters to be below quantitation limits. No point source for the ground water contamination observed at MW-21S has been identified. Data collected during this investigation do not support the existence of a suitable target for soil remediation.

The RI and RI Addendum data, which were used to delineate the vertical and horizontal extent of contamination at the site, were also used to develop and then screen a list of combined remedial alternatives to remediate the identified contamination. The remedial alternatives were refined in the RI Report and the remaining alternatives were carried through into the preliminary screening portion of the FS. Results of the preliminary screening and the detailed analysis along with a conceptual design of the most feasible alternative selected for each area are presented in the following sections of this report.

3.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

3.1 DEFINITION OF OPERABLE UNITS

3.1.1 General Approach

Information gathered during the RI and results of the Baseline Human Health Risk Assessment were used to determine the extent of contamination at the site, as well as to identify the media requiring remediation. VOC contamination, which consists predominantly of chlorinated hydrocarbons, is present at the site. The contaminated media include soil and ground water. Contaminant source areas generally appear to be areas where drums had previously been washed and stored or where underground tanks were located.

To address the contamination at the site in the FS, the site was divided into operable units based on location. As shown in Figure 3-1, the site will be addressed as follows:

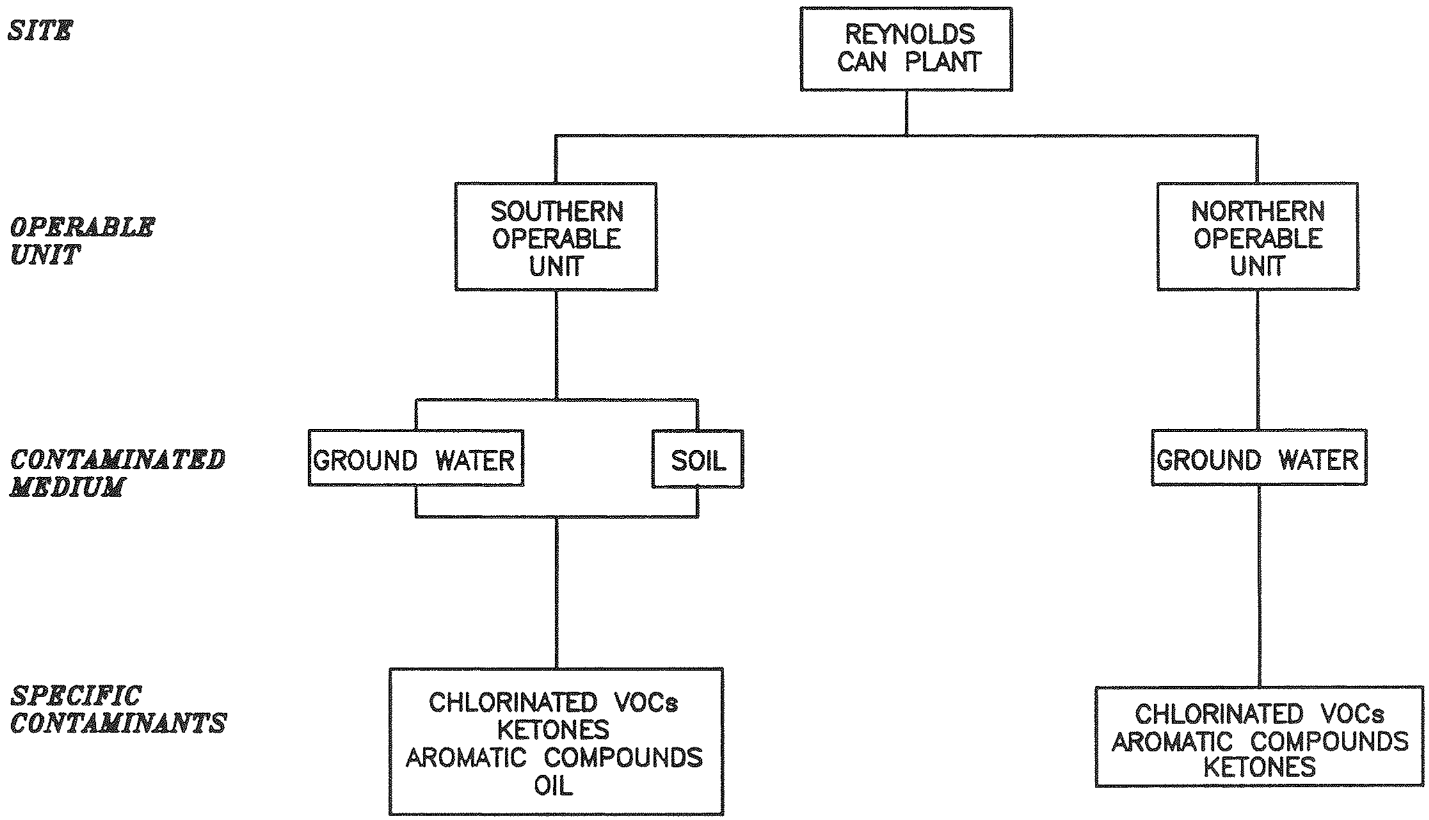
- Operable units - General areas in which contamination is present
- Contaminated media - Contaminated ground water and/or soil
- Specific contaminants - The types of contaminants which are present.

The operable units at the site are as follows:

- Southern Operable Unit
- Northern Operable Unit

The contaminated media include:

- Soil
- Ground Water



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BREAKDOWN OF SITE INTO OPERABLE UNITS

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FIGURE 3–1

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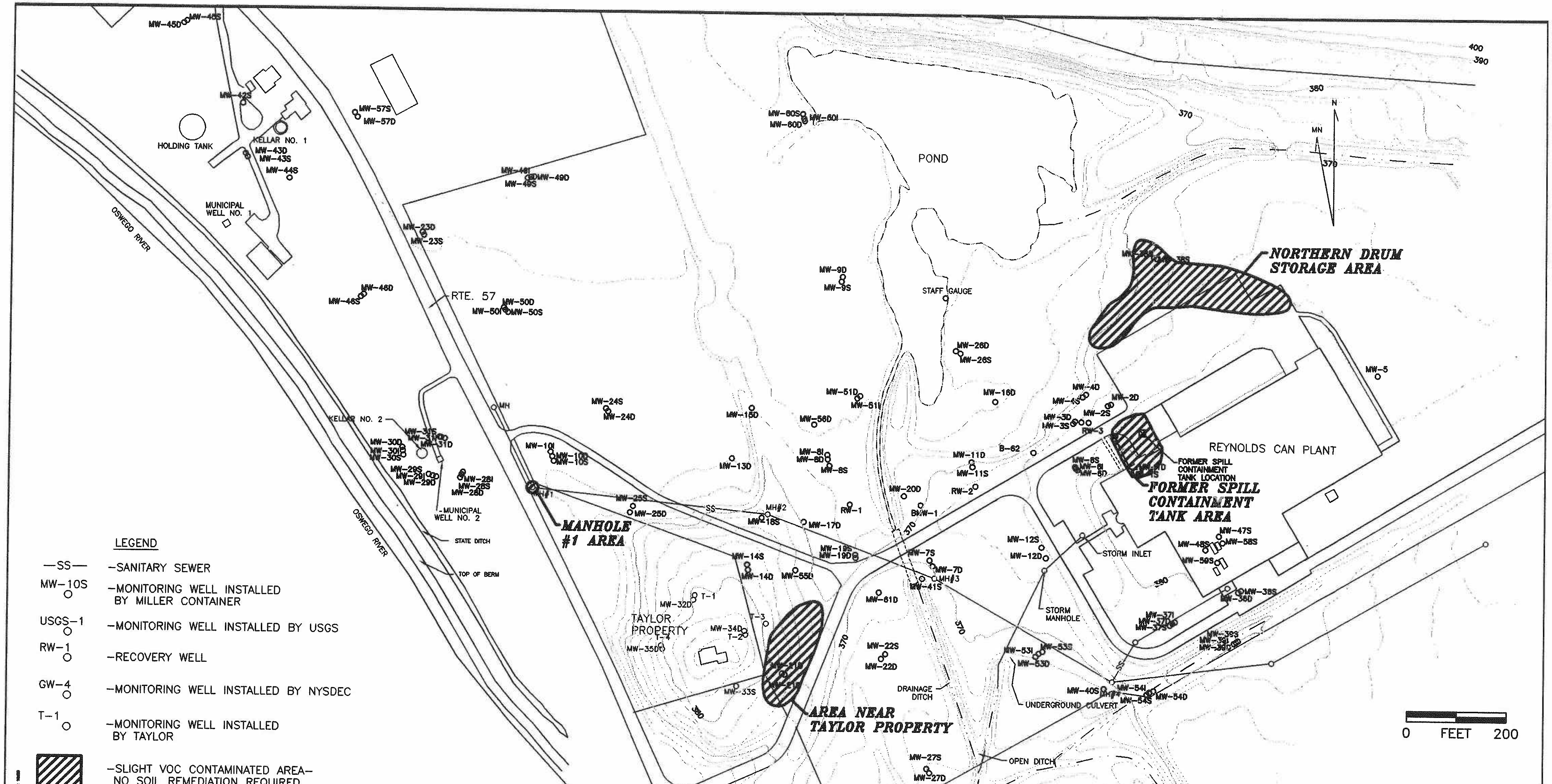
Four isolated areas of soil were also identified at the site as being slightly contaminated with VOCs, but not requiring remediation. These include the Northern Drum Storage Area, Former Spill Containment Tank Area, the area near the Taylor property and the area in the vicinity of Sanitary Sewer Manhole #1 (Figure 2-1). An explanation as to why each of these four areas of soil do not require remediation is contained below.

A) Northern Drum Storage Area

The Northern Drum Storage Area consists of low level VOC-contaminated subsurface soils beneath and just north of the Can Plant's northern-most parking lot (Figure 3-2). Analysis of soil samples obtained from this area at depths ranging from zero to ten feet below land surface have indicated the presence of acetone and tetrachloroethylene (TTCE) at very low concentrations. No VOCs were detected in a composite soil sample obtained from a depth of zero to two feet below land surface. A summary of the compounds and concentrations detected in the soil in this area is contained in Table 3-1. The soil gas surveys performed by Tracer Research Corporation (Tracer) and by Tetra-K Testing in the Northern Drum Storage Area indicated detectable levels of mostly chlorinated VOCs along with some petroleum hydrocarbons.

Based on the data and interviews with employees who have stated that drums containing solvents were washed and dumped in this area prior to 1980, a potential risk was determined to exist to any employees whc work in this area (Baseline Human Health Risk Assessment, RI Report). However, activities in this area appear to be limited to lawn maintenance; and, as stated in the risk assessment, the risks associated with the potential exposure routes appear to be low. The majority of the contaminants detected in the soil gas samples collected in this area are highly volatile, and it is likely that they have flashed off from the near-surface soils. The soil sample collected from zero to two feet below land surface showed non-detectable levels of all compounds on the USEPA Method 8240 list. Also, the area is grass covered, and contact with the soil should be minimal.

Soil contaminant levels in this area are lower than their respective clean-up goals (as referenced in Table 3-1, and established in Section 3.2). Thus, the Northern Drum Storage Area soil is not included in the northern operable unit as requiring remediation, and no ground water remedial alternatives incorporating soil remediation in the Northern Drum Storage Area will be evaluated.



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CONTAMINANT SOURCE AREAS WHERE SOIL REMEDIATION IS NOT REQUIRED

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Date	Figure No.
06/94	3-2

TABLE 3-1
REYNOLDS CAN PLANT SITE
AREAS OF SOIL NOT REQUIRING REMEDIATION
COMPARISON OF SOIL CONTAMINANT CONCENTRATIONS TO CLEAN-UP LEVELS

COMPOUND	Northern Drum Storage Area		Former Spill Containment Tank Area		Manhole #1 Area	
	Range of Detected Conc's (ug/kg)	Soil Clean Up Level* (ppb)	Range of Detected Conc's (ug/kg)	Soil Clean Up Level* (ppb)	Range of Detected Conc's (ug/kg)	Soil Clean Up Level* (ppb)
Acetone	17	253	110	143		
1,1-Dichloroethylene			16	422	5.4	672
1,2-Dichloroethylene, total			380	NA**		
1,1,1-Trichloroethane			6.6-64	988	2.6-27	1573
Tetrachloroethylene	5-180	4186+	7-380	2366+	95-340	3767+
Methylene Chloride			7-22	136	1.1-1.7	217
Trichloroethylene			55	819	1.3-3.1	1304
Toluene			210	1950	0.6	3105
Xylenes, total			65-350	1560		
Ethylbenzene			65	7150		

P:\PROJ\1028258\TABLE3-1.WK1

Notes:
A blank indicates not detected

* Soil clean-up levels were determined in accordance with the NYSDEC Technical and Administrative Guidance Memorandum on Determination of Clean-Up Levels, dated January 24, 1994, and are based on the average percent organic carbon content of soil in each area (as determined through sampling and analysis). For the Manhole #1 Area, soil clean-up levels were calculated using the average soil organic carbon content for the site, since soil in this area was not analyzed for this parameter. The following percent organic carbon content values were used in calculating clean-up levels:
Northern Drum Storage Area – 2.3%; Spill Containment Tank Area – 1.3%; Manhole #1 Area – 2.07%

TABLE 3-1
REYNOLDS CAN PLANT SITE
AREAS OF SOIL NOT REQUIRING REMEDIATION
COMPARISON OF SOIL CONTAMINANT CONCENTRATIONS
TO CLEAN-UP LEVELS

Notes (cont.):
** NA = Not available. The recommended soil clean-up goal for the trans-isomer of the compound is 383 ppb.

+ Limit calculated using partition coefficient (Koc) of 364 ml/g, which was obtained from Exhibit A-1 of the USEPA Superfund Public Health Evaluation Manual. Although this manual is recommended in the NYSDEC Guidance Memorandum as the source from which Koc values should be obtained, the value of 364 ml/g differs from the one used by the NYSDEC (277 ml/g) in determining its recommended clean-up objective.

B) Former Spill Containment Tank Area

The spill containment tank was excavated and removed along with its associated piping during April 1986. Analysis of soil samples obtained from a test pit and several boreholes at depths ranging from five to 42 feet below land surface since the removal of the tank indicated that some VOCs are present at relatively low concentrations. Figure 3-2 shows the location of this area. The main contaminants detected have been chlorinated VOCs, including methylene chloride, TTCE, and TCA. Xylenes, toluene and ethylbenzene have also been detected, but only once or twice during 15 sampling occasions. A summary of the compounds detected and their range of concentrations is provided in Table 3-1.

As with the soil in the Northern Drum Storage Area, contaminant levels detected in the Former Spill Containment Tank Area soil do not warrant remediation when compared to the soil clean-up goals. In addition, no pathways of concern were identified as possible exposure scenarios for the soil in the Human Health Risk Assessment. Remediation of the soil in this area will not be further evaluated.

C) Area Near Taylor Property

Results of the Tracer June 1990 soil gas sampling conducted in the area near the Taylor property indicated the presence of low level VOC contamination. According to Tracer, the VOCs detected in this area (shown in Figure 3-2) were too low to indicate a nearby isolated source of contamination. Thus, the very low soil gas concentrations detected in the area near the Taylor property indicated that remediation of the soil in this area was not required.

Results of additional soil gas sampling conducted by Tetra-K during April 1994 in the area of the Taylor property indicated localized, relatively low-level contamination isolated in the vicinity of MW-21S,D. No VOCs were detected when a soil sample obtained from a boring in this area was analyzed. Thus, remediation of soil in the area near the Taylor property is not required.

D) Area Near Manhole #1

Manhole #1 is shown in Figure 3-2. Analysis of two soil samples obtained from the sewer bedding in the area of Manhole #1 during February 1991 by Miller representatives indicated the presence of low concentrations of several VOCs. However, the detected concentrations were all less than their respective soil clean-up goals (refer to Table 3-1). Thus, remediation in this area is not required.

A brief summary of the specific contaminants of concern and the extent of contamination in each contaminated area, or operable unit, requiring remediation at the site is provided in the following sections.

3.1.2 Southern Operable Unit

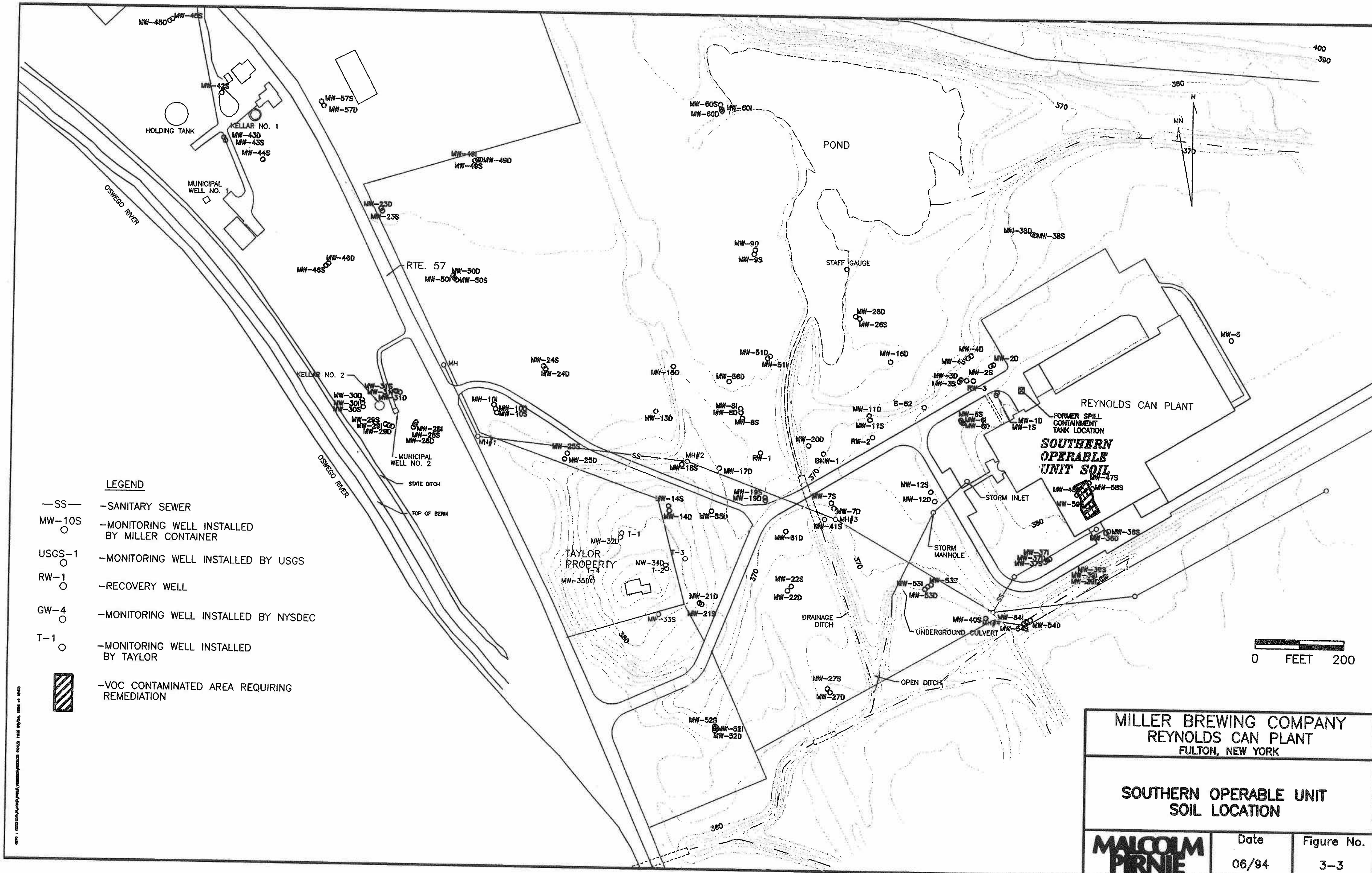
The southern operable unit is comprised of contaminated soil and ground water.

Soil

VOC-contaminated subsurface soils requiring remediation are present beneath the south end of the Can Plant. Four underground tanks are located below the portion of the Can Plant near the WWTF. Three of these tanks were used to contain oily waste, and leakage from the tanks occurred in the past. The fourth tank was used to contain non-oily waste. Spent cleaning solvents were disposed directly into one or more of the tanks as well as into trenches that ultimately empty into the tanks. As a result of these past disposal practices, VOC contamination has been found in oil recovered from a sump installed near the tanks and from the sumps installed in two of the tanks. The recovery of oil from the soil in the vicinity of the tanks is being completed under the guidance of the NYSDEC Division of Spills Management. Conditions which must be met in order for oil recovery and tank closure to be complete under this program are outlined in MPI's Container Plant Interior Oil Contamination Project, Addendum #1, Tank Closure Work Plan, dated June 1992. Residual VOC and oil contamination that remains in the soil after the bulk of the oil is removed will be addressed through implementation of the remedial action selected through the FS process.

Figure 3-3 shows the approximate areal extent of VOC contaminated soils in this area. Oil and VOC contamination of the soil has been detected at depths of up to 12 feet below grade. The main contaminants of concern are chlorinated VOCs, including TTCE, TCE and TCA. Ketones, such as acetone and methyl isobutyl ketone (MIBK), are also present, but at relatively low levels. Benzene and toluene have also been detected.

Oil contamination is present in the tank area apparently as a result of a combination of leakage from the bottom of the 4,000-gallon oily waste scavenger tank and leakage occurring from the space between the manway above the tanks and the top of the three oily waste storage tanks. Traces of oil were found in some of the soil samples collected from the shallow monitoring well borings inside the Can Plant; however, no oil-saturated soil was discovered. A sump which was installed in the vicinity of the underground tanks was converted to an oil recovery sump. In addition, holes have been drilled in three of the tanks, and sumps have been installed below two of


LEGEND
—SS— -SANITARY SEWER
MW-10S -MONITORING WELL INSTALLED BY MILLER CONTAINER
USGS-1 -MONITORING WELL INSTALLED BY USGS
RW-1 -RECOVERY WELL
GW-4 -MONITORING WELL INSTALLED BY NYSDEC
T-1 -MONITORING WELL INSTALLED BY TAYLOR
-VOC CONTAMINATED AREA REQUIRING REMEDIATION
OSWEGO RIVER
HOLDING TANK
KELLAR NO. 1
MUNICIPAL WELL NO. 1
RTE. 57
KELLAR NO. 2
MUNICIPAL WELL NO. 2
STATE DITCH
TOP OF BERM
TAYLOR PROPERTY
POND
STAFF GAUGE
REYNOLDS CAN PLANT
FORMER SPILL CONTAINMENT TANK LOCATION
SOUTHERN OPERABLE UNIT SOIL
STORM INLET
STORM MANHOLE
DRAINAGE DITCH
UNDERGROUND CULVERT
OPEN DITCH
0 FEET 200
MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK
SOUTHERN OPERABLE UNIT
SOIL LOCATION
MALCOLM PIRNIE
Date 06/94
Figure No. 3-3

them to allow for the collection of oil and water. A sump is planned for installation below the third tank.

Slight VOC contamination has been detected in the subsurface soils adjacent to and south of the plant, in the vicinity of a former drum washing and storage area. TTCE (6.3-800 ug/kg) and acetone (52 ug/kg) were found to be present at levels below their respective soil clean-up goals in samples obtained from two borings advanced in this area. The borings were installed in the area of highest soil gas concentrations. Since sampling has indicated that soil outside the Can Plant does not require remediation, the southern operable unit soil is confined to the vicinity of the underground tanks beneath the Can Plant.

Ground Water - Shallow/Deep

The major contaminants detected in the shallow ground water beneath the Can Plant and in the shallow and deep ground water south of the Can Plant are chlorinated VOCs. These include total and cis-1,2-DCE, TCA, 1,1-dichloroethane (1,1-DCA) and methylene chloride. Toluene, ethylbenzene and xylenes have also been detected in the ground water, mainly in the shallow and intermediate wells, but at a much lower frequency than the chlorinated VOCs. The ketones, acetone, MIBK and methyl ethyl ketone (MEK), have been detected in the shallow ground water south of the Can Plant. Acetone has been found in the shallow ground water beneath the Can Plant.

The ground water contamination below the Can Plant is believed to be due to the leaching of VOCs from the oil and soil in the underground tank area and the migration of VOCs from the former Southern Drum Storage Area. The water table beneath the plant occurs at a depth of six to eight feet below the lowest evidence of oil staining observed during the drilling for the monitoring wells in this area. No oil has been found on the water table at MW-47S or MW-48S. The oil in the vicinity of the tanks and the sump may be concentrated primarily in the fill material in the vicinity of the tanks due to the low permeability soil around the gravel backfill and the viscosity of the oil. Up to five feet of oil have been found on the water table in well MW-58S, and traces of oil have been found on the water table at MW-59S, but the presence of oil at these locations may have resulted from the migration of oil into the well screens, then downward to the water table.

Contaminant concentrations in the shallow ground water at the site are highest on the Can Plant's south side and below the Can Plant near the underground tank area. However, the relatively low average horizontal hydraulic conductivity in the shallow, intermediate and deep ground water zones (4.5E - 04 cm/sec) and the low hydraulic gradient (0.005) in this area indicate that the contaminant migration rate is slow in the south and southeastern portions of the site compared to some other areas of the site. Ground water analytical data from wells installed in this area support this conclusion (Figure 3-4).

3.1.3 Northern Operable Unit

The northern operable unit is comprised of contaminated ground water.

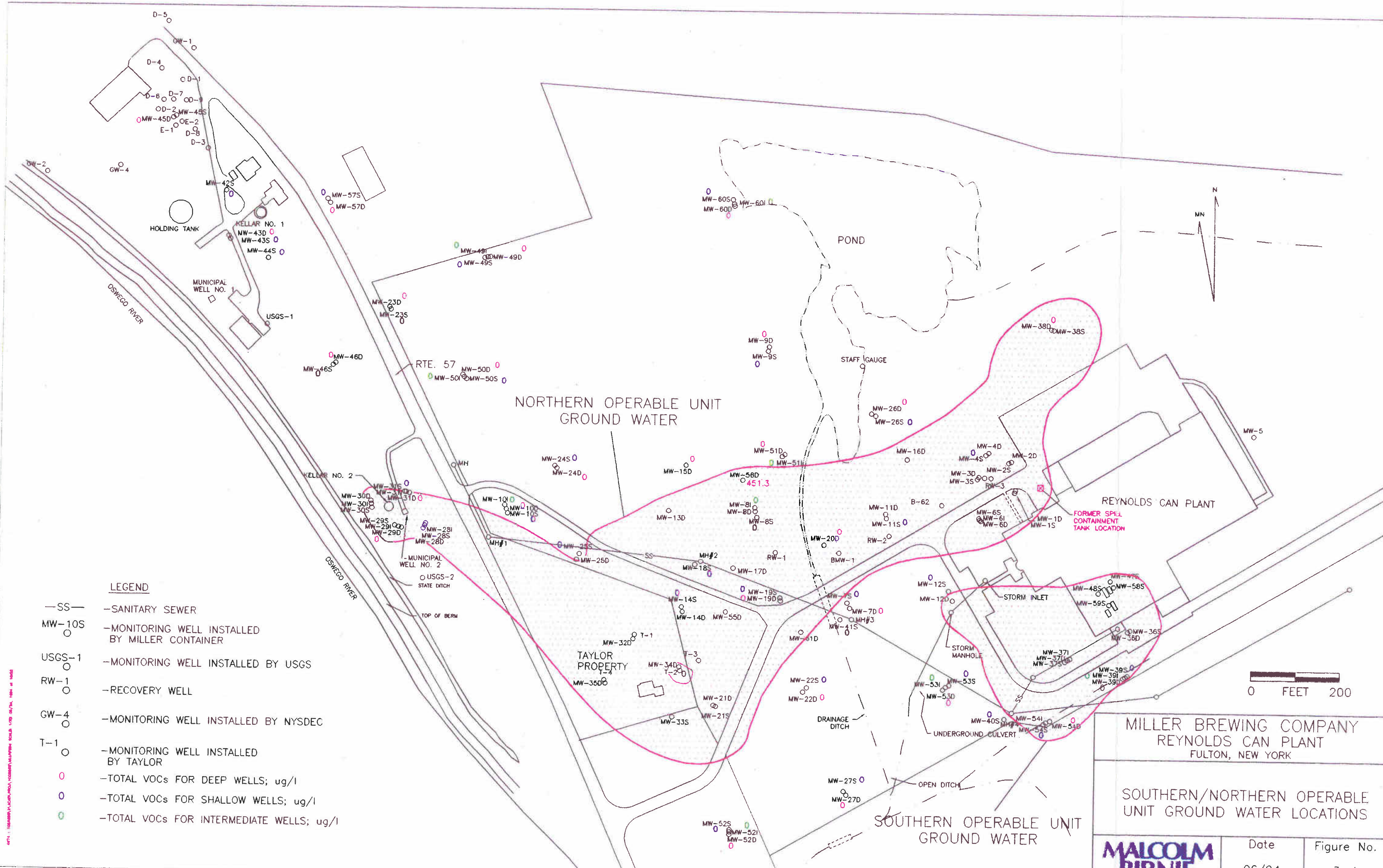
Ground Water - Shallow/Deep

The northern operable unit ground water is comprised of contaminated ground water originating from three source areas at the Reynolds Can Plant site. These areas are the Northern Drum Storage Area, the Former Spill Containment Tank Area, and the area located just east of the Taylor property. As shown in Figure 3-4, the contaminant plumes originating from these areas join together before being intercepted by either the on-site recovery well/treatment system or the off-site municipal well/treatment system; therefore, they will be treated as one operable unit. The plume originating from the Northern Drum Storage Area appears to join the plume coming from the Former Spill Containment Tank Area. In addition, the most likely source of the deeper zone contamination detected at MW-13D appears to be the migration of contaminated ground water that originates in the shallow zone in the Northern Drum Storage Area. The plume from the MW-13D area extends into the MW-25S,D area where it joins the plume of contamination originating in the MW-14D, MW-21S and Taylor property area. The migration of contaminants from these areas is toward K-2 and M-2.

A description of the contaminants present in the ground water located in the vicinity of each of the three areas included in the northern operable unit ground water is contained below. The approximate extent of the northern operable unit ground water is shown in Figure 3-4.

<u>Northern Drum Storage Area - Shallow</u>

Chlorinated VOCs such as TCA, TTCE, 1,1-DCA, and 1,1-DCE are present in the shallow ground water in the vicinity of the Northern Drum Storage Area. MIBK has also been found in the shallow ground water in the Northern Drum Storage Area. Contaminants originating from this area appear to be migrating to the intermediate zone, then to the deeper zone and joining the plume originating from the Former Spill Containment Tank Area. Eventually, contamination from these areas joins the contaminant plume emanating from the area east of the Taylor property.



MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK

SOUTHERN/NORTHERN OPERABLE UNIT GROUND WATER LOCATIONS

MALCOLM PIRNIE

Date	Figure No.
06/94	3-4

Former Spill Containment Tank Area - Shallow/Deep

Operation of the current ground water recovery well/treatment system at the site began in June 1988. The system was designed to capture the contaminant plume originating from the Former Spill Containment Tank Area. VOC contamination in the shallow ground water in the former tank area appears to be limited to the immediate vicinity. However, a deeper plume extends to the west and, for the most part, is being intercepted by the recovery well system. Ground water contaminant migration from the Former Spill Containment Tank Area is basically a function of the ground water flow patterns. Again, the major contaminants originating from this area are chlorinated VOCs, including TCA, TTCE, 1,1-DCE and 1,1-DCA.

Area Near Taylor Property - Shallow/Deep

Chlorinated VOCs are present in the shallow and deep ground water beneath, as well as east of the Taylor property. The shallow zone contamination, which is also found in the Former Spill Containment Tank Area and in the former Northern Drum Storage Area, is absent across the middle of the site, but reappears near MW-21S and in the shallow wells on the Taylor property. These data suggest a potential source area for ground water contamination east of MW-14D, MW-21S and the Taylor property.

The predominant compounds detected in the ground water sampled from MW-14D and MW-21S include TCA, TTCE, 1,1-DCE and methylene chloride. As previously stated, ground water contamination detected at K-2 and M-2 is connected to the contamination detected beneath the Taylor property and at MW-14D and MW-21S.

3.2 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are defined as goals established to protect human health and the environment. These are based on applicable standards, criteria and guidelines (SCGs), or applicable or relevant and appropriate requirements (ARARs), and the results of the baseline risk assessment. A summary of SCGs/ARARs is provided in Appendix A.

The remedial action objectives for contaminated media at the site (soil and ground water) are discussed in the following subsections.

3.2.1 Soil

Presently, there is little risk associated with the contaminated unit of soil at the Can Plant site which requires remediation. In the Human Health Risk Assessment, no pathways of concern were identified as possible exposure scenarios for the southern operable unit soil. Thus, the objective for remediation of the soil is to prevent the release of contaminants which would result in ground water or surface water contaminant levels in excess of SCGs/ARARs. The NYSDEC January 24, 1994 TAGM on the determination of soil cleanup objectives and levels was used to determine appropriate soil cleanup goals. These values are listed in Appendix A, and represent concentrations which would be protective of ground water/drinking water quality for its best use (based on each compound's affinity to adsorb onto soil organic material).

If the soil is excavated and treated, hazardous constituent concentrations will have to be brought down to action level concentrations in order for the medium to be classified as non-hazardous. This assumes that the soil contains hazardous constituents from listed hazardous waste identified in 6 NYCRR Part 371. Action level concentrations are defined in the NYSDEC November 30, 1992 TAGM, "Contained-In" Criteria for Environmental Media, and are listed in Appendix A.

3.2.2 Ground Water

The remedial action objectives for the contaminated ground water at the site are: 1) to reduce remaining VOC levels in ground water to their respective SCGs/ARARs (drinking water MCLs/Class GA values) and 2) to minimize the migration of contaminants beyond the site boundary at levels in excess of applicable SCGs/ARARs. The latter objective is based on the NYSDEC's requirement of providing comprehensive plume containment/control (June 21, 1994 letter).

If, during remedial action implementation, it is determined that reducing ground water contaminant levels at the site to their respective SCGs/ARARs is not feasible, this goal will be reevaluated. Specifically, a reevaluation will be performed if, after pumping the ground water for an extended period of time, contaminant levels in the ground water at the site are no longer being reduced by an appreciable amount.

If the ground water is extracted and treated as part of a selected remedial action, several action-specific SCGs/ARARs may apply, depending on the point of discharge. State Pollutant Discharge Elimination System (SPDES) standards for surface discharge to the Oswego River (a Class B stream), or Class GA ground water effluent standards for reapplication to ground water not under the influence of recovery well pumping may be applicable. If the ground water is discharged to the POTW, sewer use standards will apply. The SCGs/ARARs for Class GA ground water and Class B surface water can be found in Appendix A.

The SPDES discharge limits would be determined based on the Class B stream standards. The SPDES discharge limits established by the NYSDEC for discharge from the 1 MGD City of Fulton Water Treatment Facility (WTF) to the Oswego River have been used throughout this FS for purposes of determining the level of ground water treatment that will be required at the site prior to discharge to the river. Most of the compounds detected at the site are listed on the City of Fulton WTF SPDES Permit. The discharge limit for the compounds on the Permit is 10 ug/l. If the selected remedial alternative includes discharge to the Oswego River under a SPDES Permit, when VOC contaminant levels in the extracted ground water fall below the required SPDES discharge limitations, direct discharge without treatment to the River should be possible.

It should be noted that the classification of the Oswego River in the vicinity of the Can Plant site is proposed to be changed from B to A as part of the Oswego River Basin reclassification being undertaken by the State; however, it has been communicated to Miller by a NYSDEC representative that the SPDES discharge limits for the City of Fulton WTF will not probably change even if the reclassification occurs.

3.3 GENERAL RESPONSE ACTIONS

General response actions were identified for each of the contaminated media at the Can Plant site. These actions address the site contamination problems so that the specified remedial action objectives will be met. The response actions developed for each medium are listed below.

Contaminated Medium	General Response Action
Soil	No Action Institutional Actions Excavation/Treatment/Disposal In-Situ Treatment Containment
Ground Water	No Action Institutional Actions Collection/Treatment/Discharge In-Situ Treatment Containment

The "no action" alternative is included as a response action in each category. The inclusion of this alternative is required by the National Contingency Plan (NCP). In addition, this alternative will serve as a baseline for comparison with other potential response actions.

Institutional actions are limited-action alternatives. These could include actions such as constructing a fence around a contaminated area of soil to prevent direct contact by Reynolds employees and trespassers. Deed restrictions could also be placed on the property.

Treatment actions could be implemented to immobilize or separate contaminants, thus removing the contamination source. The medium of concern could be excavated or collected for treatment, or treatment could be done in-place (in-situ). Following treatment, the remediated soil or ground water could be disposed of on-site or off-site.

Containment alternatives involve containment of wastes with little or no treatment. This type of response action protects human health and the environment by preventing potential exposure and/or reducing the mobility of contaminants.

3.4 IDENTIFICATION AND SCREENING OF APPLICABLE TECHNOLOGIES

Applicable remedial technologies were identified for each general response action. These technologies were then screened for each medium in each operable unit at the site. Factors considered in the screening included effectiveness and implementability of each technology. Properties of the contaminants of concern, site specific conditions and characteristics, and limitations of the technologies themselves were taken into account during the evaluation. Table 3-2 contains the technology screening results for the soil medium. Ground water remedial technology screening results are contained in Table 3-3.

The following subsections describe the identified technologies and, where applicable, provide a rationale for the elimination of certain potential technologies from further consideration.

3.4.1 Contaminated Soils

3.4.1.1 Institutional Actions

Institutional actions, or limited-action technologies, would include fencing an area of contamination to prevent direct contact with both environmental receptors and Reynolds employees or trespassers. Another institutional action would be to place a deed restriction on the property. As previously stated, future use of the land should be easily controlled. Institutional actions appear to be applicable to the southern operable unit soil at the site.

3.4.1.2 Partial or Complete Removal

Contaminated soils excavation is usually followed by treatment and disposal. It is often possible to excavate and remove contaminant "hot spots" and implement other remedial measures for less contaminated soils.

Excavation of VOC contaminated soils in the southern operable unit is not considered to be feasible. The area requiring remediation in this area is located directly beneath the building. Excavation through the plant floor would not be practical, nor would excavating laterally from outside the plant. Any type of intrusive activities would disrupt normal operations. Although excavation would not be a feasible remedial technology for the southern operable unit soils, it will be included as an alternative to undergo preliminary screening, in accordance with the NYSDEC request in its August 7, 1992 Draft RI Report comment letter.

3.4.1.3 On-Site or Off-Site Treatment of Excavated Soils

On-site or off-site treatment actions include physical/chemical, biological, or thermal treatment options. A discussion of each of the available technologies is contained below.

A.) Physical/Chemical Treatment

The physical/chemical treatment processes which were reviewed include: stabilization/solidification, mechanical soil aeration, soil venting, and soil washing.

TABLE 3-2
REYNOLDS CAN PLANT – SOIL REMEDIATION
SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

General Response Action		Remedial Technology	Process Options	Applicability: Southern Operable Unit
No Action		No action	Not applicable	YES
Institutional Actions		Access restrictions	Deed restrictions	YES
			Fencing	YES
Excavation/Treatment/Disposal				
	Excavation	Excavation	Soils excavation/partial excavation	YES*
	Treatment	Stabilization/Solidification	Sorption	NO
			Pozzuolanic agents – cement, fly ash	NO
			Encapsulation	NO
		Dewatering	Dewatering/drying beds	YES
		Physical	Aeration	YES
			Soil venting	YES
		Chemical	Soil washing	YES
		Biological	Cultured micro-organisms	YES
		Thermal	Incineration – Rotary kiln	YES
			– Infrared	YES
			– Fluidized/Circulating bed	YES
			Pyrolysis	YES
			Low temperature thermal treatment	YES
	Disposal	On-site	Landfill	NO
			Backfill excavation	YES
		Off-site	RCRA facility	YES
			Non-RCRA facility	YES
In-situ Treatment		In-situ	Vapor extraction	YES
			Bioremediation	YES
			Soil flushing	YES
			Solidification/stabilization	NO
			Vitrification	NO
			Bioventing	NO
			Steam injection	YES
Containment		Capping/Horizontal Barriers	Clay/soil cap	NO
			Asphalt/concrete cap	NO
			Synthetic membrane	NO
			Multilayer cap	NO
			Liners	NO
			Grout injection	NO
		Vertical barriers	Slurry wall	NO
			Grout curtain	NO
			Sheet piling	NO
		Surface controls	Diversion/collection	NO
			Grading	NO
			Stabilization	NO

NOTE: * Indicates technology was requested by the NYSDEC to be included as an alternative to undergo preliminary screening (NYSDEC August 7, 1992 letter).

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TABLE 3-3
REYNOLDS CAN PLANT – GROUND WATER REMEDIATION
SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

General Response Action	Remedial Technology	Process Options	Applicability	
			Southern Operable Unit	Northern Operable Unit
No Action/No Further Action	No action	Not applicable	YES	YES
Institutional Actions	Access restrictions	Deed restrictions	YES	YES
	Monitoring	Ground water monitoring	YES	NO
Collection/Treatment/Discharge				
Collection	Extraction/pumping	Wells	YES	YES
	Drains	Interceptor trenches	NO	NO
Treatment	Biological	Aerobic	YES	NO
		Anaerobic	YES	NO
	Physical	Air stripping: tower	YES	YES
		diffused bubble	YES	YES
		Steam stripping	YES	YES
		Distillation	NO	NO
		Carbon adsorption	YES	YES
		Coagulation/flocculation	NO	NO
		Ion exchange	NO	NO
		Oil-water separation	YES	NO
	Chemical	Precipitation: sulfide	NO	NO
		carbonate/hydroxide	NO	NO
		phosphate	NO	NO
		Oxidation: ozone/hydrogen peroxide	YES	YES
		hydrogen peroxide/UV	YES	YES
		UV/ozone	YES	YES
		Membrane-assisted solvent extraction	NO	NO
	Off-site	WWTP	NO	NO
		RCRA facility	NO	NO
Discharge	On-site	On-site pond	YES	YES
		Reapplication to ground water	YES	YES
		Deep well injection	NO	NO
	Off-site	WWTP	YES	YES
		Oswego River	YES	YES
In-situ Treatment	In-situ	Bioremediation	YES	NO
		Aeration/Air sparging	YES	YES
Containment	Capping/Horizontal barriers	Clay/soil cap	NO	NO
		Asphalt/concrete cap	NO	NO
		Synthetic membrane	NO	NO
		Multilayer cap	NO	NO
		Liners	NO	NO
		Grout injection	NO	NO
	Vertical barriers	Slurry wall	NO	NO
		Grout curtain	NO	NO
		Sheet piling	NO	NO

- **Stabilization/Solidification**

Stabilization and solidification are technologies used to modify the chemical and physical matrix of a waste to reduce the mobility and/or solubility of the contaminants present. Stabilization usually involves the addition of materials which chemically limit waste constituent solubility or mobility. Solidification technologies are implemented to mechanically bind contaminants in a material with high structural integrity. Solidification does not necessarily reduce the leaching of hazardous constituents. Remedial actions involving a combination of both stabilization and solidification are often used to maximize their effectiveness.

Most stabilization/solidification techniques involve the thorough mixing of a solidifying agent with the waste. This, in turn, can greatly increase the resulting volume of material and limit on-site usage to areas where adequate space is available. If off-site disposal of the treated waste is planned, a greater amount of material will have to be transported and disposed.

In addition, stabilization/solidification technologies generally are not as effective in controlling VOC contaminants as they are with metals. Thus, stabilization and solidification would not be applicable to the contaminated soils at the Reynolds Can Plant site and will not be considered further in the FS.

- **Mechanical Soil Aeration**

Volatilization of organics can be accomplished by mechanically aerating VOC contaminated soil. The soil is excavated and spread out on an impermeable surface where it is aerated. Air emissions must be considered, and some type of engineering control may be necessary. Adequate space is also required since the depth of the material to be aerated should be kept to a minimum. The soil should be kept dry to improve volatilization.

Since space is available for soil aeration at the site, and air emissions could be controlled through the implementation of engineering controls (such as construction of a bubble-type enclosure), this technology will be considered further for the treatment of excavated soils at the Can Plant site.

- **Soil Venting**

This technology is used to remove VOCs from excavated soils and involves drawing a vacuum on perforated pipes installed in the excavated soil piles. The induced vacuum creates air flow through the soil, and VOC-contaminated vapor is withdrawn. The removed air can then be discharged to the atmosphere, treated with carbon, a catalytic oxidizer, or an incinerator. The properties of the VOCs identified at the site are generally within the range considered amenable to soil venting. However, an area with an impermeable surface would be required for staging the excavated soil for treatment. This technology will be considered further in the FS for the treatment of excavated soils.

- **Soil Washing**

With soil washing, contaminants are leached from the soil by means of the introduction of a liquid washing solution. The solution can consist of water, complexing or chelating agents, surfactants, solvents, acids, or bases. This technology is most effective on sandy soils with moderate to high permeabilities. Clays and clay-like soils typically do not respond well to soil washing.

In a typical application, excavated soils are screened to remove rocks and other large objects. The soil is then mixed with a solvent, and the contaminants are allowed to migrate into the washing solution. After this step, the soil and solvent are separated, typically through physical dewatering. Contaminants are usually then removed from the solvent for treatment or disposal, and the fluid is reused. Soil washing would be applicable to the VOC contaminated soils that may be excavated at the Can Plant site and will be considered further.

B.) Biological Treatment-Bioremediation

Bioremediation is a process that uses microorganisms to decompose hazardous substances. This technology is possible because microorganisms can use organic compounds as food and break them down. The two types of microbial activities of most interest in bioremediation are: aerobic and anaerobic. Treatment using aerobic bacteria requires the availability of free dissolved oxygen, whereas anaerobic treatment utilizes "chemically bound" oxygen (such as nitrates), or the energy present in the organic substances, to break down organic material. Certain environmental conditions can be optimized to promote bioremediation, including: oxygen concentration, nutrient supply, pH and soil moisture content.

In addition to naturally occurring microorganisms, specially adapted or genetically manipulated microorganisms can be applied to the contaminated soil to promote remediation. Specific organisms are better at biodegrading certain compounds, so it is most feasible to have a combination of many different types of microorganisms. In this way, bacteria can degrade the primary organic compounds as well as their degradation intermediates.

Advances in biotechnology are being made which enable chlorinated VOCs to be degraded in addition to petroleum hydrocarbons. However, the use of bioremediation to destroy chlorinated VOCs has been shown to be effective mainly on the pilot scale level. Bioremediation will be considered for use in treating the southern operable unit soils, where oil is present, since this technology has been proven effective in treating petroleum hydrocarbons in the field.

C.) Thermal Treatment

Thermal treatment involves heating a contaminated material under controlled conditions to destroy or remove the hazardous constituents present. Byproducts consist of carbon dioxide, water vapor, gases, and ash. Thermal treatment technologies include incineration (rotary kiln, infrared, fluidized/circulating bed), pyrolysis (heating in the absence of oxygen), and low temperature thermal treatment.

A thermal treatment system typically consists of screening and conveyor equipment, an incinerator or kiln, a combustion or oxidizing chamber, and a vapor treatment system. In order for this technology to be effective, the boiling temperature of the contaminants must be lower than the soil melting point, and the contaminants should have high BTU values. Given these factors, thermal treatment is effective in reducing VOCs. This technology will be considered as a possible treatment alternative for any excavated contaminated soils at the Can Plant site.

3.4.1.4 On-Site or Off-Site Disposal of Excavated Soils

A.) On-Site Disposal

On-site disposal of hazardous soils and sludges generated by the excavation of contaminated material or on-site treatment processes would require the construction of a secure landfill that meets Resource Conservation and Recovery Act (RCRA) and State requirements. The landfill would have to be lined, an impermeable cover would be required to minimize infiltration and leachate production, and a leachate collection system would have to be constructed. In addition, the local ground water table could not come into contact with the facility. Since the water table at the site is variable and may be relatively shallow, and any landfilling of waste at the site would be impractical since Miller no longer owns the facility, construction of a secure landfill will not be considered further.

An on-site landfill would not necessarily have to meet all RCRA requirements if the material to be landfilled is delisted or is no longer considered a hazardous waste. This type of low-hazard waste could be disposed of on-site in a sanitary landfill constructed in accordance with 6 NYCRR Part 360. However, as previously discussed, construction of an on-site landfill is not seen as a feasible option for soils disposal.

One method of on-site disposal which will be considered further is the backfilling of treated soil into the area from which the soil originated. This could be done provided the VOC contamination was removed or reduced to a point where the soil was considered to be non-hazardous.

B.) Off-Site Disposal

Off-site contaminated soil/waste disposal involves transporting material to either a secure landfill or a sanitary landfill for disposal. If a material is classified as a hazardous waste, it must be landfilled in a secure RCRA-permitted facility. The material can be hazardous based on its source or because it exhibits hazardous characteristics (reactivity, corrosiveness, ignitability or toxicity). Certain hazardous wastes are banned from secure landfills unless they are treated to specific standards. If a characteristic waste is treated and no longer exhibits the hazardous characteristic, it can be disposed of at a sanitary landfill. Off-site disposal will be considered further in the FS.

3.4.1.5 In-Situ Treatment

A number of technologies involving in-place physical or chemical subsurface treatment have been developed to immobilize and detoxify waste constituents. These technologies include vapor extraction, bioremediation, soil flushing, stabilization/solidification, vitrification, bioventing, and steam injection.

A.) Vapor Extraction

An in-situ vapor extraction system operates by inducing air flow through the contaminated unsaturated soil layer. As air passes through the soil, it entrains and removes contaminants that exist in the vapor phase. The VOC-laden gas is collected and discharged to the air. The gas may be treated prior to discharge, depending on regulatory requirements.

A typical system consists of a series of vacuum wells installed at strategic locations in the contaminated soil area. The wells are connected by piping and manifolded to a vacuum pump or blower. The pump is usually connected to a vapor treatment unit, which serves to reduce VOC vapor concentrations to established discharge levels. The treatment unit is generally a carbon adsorber, catalytic oxidizer, or incinerator.

Air can be injected or drawn through inlet wells to enhance air flow through zones of maximum contamination. Creation of subsurface fractures by injecting high pressure air (pneumatic fracturing) increases extracted air flowrates, vapor phase VOC concentrations, and contaminant extraction rates.

Results of a vapor extraction pilot test conducted by Terra Vac in the area south of the plant during July 1992 indicated that vapor extraction would be effective at the Can Plant site, provided the ground water table is maintained at an elevation below that of the vacuum well screens. Therefore, this technology will be considered further in the FS.

B.) Bioremediation

In-situ bioremediation uses microorganisms to decompose organic compounds in soil. Naturally occurring organisms generally biodegrade a wide range of compounds, given proper nutrients and sufficient oxygen. Microbial activity can be optimized by providing an oxygen source and nutrients to the subsurface, usually through injection wells or an infiltration system. Specially adapted microorganisms are also available and can be added to the soil/ground water zone. This technology will be incorporated into clean-up alternatives for the contaminated soils in the southern operable unit because it could be effective in treating any residual oil contamination which may be left after the oil recovery process is completed.

C.) Soil Flushing

In-situ soil flushing involves applying a washing solution to contaminated soils in place in order to enhance contaminant solubility and remove the contaminants from the soil. Water or an aqueous solution of solvent or surfactant is injected into the area of contamination. The contaminant elutriate is then pumped to the surface for removal, recirculation, or on-site treatment and reintroduction.

The washing solution can be gravity fed onto the contaminated area via flooding or ponding, or it can be forced into the ground through wells. Recovery can be via wells, open ditches, drains or sumps. This process usually generates large amounts of water and requires construction of a treatment facility to separate the VOC/surfactant mixture from the water. In addition, proper control measures must be included in the design in order to prevent uncontrolled migration of contaminants and washing fluid. This technology will be considered further in the FS.

D.) **Stabilization/Solidification**

In-situ stabilization/solidification involves the injection and blending of a stabilization/solidification agent into the soil to reduce the mobility and toxicity of the contaminants present. With stabilization, the contaminated soil is converted to a more chemically stable form, whereas solidification is the conversion of a waste, or contaminated soil, to a more solid form. Both technologies would be impractical and ineffective at the site based on the rationale presented in Section 3.4.1.3-A.

E.) **Vitrification**

In-situ vitrification is a technology that converts contaminated soils into a chemically inert glass and crystalline waste form in place. Its principle of operation is joule-heating, which occurs when an electrical current is passed through a molten mass. Typically, four electrodes are inserted vertically in the contaminated soil in a square array. A mixture of graphite and glass frit is placed between the electrodes on the surface of the soil to form a conductive path. An electrical current is then passed between the electrodes, heating the soil to temperatures of 1600 to 2000°C and pyrolyzing the organics. Off gases emitted during the process are collected by a hood over the area and routed to a treatment system. When the vitrification system is turned off, the molten mass of soil cools, producing a block of crystalline material that resembles obsidian or basalt. The subsided block of material can then be covered with clean fill to grade.

This process is only used in clays, or soils with high levels of clay, with high moisture contents, and is not usable under active slabs or paved areas. Given the type of material present below the Can Plant (mostly gravel, sand and silt), in-situ vitrification is not considered feasible for the clean-up of the southern operable unit soil. In addition, this technology would not be applicable because the area is covered with concrete and is actively used.

F.) **Bioventing**

Bioventing is similar to in-situ vapor extraction; however, subsurface air flow rates are optimized in bioventing to reduce volatilization and increase aerobic conditions for biodegradation. Air is injected into contaminated soil to serve as a source of oxygen. The air must flow through the contaminated soil at rates and configurations that ensure adequate oxygenation and minimize volatilization of VOCs. The air is then withdrawn from the outlying cleaner soils, allowing the more volatile organics to degrade prior to being withdrawn. Nutrients and moisture can be added to the area being treated if necessary. This technology eliminates the need for air treatment of the extracted compounds and is effective in treating non-volatile petroleum fractions.

Bioventing, however, would not be applicable to the chlorinated VOCs present at the site. The degradation half-lives of chlorinated VOCs are much greater than those of compounds such as benzene and toluene (several hundred days compared to less than 25 days), the latter VOCs being effectively treated with this technology. The air flow induced through the areas of contaminated soil would have to be small enough to ensure that the chlorinated compounds are biodegraded and not volatilized. The length of time which would be required to do this would be extremely great, making this type of biotreatment infeasible. Vapor extraction would be much more practical since a higher air flowrate and, thus, a higher contaminant removal rate could be achieved. The period of time required for remediation would be much less for vapor extraction than bioventing. Bioventing will not be considered further in the FS.

G.) Steam Injection

Steam injection (or stripping) is also similar to vapor extraction because the contaminants are removed from the soil in vapor form. The difference is that the soil is heated to encourage evaporation. Steam can be delivered to the soil either by attaching a steam source to a bucket auger and moving the auger up and down in the contaminated zone or through injection wells. Vapors can be recovered in adjacent vapor extraction wells.

This technology is most applicable in soils with large pore spaces and low clay contents, and allows contaminated soils to be treated in a shorter amount of time than when vapor extraction is utilized alone. However, a disadvantage of this technology is that the steam can condense and serve to transport contaminants to the ground water. Since this problem can be overcome through proper system design and well placement, steam injection will be evaluated.

3.4.1.6 Containment

Containment technologies include capping or installation of horizontal barriers, installation of vertical barriers, and construction of surface controls. These actions are intended to reduce the migration potential of contaminants by limiting or preventing contaminant leaching. Each technology considered is described below.

A.) Construction of Horizontal Barriers/Capping

Horizontal barriers are surface barriers which prevent the infiltration of precipitation into contaminated soils. If surface contamination exists, these types of barriers inhibit the mobilization of the contaminants from the soil and isolate the wastes from direct contact. Horizontal barriers include impervious liners, grout barriers, and caps. Caps can be constructed of such materials as clay soils, synthetic membranes, asphalt, and concrete. This technology will not be considered for the southern operable unit since this area is already covered with concrete.

B.) Construction of Vertical Barriers

Vertical barriers are subsurface barriers which restrict ground water movement through contaminated soil or other unconsolidated material. This, in turn, restricts the transport of contaminants. An example of a vertical barrier is a slurry wall, which is constructed with either a soil-bentonite or a cement-bentonite slurry. Grout curtains and sheet piling are other examples of vertical barriers.

Vertical barriers, however, would not be very effective at the Can Plant site due to the difficulty/inability in keying them into a competent confining layer. They will be eliminated from further consideration in the FS.

C.) Installation of Surface Controls

Diversion/collection systems, grading, and soil stabilization are examples of surface controls. The purpose of these technologies is to reduce leaching from the infiltration of precipitation. These technologies are not applicable for the southern operable unit since the soil is capped beneath the plant.

3.4.2 Contaminated Ground Water

3.4.2.1 Institutional Actions

Institutional actions applicable to the ground water at the site would include restricting access to the property to prevent use of the ground water, and long-term monitoring to ensure that ground water in downgradient wells was either below SCGs or that contaminated ground water above these levels was contained on-site. Monitoring would not be an effective remedial technology for the northern ground water operable unit since the contaminant plume has migrated off-site and is being intercepted by two of the municipal wells (K-2 and M-2).

3.4.2.2 Ground Water Recovery/Collection

Ground water collection usually involves pumping ground water from recovery wells or draining ground water into interceptor trenches. These technologies are used to control contaminant plumes through adjustment of the water table elevation and the development of hydraulic barriers. They are most effective at sites where the ground water bearing units have high hydraulic conductivities and the contaminants are readily transported in water. Interceptor trenches are limited to use in shallow applications due to excavation limitations and vertical contaminant migration concerns.

Ground water recovery systems can be operated in conjunction with injection or flushing systems to accelerate contaminant removal. Treatment of extracted ground water is usually necessary. Treatment technologies are discussed in the next section. Ground water recovery will be evaluated further.

3.4.2.3 Ground Water Treatment

Ground water treatment can be carried out either on-site or off-site, or can consist of on-site pretreatment followed by off-site treatment. Technologies that may be incorporated into any of these approaches include biological and physical/chemical treatment options. A discussion of each of the available technologies is contained below.

A.) Biological Treatment

Biological treatment systems are designed to expose ground water containing biologically degradable organic compounds to microorganisms in a controlled environment that contains enough nutrients for the biological reaction to proceed. The technology is based on the ability of microorganisms to use organic carbon as a food source. The most commonly used processes are those based on aerobic and anaerobic bacteria. Treatment using aerobic bacteria requires the availability of free dissolved oxygen, whereas anaerobic treatment utilizes "chemically bound" oxygen (such as nitrates), or the energy present in the organic substances, to break down organic material. Typical biological treatment systems include but are not limited to: activated sludge (suspended growth) and fixed film (rotating biological contactor (RBC)).

Chlorinated compounds like those present at the Can Plant site resist degradation by the traditional biological wastewater treatment processes, such as activated sludge, and usually pass through these types of treatment systems. Two special processes have, however, been shown to biodegrade chlorinated VOCs when operated together. The first process involves anaerobic bacteria that transform highly chlorinated VOCs (such as TTCE) to their intermediate daughter products (which include TCE). The second process involves aerobic, methane-utilizing bacteria that complete the breakdown of the compounds. RBC reactors can be used in this application.

However, biological treatment of chlorinated VOC contaminated water is a relatively new application and is still being developed for full-scale use. This technology will be included in the remedial alternatives developed for the southern operable unit ground water for the remediation of the residual oil which may be present in the recovered water. Biological treatment will not be considered further for treating the northern operable unit ground water.

B.) Physical/Chemical Treatment

The physical and chemical ground water treatment processes considered for use at the Can Plant are described below.

- **Air Stripping/Steam Stripping**

Stripping processes rely on the principle of mass transfer to transfer contaminants from a contaminated water stream to a gas stream. In air stripping units, contaminated water comes into contact with air which strips the volatiles from the water. The gas is discharged to the atmosphere with or without treatment while the clean water exits the unit. Steam stripping is a variation of air stripping which utilizes steam as the stripping medium.

Air stripping is effective for dilute waste streams containing highly volatile organics and organics with low water solubilities (e.g., chlorinated hydrocarbons). In general, there are two different types of air strippers: towers and diffused bubble units. In towers, the contaminated water is distributed across the top of packing material and flows downward. Air is blown up through the packing to strip the VOCs into the air which is then discharged through the top of the tower. The clean water exits from the bottom of the tower. This type of unit is currently in operation at the site and was installed as part of the IRM undertaken by Miller to control the contaminant plume originating from the Former Spill Containment Tank Area.

In low profile diffused bubble strippers, air is bubbled up through chambers of flowing water. The chambers can be stacked either horizontally (multi-cell style) or vertically (tray style). These strippers require higher air flow rates than stripping towers since they operate at higher air to water ratios. Also, the blowers are usually sized larger due to the higher pressure drops encountered in the bubble strippers. However, fouling problems from high levels of iron or manganese are greatly reduced since packing material is not utilized.

Steam stripping uses steam to evaporate VOCs from contaminated water. The steam is introduced into the bottom of a tower and vaporizes volatile compounds as it passes up through the falling water. The contaminated steam then exits the top of the tower and is sent to a condenser in preparation for additional purification treatment. This type of stripping is effective in treating chlorinated VOCs as well as ketones.

Both of the above technologies would be applicable to the ground water at the Can Plant site. Steam stripping of ground water withdrawn from the southern area would enable the efficient removal of the ketones which have been detected in that area. If air stripping were to be utilized, an additional polishing step, such as carbon adsorption, would most likely be necessary to reduce ketone concentrations to the required treatment levels.

- **Distillation**

Distillation involves heating an organic contaminated aqueous waste to evaporate the volatiles, and then condensing them out for reuse or disposal. The two major types of distillation are batch and continuous fractional distillation. The technology is primarily used to separate liquid organic wastes for solvent reclamation and waste reduction. Halogenated as well as nonhalogenated solvents can be recovered through distillation. Since this process is more applicable to the separation of spent solvents than to the separation of relatively low concentrations of VOCs from ground water, this technology is not considered to be applicable to the operable unit ground water at the site.

- **Activated Carbon Adsorption**

Activated carbon removes organics from aqueous waste streams by adsorbing the contaminants onto the large internal pore surfaces of the carbon grains. Carbon adsorption is effective in treating a variety of organics, especially those exhibiting low solubilities and high molecular weights. Activated carbon is available in either a powder form or as granules. Powders are used in batch operations, where they can be added directly to the contaminated water. Powdered carbon is not used in columns due to the high pressure drop which would result. Granules are generally used in columns and can be reactivated for reuse. Reactivation involves heating the carbon to volatilize and pyrolize the adsorbed molecules, thus opening the adsorptive areas on the carbon grains.

Carbon adsorption can be readily implemented at hazardous waste sites and can effectively remove dissolved organics from aqueous wastes. Clean-up efficiencies can be reduced if there are high concentrations of suspended solids. Backwashing, however, can be implemented to remove solids from a carbon column to restore its usability. Backwashing is done by reversing water flow direction and allowing the water to flow with sufficient velocity to expand the carbon bed and dislodge any particles.

Activated carbon is effective in treating chlorinated hydrocarbons, such as TTCE and TCA. Ketones, such as MEK and MIBK, are also removed by carbon, but at a much lower efficiency. This technology will be considered further in the FS.

- **Coagulation/Flocculation**

This process involves the addition of a coagulant or coagulant aid, such as alum, organic polymer or sodium hydroxide, to water to cause colloidal particles to agglomerate into a floc large enough to be removed by a subsequent clarification process. Process performance is affected by chemical interactions, temperature, pH, solubility variances, and mixing effects. This technology is utilized to remove metals and solids from wastewater, but is not effective in removing VOCs. Thus, coagulation/flocculation will no longer be considered as a viable technology for ground water treatment at the site.

- **Ion Exchange**

In the ion exchange process, toxic ions are removed from a waste water stream and are replaced with ions held by an ion exchange resin. This technology is not applicable to VOC contaminated water and will not be considered further in the FS.

- **Oil/Water Separation**

Oil/water separation uses the force of gravity to separate oil and water, two immiscible liquids which have sufficiently different densities. The wastewater flows into a chamber where it is allowed to settle. The floating oil is skimmed off the top by a skimmer while the water flows out of the lower portion of the chamber. Acids may be used to enhance the oil removal efficiency of the process by breaking the oil/water emulsion. This process offers a simple, effective means of phase separation provided the oil and water phases separate adequately within the tank residence time. Utilizing this technology in the southern area will probably be necessary since oil is currently present below the Can Plant in that area.

- **Chemical Precipitation**

Chemical precipitation involves the adjustment of the pH of a solution to remove dissolved metals. An acid or base is added to an aqueous waste to adjust the pH to a point where the metals to be removed have their lowest solubility. The metals may precipitate out as hydroxides, sulfides, carbonates, or other salts. Since this technology is not effective in treating VOC-contaminated water, it will not be considered further in the FS.

- **Oxidation - Ultraviolet Photolysis/Hydrogen Peroxide Addition/Ozonation**

Oxidation of organic compounds in water can be accomplished by employing a combination of two of the following technologies: ultraviolet (UV) photolysis, hydrogen peroxide addition, or ozonation. Through oxidation, organic molecules are broken down into a series of less complex molecules, eventually terminating with carbon dioxide and water. UV photolysis involves supplying UV radiation to an aqueous solution. The energy is adsorbed by the contaminant molecules, and they are elevated to higher energy states. This increases the ease of bond cleavage and subsequent oxidation. Hydrogen peroxide and ozone are excellent oxidizing agents due to their ability to provide oxygen atoms. Ozone is usually produced by high-voltage ionization of atmospheric oxygen.

Oxidation is effective in treating a wide variety of chlorinated hydrocarbons as well as other organics. Treatment utilizing UV photolysis is only effective on clear water, so prefiltering would be necessary for water containing high concentrations of suspended solids. Advanced oxidation process (AOP) systems utilizing UV light and hydrogen peroxide are available, but this technology by itself would be extremely difficult to implement at the Can Plant site. Much more technically implementable options are available for ground water treatment. This technology by itself will not be considered for the operable unit ground water at the site, but may be feasible if used together with another technology, such as air stripping.

- **Membrane-Assisted Solvent Extraction**

In membrane-assisted solvent extraction, contaminated ground water is pumped into a membrane extraction module where it comes into contact with a nonvolatile solvent. The solvent extracts the contaminants from the water. A porous membrane in the module separates the two liquid phases and provides a large area for mass transfer. The treated ground water leaves the unit, and the contaminated solvent is treated and recycled back to the extraction module. Treatment of the solvent involves heating it to vaporize the VOC contaminants and subsequently recovering the VOCs in a condenser. Regeneration of the solvent is difficult, however, and a special membrane-assisted vaporization procedure must be employed. This is due to the low partial pressures of the VOCs above the solvent.

This is a newly developed and complicated technology. It has only been tested on a lab-scale (1 gpm), and no full-scale systems have been constructed. Since there are options which are much more easily implemented and proven, this technology will not be evaluated further as a possible treatment alternative.

3.4.2.4 Ground Water Disposal

Four avenues were identified for treated ground water disposal: discharging it to surface water (the on-site pond or Oswego River), reapplying it to soil/shallow ground water, deep well injection and routing the water to the publicly owned WWTP. These options are described below.

A.) Surface Water Discharge

Treated ground water may be discharged to a nearby body of surface water. Two possible water bodies into which the water from the site could be discharged are the on-site pond and the Oswego River. The effluent criteria for a treated ground water discharge to the pond, however, would be much more stringent than if the ground water were discharged to the Oswego River since the on-site pond recharges ground water and the dilution afforded by the volume of Oswego River water would not be available in the pond. SPDES requirements would have to be met for off-site disposal into the Oswego River; however, the actual permitting process would be minimized since any remedial work would be performed under an Order on Consent. Disposal to surface water (the Oswego River) is seen as an applicable technology at the Can Plant site.

B.) Recirculation to Ground Water

Treated ground water may be recirculated back into the aquifer from which it was withdrawn. This approach can be used to help direct the flow of contaminated ground water toward recovery wells or interceptor trenches. This technology can also be utilized to wash contaminants from in-situ contaminated soils or distribute nutrients to the subsurface to enhance microbial activity for bioremediation. Ground water reapplication within the capture zone of recovery wells may be a feasible alternative and will be considered further in the FS.

C.) Deep Well Injection

Deep well injection is usually employed to dispose of highly contaminated or very toxic wastes which are not easily treated or disposed of by other methods. It involves pumping liquid waste underground into geologically safe strata. There must be a substantial impervious caprock stratum overlying a porous stratum that is isolated from drinkable water and extractable minerals. This disposal method permanently isolates liquid wastes from the environment.

Deep wells are drilled through impervious caprock layers into such unusable strata as brine or saline aquifers. Great care is required in well-casing design and operations to avoid waste leakage which could contaminate usable fresh water supplies. It is also important that the disposal formation is able to dissipate the hydraulic head of injection.

Although the USEPA administers the deep well injection program, the NYSDEC does not recognize deep well injection as an acceptable means of disposal. Also, the permitting process itself could make this technology infeasible to implement due to lengthy delays. Only one deep well injection permit has been issued in New York State. Because of the extreme difficulty involved in implementing this technology, deep well injection will no longer be considered as a feasible alternative for ground water disposal.

D.) Wastewater Treatment Plant (WWTP)

Contaminated ground water from the site may be pretreated on-site and then discharged to the sanitary sewer for final treatment at the WWTP, or it may be routed directly to the WWTP for treatment. The latter case would not be applicable at the Can Plant site, since adequate treatment of the chlorinated compounds might not be provided by the WWTP alone.

However, on-site pretreatment followed by disposal to the WWTP is a feasible alternative. This type of treatment is currently being implemented in accordance with City of Fulton Industrial Wastewater Discharge Permit No. 008 for the ground water withdrawn from the three recovery wells at the site. The ground water is being recovered to control the contaminant plume originating from the Former Spill Containment Tank Area and is being treated with an air stripping tower before being discharged to the sanitary sewer/WWTP. Discharge of pretreated water from an expanded recovery system to the City of Fulton WWTP would require a new Sewer Use Permit. The feasibility of this alternative will be evaluated in the FS for the operable unit ground water at the site.

3.4.2.5 In-Situ Treatment

In-situ treatment entails the use of biological, physical or chemical methods to degrade or remove contaminants in place. The most frequently used technologies are described below.

A.) Bioremediation

Bioremediation of ground water is a technique used for treating zones of contamination by aerobic and/or anaerobic microbial degradation. The basic concept involves altering environmental conditions to enhance microbial metabolism of organic compounds. Typically, extraction/injection wells are used to extract the contaminated ground water for oxygenation and the addition of nutrients and bacteria and recirculate it back into the ground. The bacteria can then degrade contaminants present in the in-situ soil and ground water.

This technology has been successfully applied to nonhalogenated organics to reduce contaminant levels in soils and ground water. However, a process employing both anaerobic and aerobic bacteria has been shown to be effective in treating chlorinated compounds as well. This process, known as Two-Zone Plume Interception Treatment, employs anaerobic reductive dehalogenation followed by aerobic treatment of the byproducts. Recovery and injection wells are used to establish two zones through which the contaminated plume flows. The first zone, immediately downgradient of the plume, is created by withdrawing ground water from a first row of wells. Nutrients are added and the treated water is reinjected. The nutrients increase the action of the anaerobic methanogens, encouraging partial dechlorination of contaminants such as TTCE. In the second zone, located immediately downgradient of the first, the ground water is withdrawn from a second set of wells, aerated using oxygen or hydrogen peroxide, and is reinjected. This creates conditions that favor the growth of aerobic, methane utilizing bacteria which degrade the remaining contaminants. Two-Zone Plume Interception Treatment has only recently been developed and would be extremely difficult to implement and control at the Can Plant site. Bioremediation may be applicable to the southern operable unit ground water to treat any oil contamination, and will be carried through as a possible remedial alternative for that unit. However, the technology will not be considered further for the northern operable unit ground water because of the difficulty associated with its implementation for chlorinated VOC treatment.

B.) Aeration/Air Sparging

Air sparging, or in-situ air stripping of ground water, involves injecting air into the ground water and subsequently recovering the air through vapor extraction wells screened above the water table. The injected air comes into contact with the contaminated ground water and strips the VOCs from the water. The contaminated air is then drawn up into the vacuum wells and discharged to the atmosphere. The air may be treated prior to discharge, depending on regulatory requirements. Treatment generally consists of carbon adsorption, catalytic oxidation, or thermal incineration.

This technology is applicable to high-permeability settings with limited soil layering involving low permeability layers and eliminates aboveground treatment of extracted ground water. It is effective in treating most light hydrocarbons and chlorinated VOCs. Air sparging is considered to be a possible alternative for the remediation of the ground water in the site operable units.

3.4.2.6 Containment

Ground water containment consists of constructing barriers to restrict the vertical and/or horizontal movement of ground water. The vertical flow of ground water and the infiltration of precipitation into contaminated soils is prevented by the installation of horizontal barriers. These types of barriers include caps, impervious liners, and grout barriers.

Horizontal or lateral movement of ground water can be restricted by constructing vertical subsurface barriers. Typical technologies include slurry walls, grout curtains, and sheet piling. A slurry wall is constructed by excavating a vertical trench and filling it with either a soil-bentonite or a cement-bentonite slurry. The slurry is then allowed to dry, forming a hardened wall. Grout curtains are constructed by injecting one of a variety of fluids into a rock or soil mass. Once injected, the fluid remains in place to reduce water flow and strengthen the formation. However, grouted barriers are seldom used for containing ground water flow in unconsolidated materials at hazardous waste sites because of the difficulty in implementing the technology. Sheet piles can also be used to form a ground water barrier, and can be made of wood, precast concrete, or steel.

Construction of a horizontal barrier will not be considered for the southern operable unit since this area is already covered with concrete and asphalt. Also, this type of barrier will not be considered for the northern operable unit since contaminant levels in the source area soils are below their respective clean-up goals. Barriers would not be necessary to prevent the leaching of contaminants into ground water at levels exceeding SCGs since the levels present in the soils are below those determined to be protective of ground water/drinking water quality for its best use. Vertical barriers would not be effective at the Can Plant site due to the difficulty in keying them into a competent confining layer. Thus, vertical barriers will be eliminated from further consideration in the FS.

3.5 DEFINITION OF REMEDIAL ACTION ALTERNATIVES

In this section, the technologies determined to be potentially applicable for the remediation of each medium in each operable unit at the site are combined into remedial alternatives. Brief descriptions of the alternatives are provided.

3.5.1 Definition of Alternatives for Southern Operable Unit

3.5.1.1 Soil

The alternatives considered for the remediation of the VOC (and residual oil) -contaminated subsurface soils in the southern operable unit are listed below.

1. No action
2. Institutional actions - restrict access
3. Excavation/treatment/backfill on site
4. Excavation/off-site disposal
5. Excavation/treatment/off-site disposal
6. Vapor extraction
7. In-situ bioremediation
8. In-situ soil flushing
9. Steam injection

These alternatives are defined as follows:

Alternative 1 No action would be taken. The plant's concrete floor would remain intact and would serve as a barrier to prevent contact with the contaminated soils. This alternative is used as a baseline for comparison with the other remedial alternatives, and its inclusion is required by the NCP.

Alternative 2 The existing fence around the site would be maintained, and future use of the land would be restricted. As in the previous alternative, the concrete floor would serve as a barrier to the contaminated soils.

Alternative 3 The contaminated soils would be excavated, treated on-site and backfilled into the original excavation. Treatment options include physical, chemical, biological, or thermal methods. The concrete floor of the plant would have to be removed prior to excavation, and the excavation itself would remain open until the soil was treated and backfilled. The floor would then require replacement.

Alternative 4 The contaminated soils would be excavated and transported to an off-site disposal facility. Excavation in this area would be extremely difficult, though, since the soil contamination is located beneath the Can Plant. The plant's concrete floor would have to be removed and then replaced following excavation activities. Disposal of the excavated material would most likely occur at a RCRA-permitted facility (secure landfill).

Alternative 5 This alternative is similar to Alternative 4, but the excavated material would be treated on-site prior to being transported off-site for disposal. Treatment options include physical, chemical, biological, or thermal methods. Disposal at a sanitary landfill may be possible since the VOC contamination would be removed or reduced to a point where the material would be considered non-hazardous. Again, the concrete floor in the plant would have to be removed and replaced to allow for soils excavation.

Alternative 6 The VOCs in this area would be extracted as vapors which would be treated, if necessary, prior to being discharged to the atmosphere. The existing monitoring/recovery wells inside the plant (MW-58S and MW-59S) would be used as vapor extraction wells. Introduction of air to the subsurface could also promote biodegradation of any residual oil.

Alternative 7 Environmental conditions would be optimized in the southern operable unit soils to promote microbial degradation of the non-chlorinated VOCs (as well as the residual oil). Ground water would be withdrawn, nutrients or oxygen added, then the water would be recycled back into the soil in the area. The decommissioned underground tanks located below the plant could be used as withdrawal/reapplication points. Specially adapted microorganisms could also be added to the ground water before reinjection. To effectively treat the chlorinated VOCs, the withdrawn contaminated water may have to be treated through an additional process.

Alternative 8 A washing solution, such as water, would be applied to the in-situ soils in the area. The solution would then be withdrawn and treated prior to its reapplication. Again, the tanks below the plant could be utilized.

Alternative 9 Steam would be injected into the soils to strip the VOCs into vapor form. The vapors would then be recovered through vapor extraction wells and treated, if necessary, before being discharged to the atmosphere. As with Alternative 6, the existing monitoring/recovery wells inside the plant would be used as vapor extraction wells/steam injection wells.

3.5.1.2 Ground Water

The remedial alternatives developed for the ground water in the southern operable unit are as follows:

1. No action
2. Institutional actions - access restrictions/continued monitoring
3. Extraction/treatment/discharge*
4. Extraction/treatment/discharge with reapplication/bioremediation*
5. Extraction/treatment/discharge with air sparging/vapor extraction*

Note: * Alternatives 3 through 5, which involve extracting the ground water for treatment, would be expected to include oil-water separation.

A definition of each alternative is contained below.

Alternative 1 No action would be taken to remediate the contaminated ground water.

Alternative 2 Access restrictions would be maintained to prevent use of the ground water in this area. Also, sampling would continue to ensure that contaminants originating from the Southern Source Area are not migrating off site.

Alternative 3 The ground water would be pumped from both the existing six inch monitoring/recovery wells inside the plant and the recovery wells which would be installed outside the facility. The water withdrawn from the recovery wells inside the plant would pass through an oil-water separator, then the combined flow from all wells would pass through a VOC treatment system. The treated water would be discharged to either the sanitary sewer or surface water. If the water were to be discharged to surface water, discharging to the Oswego River would be more feasible than discharging to the on-site pond since effluent limits would be less stringent for the river due to its volume.

Alternative 4 Following extraction and treatment of the ground water in the southern area of the Can Plant, nutrients, oxygen, and, if necessary, bacteria would be added to a portion of the treated water. This portion would then be pumped back into the contaminated soils located below the Can Plant through the decommissioned underground tanks located inside the WWTF. These tanks have had holes drilled through them and sumps installed below them to recover oil from the gravel backfill material around the tanks. Conditions favorable for the biodegradation of the non-chlorinated VOCs and residual oil present in the soil would be created. The chlorinated VOCs would be removed from the withdrawn ground water by passing the water through carbon or through another type of process effective for chlorinated VOC removal prior to the in-situ biological treatment.

The portion of water not pumped back into the soils would be discharged to either the sanitary sewer or surface water. Recovery of the ground water would be facilitated by the existing recovery wells inside the plant and recovery wells which would be installed outside the facility.

Alternative 5 Ground water would be pumped from recovery wells in the southern operable unit, treated, and discharged to either the sanitary sewer or surface water. Air sparging would be implemented in the area of highest ground water contamination. Air would be injected into the ground water via injection wells, and a vapor extraction system would be used to recover the air through vacuum wells installed above the water table. The recovered vapors would be treated if necessary prior to discharging them to the atmosphere.

3.5.2 Definition of Alternatives for Northern Operable Unit

3.5.2.1 Ground Water

The alternatives considered for the remediation of the contaminated ground water extending westward from the Northern Drum Storage Area to the Taylor property and municipal wells are described below.

1. No further action - continued pumping of existing system at present rate (10 gpm)/continued discharge to WWTP
2. Institutional actions - access restrictions
3. Accelerated pumping from present recovery system at up to 17 gpm/discharge
4. Installation of additional recovery wells/extraction/treatment/discharge
5. Installation of additional recovery wells/extraction/treatment/discharge with air sparging/vapor extraction

<u>Alternative 1</u> No further action would be taken at the site. The current ground water recovery and treatment system at the site would continue to operate as at present. Treated water would continue to be discharged to the sanitary sewer/WWTP. Note: It may be necessary to replace the three existing recovery wells at the site due to age and wear of the recovery well casings and screens.

<u>Alternative 2</u> Operation of the current recovery well/treatment system would continue. In addition, limited action, such as restricting site access to prevent use of the ground water, would be taken. Ground water contamination originating from this area is migrating off-site toward the K-2 and M-2 municipal wells, where it is being intercepted. However, an air stripper designed to treat the water for municipal use is currently in operation at the waterworks. Under this alternative, replacement of the three existing recovery wells may be necessary due to their age.

<u>Alternative 3</u> Recovery of ground water from the existing withdrawal/treatment system would be increased to extend the cone of influence of each recovery well. The water treated with the air stripper would be discharged to the Fulton WWTP or surface water.

<u>Alternative 4</u> Additional recovery wells would be installed in the vicinity of the Northern Drum Storage Area, the Former Spill Containment Tank Area, and the area east of the Taylor property. Ground water withdrawn from these new wells and the three existing recovery wells would be piped to a treatment system. Treated water would be discharged to the sanitary sewer or surface water.

Alternative 5 Under this alternative, recovery wells would be installed in the Northern Drum Storage Area, in the Former Spill Containment Tank Area, and in the area east of the Taylor property. The new wells, along with the existing recovery wells, would be connected to a treatment system. Treated water would be discharged to either the sanitary sewer or surface water. Air sparging would also be implemented in the area of highest ground water contamination. Air would be injected into the ground water to strip the VOCs from the water into vapor form. The contaminated vapor would then be withdrawn through vacuum wells and discharged to the atmosphere. Treatment of the vapor prior to discharge may be necessary, depending on regulatory requirements. This alternative would involve the installation of air injection and vacuum wells throughout this area of the site.

4.0 PRELIMINARY SCREENING OF REMEDIAL ACTION ALTERNATIVES

4.1 SCREENING METHODOLOGY

In this section, the alternatives developed for the remediation of each medium in each operable unit at the site are screened on the basis of their effectiveness and implementability to determine which alternatives should be analyzed in detail. Alternatives determined to be cost prohibitive are also screened out in accordance with Section 7.3 of the NYSDEC-approved October 1990 RI/FS Work Plan. Alternatives surviving the preliminary screening stage are identified and will be incorporated into combined alternatives to address the site as a whole (Section 5.0). These combined alternatives will then be evaluated in greater detail in Section 6.0. The criteria used to screen the alternatives are contained in the USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, October 1988, and the NYSDEC TAGM "Selection of Remedial Actions At Inactive Hazardous Waste Sites", dated May 15, 1990. A brief description of each of the criteria is provided below.

The **effectiveness** evaluation of the alternatives screens each alternative based on its ability to protect human health and the environment. Both short-term and long-term effectiveness are evaluated. "Short term" refers to the period of remedial construction and implementation, up until the time when the remedial response objectives are met. "Long term" refers to the period of time after the remedial action is effective.

The following items are considered in the short-term effectiveness evaluation:

- Protection of the community and workers during remediation
- Environmental impacts
- Time until the remedial action objectives are achieved

The long-term criteria include:

- Magnitude of residual risk remaining from untreated waste or treatment residuals at the conclusion of remedial activities
- Adequacy and reliability of controls

Evaluation of the **implementability** of each alternative involves the examination of the administrative and technical feasibility of implementation, as well as the availability of services and materials. The ease of undertaking additional remedial action, if warranted, is also evaluated.

4.2 SOUTHERN OPERABLE UNIT

This section summarizes the results of the preliminary screening of the remedial alternatives for the contaminated media in the southern operable unit at the Can Plant site. The effectiveness and implementability of each alternative evaluated is discussed. Any alternatives screened out due to their cost prohibitiveness are noted. A discussion is then provided which compares the effectiveness and implementability of all alternatives screened for each medium. Alternatives which will be carried through to detailed analysis are noted.

In evaluating the remedial alternatives for the southern operable unit soil, it was assumed that oil recovery currently being undertaken in the area will be completed by the time of alternative implementation. It was also assumed that the source of perched water beneath the Can Plant would be removed beforehand.

4.2.1 Soil

4.2.1.1 Screening of Individual Alternatives

Alternative 1 No Action

In the Human Health Risk Assessment, no pathways of concern were identified as possible exposure scenarios for the southern operable unit soil. The building pad constructed over the area eliminates the possibility of direct contact with the soil. Thus, if no remedial action is undertaken, and the pad is not disturbed, no short-term risks would be posed to the community. However, risks would continue to be posed to the environment due to the presence of VOCs in the soil at levels greater than those considered to be protective of ground water. Implementing this alternative would not be effective in treating the contamination present, and would not be considered a permanent remedy. All untreated waste would remain in the soil.

This alternative would not be difficult to construct since no action would be taken. In addition, no delays would be expected and minimal coordination would be required. However, some future remedial action would most likely be necessary to treat or remove the contaminants from the soil. If no action is taken to reduce contaminant levels in the soil to levels protective of the ground water, remediation of the ground water would be required for a longer period of time than if the soil were remediated. Overall, the no action alternative would be very implementable but not effective.

Alternative 2 Institutional Actions

The effectiveness of this alternative would be similar to that of the no action alternative. Short-term risks would not be posed to the community; however, continued risks would be posed to the environment. Again, untreated waste would be left in the soil. Some minor maintenance would be necessary as part of this alternative to ensure that the barrier on top of the soil (currently the plant floor) remain intact and continue to prevent direct contact with the soil. Future use of the land would be restricted.

This alternative would not be difficult to construct, since it would involve only continued maintenance of an already existing barrier. Delays in implementing the action would be unlikely, and coordination with regulatory agencies would be minimal. As with the no action alternative, however, some future remedial action would be necessary. In addition, if the southern operable unit ground water requires treatment, the ground water remediation time frame would be longer if this alternative were implemented instead of a soil treatment option.

Alternative 3 Excavation/Treatment/Backfill On Site

Excavating the contaminated soil from beneath the plant for treatment would pose short-term risks during implementation. The resulting volatile emissions could pose a risk to employees and others working in the area during excavation, and the emissions would be difficult to control. However, this alternative would require little time to implement and, since on-site treatment of the soil would occur, the remedy would be classified as permanent. Provided access to all contaminated soil in the area could be gained, the remedial action objectives would be met and very little monitoring would be required to ensure the effectiveness of the action.

Due to the location of the contaminated unit of soil, this alternative would be extremely difficult to implement. All activity would have to take place when the Can Plant is shut down. Accurate as-built drawings are not available for the Can Plant, so it is not certain what structures or utility lines would be excavated. The excavation would also have to remain open until the soil was treated and could be backfilled. Mobilizing the necessary equipment into this area of the Can Plant and ensuring all emissions are captured and treated during excavation would also be difficult. Delays would be likely, and some future remedial action could be required if all soil contamination is not excavated.

Alternative 4 Excavation/Off-site Disposal

As described for Alternative 3, excavating the contaminated soil from beneath the Can Plant would pose short-term risks to workers and any employees in the area. Short-term risks could also be posed to the environment through the excavation and transportation of contaminated material off site where it would be treated and disposed. These risks would be minimized, though, through proper handling and management of the waste. By implementing this alternative, remedial action objectives would be expected to be met in a small amount of time since the contaminated soil would be removed from the site. Provided access to all contaminated soil in the area could be gained, very little monitoring would be required to ensure the effectiveness of the action.

The implementability of this alternative would be similar to that of Alternative 3, which also involves soils excavation. It would be difficult to construct, and delays would be likely. Delays could be due to problems encountered during excavation or coordination with the off-site disposal facility.

Alternative 5 Excavation/Treatment/Off-site Disposal

The effectiveness of this alternative would be very similar to the effectiveness of Alternatives 3 and 4, which also involve soils excavation. As previously discussed, short-term risks would be posed to both workers and any employees present in the area during implementation. Remedial action objectives would be met since the contaminated soil would be removed from beneath the plant. This alternative would be implemented in a relatively short time frame, and very little long-term monitoring would be required to ensure the effectiveness of the action.

Due to the combined post-excavation activities of treatment and off-site disposal, this alternative would be more difficult to implement than the previous alternative. More coordination would be necessary. As with the previous two, however, delays would be likely and some future remedial action may be required if all soil contamination is not recovered. In addition, ground water remediation, if undertaken, would take longer.

Alternative 6 Vapor Extraction

This alternative would involve the extraction and treatment of contaminant vapors from the existing monitoring wells/recovery wells inside the Can Plant. Short-term risks to on-site workers would be possible based on the potential for fugitive emissions during piezometer installation. However, these risks are considered to be minimal. Monitoring would be conducted and appropriate protective equipment would be worn. This alternative would be effective in treating the VOC contamination, and would minimally affect residual oil contamination left in the area by introducing air into the subsurface soils, thereby enhancing biodegradation of the oil. Vapor extraction would involve on-site treatment of the waste and would be classified as a permanent remedy. Remedial action objectives would be expected to be met through the implementation of vapor extraction, and no controls would be required after remediation.

This in-situ alternative would be more implementable than the excavation options since little to no intrusive activities would be necessary inside the Can Plant. The installation of additional vacuum wells would be required, though, if the contaminated area was not fully affected by the existing wells. Initial start-up testing would be required to verify the effectiveness of vapor extraction beneath the building. This technology is commercially available, and more than one vendor could bid on the project.

Alternative 7 In-situ Bioremediation

This alternative actually involves in-situ and ex-situ treatment. It would involve withdrawing ground water from the area, treating it for VOC contamination, adding nutrients or oxygen to the water, and flushing some of the treated water back through the subsurface soils. The underground tanks could serve as application and collection points. Risks posed to the environment would be controlled through proper operation of the ground water injection/recovery system. Remedial action objectives would be expected to be met with this alternative in a relatively short amount of time; however, the implementation time frame would be greater than that for the excavation alternatives. This alternative would be effective in treating the contamination, and only a minimal amount of long-term monitoring would be required to ensure the effectiveness of the alternative. Initial testing would be required, however, to determine the applicability of this alternative. Initial testing would include the performance of bench and pilot tests.

This in-situ alternative would be more implementable than the excavation options since little to no intrusive activities would be necessary inside the Can Plant. The installation of additional injection/withdrawal wells would be required, though, if the contaminated area was not fully affected by the existing injection points and wells. This technology is commercially available, and more than one vendor could bid on the project.

Alternative 8 In-situ Soil Flushing

The effectiveness of soil flushing would be comparable to that of in-situ bioremediation. The two processes are very similar, but bioremediation would involve an additional treatment step to break down the nonchlorinated compounds and residual oil. The short-term risks would be similar, but the time required to implement soil flushing (achieve remedial action objectives) could be slightly longer, since the additional step of bioremediation is not included in Alternative 8. This alternative would be effective in treating the contamination, and only a minimal amount of long-term monitoring would be required to ensure the effectiveness of the alternative. As with bioremediation, however, this technology has not been demonstrated at the site. Initial testing would be required to verify the applicability of soil flushing.

This in-situ alternative would be more implementable than the excavation options since little to no intrusive activities would be necessary inside the Can Plant. The installation of additional injection/withdrawal wells would be required, though, if the contaminated area was not fully affected by the existing injection points and wells. This technology is commercially available, and more than one vendor could bid on the project.

Alternative 9 Steam Injection

This alternative would involve the injection of steam into the soils below the Can Plant and extraction and treatment of contaminant vapors from the existing monitoring wells/recovery wells. Risks posed to the environment would be controlled through proper operation of the steam injection/vapor withdrawal system. This alternative would be more aggressive at cleaning the soil than vapor extraction, since the contaminants would be heated, volatilized, and captured. The time required to achieve remedial action objectives would thus be less. This alternative would be effective in treating the contamination, and only a minimal amount of long-term monitoring would be required to ensure the effectiveness of the alternative.

This alternative would be expected to be more difficult to implement than the other in-situ treatment alternatives. This is mainly due to the increased difficulty in constructing the system, with the installation of additional points for steam injection and the handling of steam itself. However, it is anticipated that no future remedial actions would be necessary, and this technology is commercially available.

Steam injection would be cost prohibitive. An extremely large amount of steam would have to be produced to remediate the soils below the southern portion of the Can Plant. In general, the disadvantage of the costs associated with steam generation and injection would far outweigh the advantage of possibly reducing the clean-up time frame over that of vapor extraction.

4.2.1.2 Screening Summary

A) Effectiveness Comparison

The most effective remedial alternatives were determined to be those involving treatment of the contaminated soils in place, without excavation. These alternatives are vapor extraction (#6), bioremediation (#7), soil flushing (#8), and steam injection (#9). The in-situ treatment alternatives would involve on-site treatment and would be classified as permanent in accordance with the NYSDEC TAGM. A minimum amount of waste would be left on site, and a minimum amount of long-term monitoring would be required. Alternatives 3, 4, and 5, which involve excavation, ranked lower than the in-situ methods mainly because of the short-term risks posed to the community (including employees and workers). Excavating the VOC-contaminated soils would allow the compounds present to volatilize. The resulting emissions could pose a risk to employees and others working in the area during excavation, and the emissions would be difficult to control.

The no-action and institutional action alternatives ranked as high or higher than the in-situ treatment actions in terms of short-term protection of the community since no current pathways of concern were identified as possible exposure scenarios in the Human Health Risk Assessment. However, these two alternatives ranked lowest in terms of their overall effectiveness because existing risks to the environment would not be addressed, and the contaminants present would remain in the soils. This would result in a longer time frame for ground water remediation, if undertaken. Remedial response objectives would not be met if either of these alternatives were implemented.

B) Implementability Comparison

The most implementable alternatives were determined to be those involving no action and institutional actions. Although these alternatives would not be reliable and some remedial action would be necessary in the future, they would be easily implemented, delays would be unlikely and minimal coordination would be required.

The in-situ treatment options would be more difficult to implement since they would be more difficult to construct and delays would be more likely. However, once any of the in-situ alternatives were implemented, no future remedial actions would be expected.

The alternatives involving soils excavation would be extremely difficult to implement since the contamination is located below the floor of the Can Plant. Getting to all of the contamination would be nearly impossible. Some future remedial action would most likely be necessary since removal of all contaminated soil beneath the building would probably not occur.

C) Overall Screening Results

The alternatives which rated the highest in terms of their combined effectiveness and implementability were the in-situ options of vapor extraction, bioremediation, soil flushing, and steam injection. All four of these alternatives would be expected to meet or exceed established SCGs/ARARs. However, only the first three of these will be carried through to detailed analysis for the southern operable unit soils. Steam injection will be dropped from further consideration because it would be cost prohibitive to implement this technology. An extremely large amount of steam would have to be produced to remediate the soils below the southern portion of the Can Plant. In general, the disadvantage of the costs associated with steam generation and injection would far outweigh the advantage of possibly reducing the clean-up time frame over that of vapor extraction.

4.2.2 Ground Water

4.2.2.1 Screening of Individual Alternatives

Alternative 1 No Action

In the Human Health Risk Assessment, no pathways of concern were identified as possible exposure scenarios for the southern operable unit ground water. Thus, if no remedial action is undertaken, no short-term risks would be posed to the community. However, risks would continue to be posed to the environment due to the presence of VOCs in the ground water. Remedial action objectives would not be met with this alternative since ground water contaminant levels would not be reduced to their respective SCGs/ARARs and migration of contaminants beyond the site boundary would not be controlled. This alternative would not be a permanent remedy, and all untreated waste would remain at the site. However, no long-term monitoring, operation, or maintenance would be required if this alternative were implemented since no action at all would be taken.

This alternative would not be difficult to construct. In addition, no delays would be expected and minimal coordination would be required. However, some future remedial action would most likely be necessary to remove the contaminants from the ground water or control contaminant transport. Overall, the no-action alternative would be very implementable but not effective.

Alternative 2 Institutional Actions

The effectiveness of this alternative would be similar to that of the no-action alternative. Risks would not be posed to the community; however, continued risks would be posed to the environment. Again, untreated waste would be left at the site. Some minor maintenance (of ground water monitoring wells) and long-term monitoring would be necessary as part of this alternative to ensure that contaminants originating from the southern operable unit are not migrating off site. Future use of the land would be restricted.

This alternative would not be difficult to construct, since it would involve only ground water monitoring and implementation of access restrictions. Delays in implementing the action would be unlikely, and coordination with regulatory agencies would be minimal. As with the no-action alternative, however, some future remedial action may be necessary.

Alternative 3 Extraction/Treatment/Discharge

Under this alternative, ground water from the southern operable unit would be pumped from existing monitoring/recovery wells inside the Can Plant and new recovery wells installed outside the facility. After being passed through a treatment system, the water would be discharged to either the sanitary sewer or surface water. Short-term risks to on-site workers and the community would be due to fugitive emissions during installation of the ground water recovery wells and remediation. However, these risks are considered to be minimal. All risks would be easily controlled through proper system operation, maintenance, and monitoring.

This alternative would involve on-site treatment, but would not be considered a permanent remedy since, according to the NYSDEC TAGM, it is a "control and isolation technology". Assuming that the remedial objectives would eventually be met with this alternative, only a minimum amount of long-term monitoring would be required.

This alternative would be somewhat difficult to construct, more so than Alternatives 1 and 2. Implementation of the pump and treat technology would prove to be reliable in terms of plume containment and management. The addition of source area soil remediation would shorten the ground water remediation time frame. Some delays would be likely, especially during system start-up, but no future remedial actions would be anticipated once remedial objectives have been met. The technologies utilized in this remedial alternative are commercially available, and more than one vendor could bid on the project.

Alternative 4 Extraction/Treatment/Discharge with Reapplication/Bioremediation

This alternative is similar to Alternative 3; however, a portion of the treated water would undergo additional treatment through the addition of nutrients, oxygen, and, if necessary, bacteria prior to being reapplied to the vadose zone through the underground tanks inside the Can Plant. Conditions favorable for the biodegradation of the non-chlorinated VOCs and any residual oil present in the soil would be created, thereby reducing source concentrations. The short-term risks to the community and environment described for the previous alternative would also exist for this alternative during implementation. Any risks to the environment would be controlled through proper operation of the ground water injection/recovery system. Remedial action objectives would be expected to be met in a slightly shorter time frame with this alternative than with ground water pump and treat alone since a source remediation technology would also be implemented. However, initial testing (such as bench testing) would be required to verify that this alternative would be effective in treating the contamination. If this alternative proved to be effective, only a minimal amount of long-term monitoring would be required to ensure its effectiveness.

This alternative would be somewhat more difficult to construct than the previous alternative due to the additional bioremediation step. Implementation of this alternative would prove to be reliable in terms of plume containment and management and may aid in reducing the ground water clean-up time frame. Some delays would be likely, especially during system start-up, but no future remedial actions would be anticipated once remedial objectives have been met. The technologies utilized in this remedial alternative are commercially available, and more than one vendor could bid on the project.

Alternative 5 Extraction/Treatment/Discharge with Air Sparging/Vapor Extraction

Under this alternative, ground water would be pumped from the southern operable unit, treated, and discharged to either the sanitary sewer or surface water. An air sparging system would also be installed and operated in the area of highest ground water contamination. Short-term risks posed to the community and environment would be similar to those outlined for Alternative 3, ground water extraction/treatment/discharge. This air sparging alternative would be a permanent remedy and would provide for source control and plume containment. Remedial action objectives would be expected to be met through its implementation, and no controls would be required after remediation.

This alternative would be the most difficult to construct of the five ground water alternatives examined. Additional injection/vapor recovery wells would require installation, and the use of horizontal wells may be most effective. However, this alternative is actually a combined alternative which would also address the soil contamination. Based on the data collected to date, it appears that air sparging would meet the performance goals at the site, but pilot testing would have to be performed to verify its effectiveness. No future remedial actions would be expected to be undertaken following remediation, and normal coordination with other agencies would be required during the implementation period. Although not as well established as some of the other ground water treatment technologies, air sparging is becoming an effective ground water remedial option and is commercially available.

4.2.2.2 Screening Summary

A) Effectiveness Comparison

The three alternatives which involved ground water extraction and treatment in the southern operable unit ranked very closely in terms of their overall effectiveness. The no-action and institutional action alternatives were rated the lowest for effectiveness.

Little to no risks would be posed to the community during the implementation of any of the alternatives screened. The current environmental risks would not be addressed with the no-action and limited action alternatives. Any environmental risks posed by the other alternatives would be easily controlled through proper system operation.

The two extraction/treatment/discharge options with additional in-situ treatment were rated higher than the other alternatives in terms of implementation time since the response objectives might be achieved sooner with these remedial actions. All alternatives except for Alternatives 1 and 2 would utilize on-site treatment; however, only in-situ bioremediation and air sparging would be considered permanent. According to the NYSDEC TAGM, pumping and treating of contaminated ground water is considered to be a "control and isolation technology" and is not a permanent remedy. However, the duration of the effectiveness of the extraction/treatment/discharge technologies is taken into account.

Alternatives 3 through 5 would provide for the removal of the contamination from the ground water. Once the response objectives are met with these options, very little operation, maintenance and monitoring would be required.

B) Implementability Comparison

The highest rated alternative for implementability was no action. The alternatives which were determined to be the less implementable overall were the extraction/treatment/discharge options.

The technically most feasible alternatives are the no-action and institutional-action options. Although future remedial actions would be necessary if either of these two were implemented, these options would not be difficult to construct and delays would not be likely. The other alternatives would be difficult to construct, when compared to the above two alternatives, and delays would be likely. The air sparging alternative would be the most difficult to construct due to the installation of perforated wells and the requirement to distribute air uniformly throughout the well.

Administratively, the no-action alternative would be the most feasible. This is because little to no coordination with other agencies would be required. The extraction/treatment/discharge options would require normal coordination. Extensive coordination would be required if one of the options involving the discharge of treated water to the sanitary sewer were implemented. Coordination with both the NYSDEC and City of Fulton would be required to revise the existing wastewater discharge permit.

C) Overall Screening Results

The alternatives involving the extraction/treatment/discharge of the contaminated ground water (Alternatives 3 through 5) and the no-action alternative will be carried through to detailed analysis. The pump and treat options would be expected to reduce the remaining VOC levels in the ground water to their respective SCGs/ARARs. All pump and treat alternatives would also reduce the likelihood of present or future threat from hazardous substances and provide significant protection to the public health and welfare and the environment. The no-action alternative will be carried through to detailed evaluation to serve only as a baseline for comparison for the other alternatives. This is required by the NCP.

4.3 NORTHERN OPERABLE UNIT

This section summarizes the results of the preliminary screening of remedial alternatives for the northern operable unit. The effectiveness and implementability of each alternative is discussed. In addition, the alternatives are compared and contrasted in terms of their effectiveness and implementability, and those alternatives surviving the preliminary screening are identified.

4.3.1 Ground Water

4.3.1.1 Screening of Individual Alternatives

Alternative 1 No Further Action - Continued Pumping as at Present

Under this alternative, pumping and treating the ground water from the three recovery wells at the site would continue. No additional action would be taken. Although contaminant concentrations would be reduced somewhat by the on-site extraction and treatment system, a portion of the contaminant plume would continue to migrate off-site toward the municipal wells. However, ground water downgradient from the site is currently undergoing treatment prior to distribution in the municipal supply. The treatment system is designed to remove contaminants to levels below an analytical detection limit of 0.5 ug/l. Thus, in the Human Health Risk Assessment, no pathways of concern were identified as possible exposure scenarios for the northern operable unit ground water. If no additional action is taken, no short-term risks would be posed to the community. Risks would continue to be posed to the environment due to the presence of VOCs in the ground water.

Remedial action objectives would not be met with this alternative since ground water contaminant levels would not be reduced to their respective SCGs/ARARs and there would be no mechanism in place to fully contain the plume on site. This alternative would not be a permanent remedy, and operation of the ground water treatment system at the municipal wells would be required to continue.

Although some future remedial actions may be necessary at the site and this alternative would not be expected to meet performance goals, to continue to pump and treat as at present would be easily implemented. The alternative would not be difficult to construct, no delays would be expected, and minimal coordination would be necessary.

Alternative 2 Institutional Actions

The effectiveness of this alternative would be similar to that of the no-further-action alternative. Short-term risks would not be posed to the community; however, continued risks would be posed to the environment. A portion of the contaminant plume would continue to migrate off-site, and future use of the land would be restricted. Continued operation of the treatment facility at the water works would also be required.

This alternative would not be difficult to construct since it would involve only implementation of access restrictions. Delays in implementing the action would be unlikely, and coordination with regulatory agencies would be minimal. As with the no-further-action alternative, some future remedial action may be necessary at the site.

Alternative 3 Accelerated Pumping From Present Recovery System /Discharge

The overall effectiveness of this alternative would be similar to that of the previous two alternatives. Although the ground water withdrawal rate would be increased and some removal of VOCs from the ground water would occur, full plume containment and remediation would still not be achieved. Remedial action objectives would not be met with this alternative since ground water contaminant levels would not be reduced to their respective SCGs/ARARs and there would be no mechanism in place to fully contain the plume on site. This alternative would not be a permanent remedy, and operation of the ground water treatment system at the municipal wells would be required to continue.

The implementability of this alternative would also be very similar to that of the previous alternatives. Little additional coordination with other agencies would be required with this alternative.

Alternative 4 Installation of Additional Recovery Wells/Extraction/Treatment/Discharge

Under this alternative, additional ground water recovery wells would be installed in the northern operable unit. Ground water would be pumped from the recovery wells, passed through a treatment system, and discharged to either the sanitary sewer or surface water. Short-term risks to on-site workers and the community would be due to fugitive emissions during installation of the ground water recovery wells and remediation. However, these risks are considered to be minimal. All risks would be easily controlled through proper system operation, maintenance, and monitoring.

This alternative would involve on-site treatment, but would not be considered a permanent remedy since, according to the NYSDEC TAGM, it is a "control and isolation technology". Assuming that the remedial objectives would eventually be met with this alternative, only a minimum amount of long-term monitoring would be required.

This alternative would be somewhat difficult to construct, more so than Alternatives 1 through 3. Implementation of the pump and treat technology alone would prove to be reliable in terms of plume containment and management; however, to shorten the duration of the remedy the alternative would have to be implemented in tandem with source remediation. Some delays would be likely, especially during system start-up, but no future remedial actions would be anticipated once remedial objectives have been met. The technologies utilized in this remedial alternative are commercially available, and more than one vendor could bid on the project.

Alternative 5 Installation of Additional Recovery Wells/Extraction/Treatment/Discharge with Air Sparging/Vapor Extraction

As a part of this alternative, ground water would be pumped from the northern operable unit, treated, and discharged to either the sanitary sewer or surface water. An air-sparging system would also be installed and operated in the area of highest ground water contamination. Short-term risks posed to the community and environment would be similar to those outlined for Alternative 4, ground water extraction/treatment/discharge. This air sparging alternative would be a permanent remedy and would provide for plume containment and protection of the municipal water supply. Remedial action objectives would be expected to be met through its implementation, and no controls would be required after remediation.

This alternative would be the most difficult to construct of the five ground water alternatives examined. Additional injection/vapor recovery wells would require installation, and the use of horizontal wells may be most effective. Based on the data collected to date, it appears that air sparging would meet the performance goals at the site, but pilot testing would have to be performed to verify its effectiveness. No future remedial actions would be expected to be undertaken following remediation, and normal coordination with other agencies would be required during the implementation period. Although not as well established as some of the other ground water treatment technologies, air sparging is becoming an effective ground water remedial option and is commercially available.

4.3.1.2 Screening Summary

A) Effectiveness Comparison

The most effective alternatives for remediating the northern operable unit ground water were determined to be the pump and treat options involving the installation of additional recovery wells (Alternatives 4 and 5). Any risks posed to the community or environment through the implementation of these options would be easily controlled. Both alternatives would utilize on-site treatment. As explained in the previous subsection, the extraction/treatment/discharge alternatives would not be considered permanent remedies. The expected lifetime of their effectiveness, however, would be great. Air sparging is a permanent remedy due to its classification as a separation/treatment alternative.

Alternatives 4 and 5 would provide for the removal of waste from the ground water, and no treated residuals would be left at the site. Only a minimum amount of long-term maintenance and monitoring would be required.

The next most effective alternative would be the one involving the operation of the existing recovery well and air stripping system at an accelerated rate (Alternative 3). This alternative ranked much lower than the two alternatives discussed above since the contaminant plume would not be completely intercepted by the recovery wells. Even though the recovery well pumping rates would be increased, the contaminated ground water in the area east of and beneath the Taylor property and the portion of the northern operable unit ground water north of RW-1, where bypass of the recovery well is occurring, would be unaffected. The plume in this area would continue to migrate toward municipal wells K-2 and M-2. The steps taken toward remediation would not be totally effective, and contamination would remain at the Reynolds Can Plant site.

The least effective alternative for the remediation of the northern operable unit ground water was determined to be institutional actions. The alternative would not be permanent. In addition, contamination would remain at the site, and long-term maintenance would be required. The no-further-action alternative ranked slightly higher since less long-term maintenance would be required.

B) Implementability Comparison

The most implementable remedial alternatives would be no further action (Alternative 1) and accelerated pumping from present recovery system (Alternative 3). These alternatives would not be difficult to construct, and delays due to technical problems would not be likely. However, some future remedial action would probably be necessary. Only minimal coordination with other agencies would be required, and, where applicable, services and materials would be readily available.

The extraction/treatment/discharge options (with additional recovery wells) would be difficult to construct, when compared to the above alternatives, and delays would be more likely. The air-sparging alternative would be the most difficult to construct due to the installation of more complicated recovery wells (horizontal, perforated wells). Both would require normal coordination. Extensive coordination would be required if one of these two alternatives were to be implemented with the discharge of treated water to the sanitary sewer. Coordination with both the NYSDEC and City of Fulton would be required to revise the existing wastewater discharge permit.

C) Overall Screening Results

The alternatives which rated the highest in terms of their combined effectiveness and implementability were Alternatives 4 and 5. These are the ground water pump and treat options involving additional recovery well installation. The pump and treat options would be expected to reduce the remaining VOC levels in the ground water to their respective SCGs/ARARs. Both pump and treat alternatives would also reduce the likelihood of present or future threat from hazardous substances and provide significant protection to the public health and welfare and the environment. These two alternatives will be carried through for detailed analysis in the next phase of the FS, along with the no-further-action alternative. The latter alternative is required to be included as a baseline for comparison by the NCP.

5.0 ALTERNATIVE REFINEMENT

To effectively analyze in detail the alternatives surviving the preliminary screening, several aspects of the ground water extraction/treatment/discharge alternatives must first be defined. Once these aspects are better defined, the remedial alternatives surviving the preliminary screening for the southern operable unit (soil and ground water) and northern operable unit (ground water) will be incorporated into combined alternatives to address the site as a whole. These combined alternatives will undergo detailed analysis in Section 6.0.

The aspects which must be better defined for the ground water remedial alternatives are:

1. the conceptual layout of the required ground water recovery well system and estimated total flow rate,
2. the location of the treatment facility (one central treatment facility or one (two total) in each operable unit),
3. the type of ground water treatment technology utilized, and
4. whether to discharge the treated ground water to the sanitary sewer or surface water (Oswego River).

The approximate locations of the ground water recovery wells which will be installed at the Can Plant site to facilitate the extraction/treatment/discharge alternatives are described below. Rationale for their locations is also provided. Also included in this section is a summary of the results of a preliminary evaluation done to determine which ground water treatment option and technology and which discharge option would be the most feasible to implement. These options will become part of the ground water extraction/treatment/discharge alternatives analyzed in detail in the next section of this FS Report.

5.1 ESTIMATED LOCATIONS OF GROUND WATER RECOVERY WELLS/RATIONALE

Recovery wells have been proposed for several areas. These areas include the contamination source areas where contaminant concentrations are generally greatest, and downgradient areas, where ground water contaminant plumes must be cut-off before further degradation of the City of Fulton municipal supply wells (M-2 and K-2) occurs.

A two-dimensional finite-difference numerical model (Flowpath) was used to accomplish the following goals:

- the effect of adding recovery wells at the site to enhance plume capture and remediation, and
- the optimum number and location of recovery wells that might be required.

The site conditions are relatively complex. Numerous different, laterally and vertically discontinuous geologic units exist which create both unconfined, and semi-confined and/or confined aquifer conditions. In addition, pumping is already occurring in different areas of and adjacent to the site. There are at least four different source areas of soil contamination that result in overlapping and isolated downgradient ground water plumes.

The modeling goals were accomplished by modeling the ground water plume source areas separately. This approach was used because the local hydrogeologic conditions at each plume source area are less complex than the entire site when considered as a whole. This approach, however, does not take into account the influence that pumping at one source area might have on adjacent source areas, where pumping is also occurring. Overlapping influence of pumping at adjacent source areas would cause the drawdown, and hence the capture zone developed, between the source areas to be somewhat greater than predicted by the models. However, based on the observed drawdown at operating pumping wells and the distances between the modeled wells in the individually modeled areas, it is likely that the effects of such overlap would not significantly affect model predictions.

Three areas were modeled: the Northern Drum Storage Area and the Former Spill Containment Tank Area; the Southern Source Area; and the area East of the Taylor property in the vicinity of MW-21S and MW-14D. A fourth area of interest, the Area North of RW-1, could not be modeled using Flowpath because of the complex hydrogeologic conditions present in this area. Since a recovery well RW-1 is located in this area, the image well theory was used to estimate the effects of adding an additional recovery well in this area.

The following paragraphs summarize both the methods used to prepare the models and the model results. Detailed information about the conceptual models used to create the computer models, the selection of boundary conditions, establishment of model grids, and calibration of the models are contained in Appendix B.

Two simulations were run for each modeled area, one representing existing conditions and one representing predicted conditions after adding one or more pumping wells. The "existing conditions" simulations were used to calibrate the models. Values of estimated parameters (hydraulic conductivity, recharge, and aquifer thickness) were varied, within reasonable limits to achieve estimated head values that were similar to those observed at the site and to ensure that the models were not overly sensitive to changes in the estimated parameters. (Collected data, including those provided by slug and pumping tests, subsurface drilling, ground water level measurement, and the City of Fulton meteorological station, were used to define the limits that were considered "reasonable".) For simulations where the effect of adding pumping wells was predicted, capture zones for proposed pumping wells were also estimated using the capture zone utility in Flowpath. The time interval that the capture zones represent is one year. Observed drawdowns based on several years of existing water level data were used to depict the capture zone in the vicinity of each of the three existing recovery wells (RW-1, RW-2, and RW-3).

Northern Drum Storage Area and Former Spill Containment Tank Area

This area was modeled to determine where recovery wells should be best located to:

- collect contaminated ground water originating from the northern drum storage area, thereby enhancing cleanup in this area, and
- collect contaminated ground water in the area south of RW-3, including the area around and to the south and southeast of monitoring well cluster MW-6S,I,D.

The grid spacing at the center of the model was about 25 feet between nodes. This spacing was finer than the spacing at the edges of the modeled area (approximately 50 feet between nodes, see Appendix B). The modeled area contains two existing pumping wells, RW-2 and RW-3. The grid was oriented such that the north and south edges paralleled the direction of ground water movement, allowing them to be considered as hydraulic no-flow boundaries. The west and east edges of the model were designated as constant head boundaries. Although in reality the hydraulic heads along these edges change slightly seasonally, the magnitude of change in each area is generally about the same, making the constant-head assumption reasonable. The hydraulic head values selected for the edges were 352 feet above Mean Sea Level (AMSL) and 372 feet AMSL for the left and right edges, respectively. These values were obtained from the most recent site deep zone potentiometric surface map.

The horizontal hydraulic conductivity of the modeled area, k_h, is shown to be relatively uniform across the Northern Drum Storage Area and Former Spill Containment Tank Area; therefore, a single value of 0.85 ft/day (3 x 10^{-4} cm/s) was used for the entire model). This value falls within the higher end of the range of hydraulic conductivities obtained from slug tests conducted in monitoring wells in the area and is also the value calculated for well MW-4D during the pumping test conducted at the existing recovery wells in 1988. The elevation used to represent the bottom of the aquifer was 317 feet AMSL, which is the average elevation of the lodgement till surface in the area.

Recharge to the modeled portion of the aquifer was applied to all areas of the model except the area comprising the Can Plant structures and associated parking lots. The recharge rate used was 7 x 10^{-4} ft/day (0.25 in/month). Although this value seems somewhat low, it provided the most realistic result in the model. The actual amount of recharge to the deep zone in this area may actually be quite low because:

1) the surficial soils are much less permeable than the material forming the "deep zone", and

2) the area is covered with grass, which is expected to take-up a significant quantity of precipitation, and the surface water drainage has been improved in the area--much of the runoff is directed to storm sewers or the pond, which is at least partially underlain by a silty clay layer and therefore may not be contributing as much recharge as might be expected.

The recovery wells were assumed to be fully penetrating and have the following discharge rates: RW-2 = 2160 gal/day (1.5 gpm), RW-3 = 2880 gal/day (2 gpm), simulated wells = 2880 gal/day. The rates used for RW-2 and RW-3 are the actual set point pumping rates for those wells. Simulated recovery wells were added to the model after it was calibrated to the existing site conditions. The locations of the simulated recovery wells were varied to obtain optimum coverage of the plume area with the minimum number of recovery wells. One recovery well was located to the north of RW-3, to simulate the effect of pumping near the Northern Drum Storage Area. The other simulated recovery well was located south of RW-3 and MW-6 S,I,D, to estimate the effect pumping would have in this area. The aquifer was assumed to be unconfined.

Results

The existing conditions model provided heads that are in general agreement with those observed in monitoring wells in the area. The size and shape of the drawdown cones produced by pumping wells RW-2 and RW-3 in the model are similar to those observed at the site for these wells.

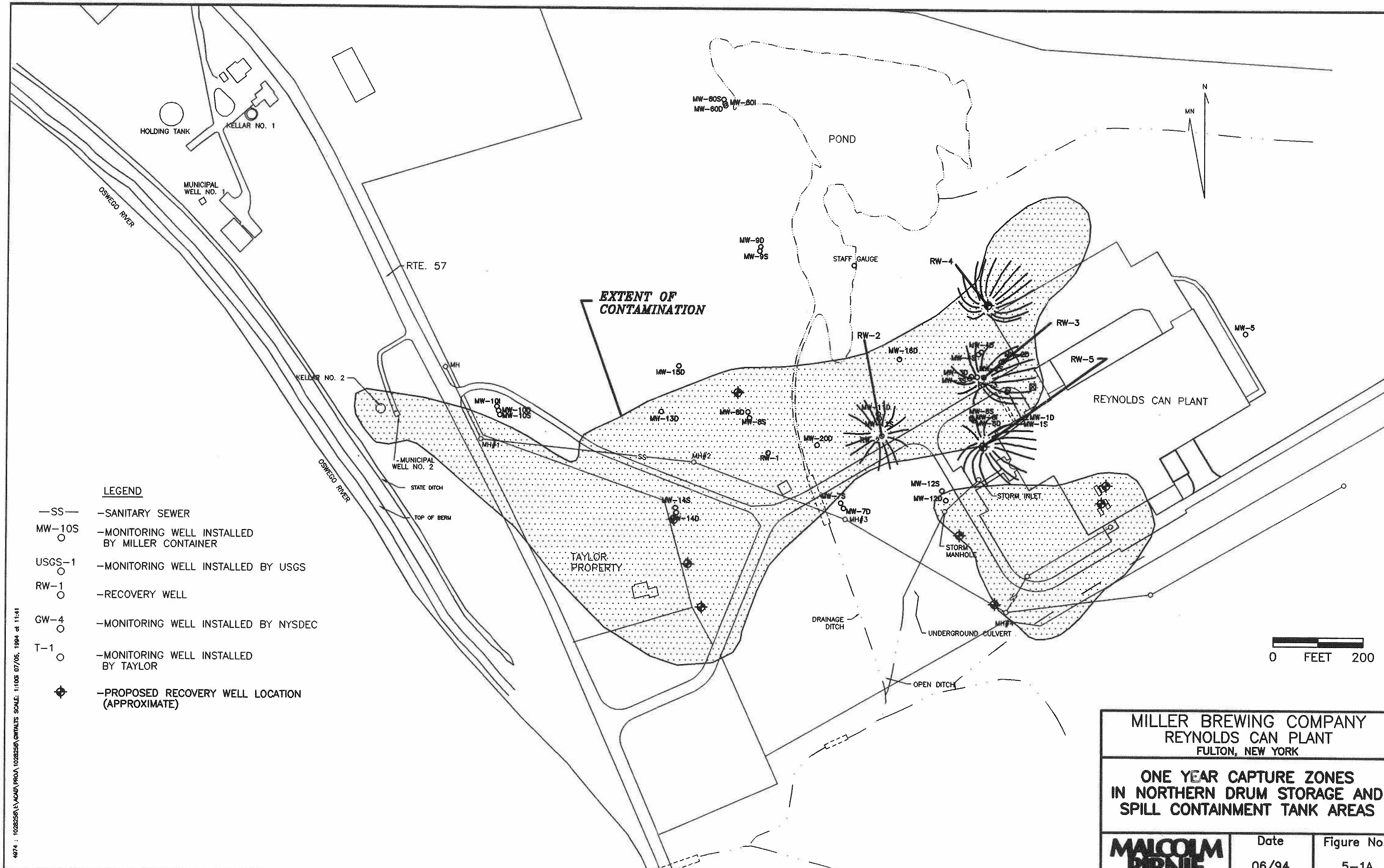
The results of the predictive model suggest that capture of the plume originating in the Northern Drum Storage and Former Spill Containment Tank Areas on the north side of the plant will be enhanced by the addition of the two recovery wells. According to available data, if the recovery wells are constructed to optimize the effective screened area in the wells, greater volumes of ground water will probably be recoverable from the new wells. Data from RW-3 at the time of its replacement (using a large diameter borehole and an extensive gravel pack) indicated that an average of about 10 gpm could be produced from the well. Optimal plume management may require pumping the new and existing wells near this rate.

The one-year capture zones predicted for the four recovery wells in this area are shown on Figure 5-1A. As discussed previously, the capture zones depicted are based on a model which assumes that pumping at other site areas will not affect the modeled area. The shape and orientation of capture zones will change if the modeled area is influenced by pumping at other areas of the site, but the size of the capture zones will not decrease. Interference by a pumping well or wells located outside the modeled area will enhance capture.

Southern Source Area

Grid orientation and spacing, boundary conditions, and recharge rates for this area were the same as the Northern Drum Storage Area and Former Spill Containment Tank Area model. Constant head values used for the left and right boundaries were 352 and 373 feet AMSL, respectively. A second area of "no-recharge" was added to this model. This area is located beneath the footprint of the parking lot for the adjacent brewery.

The k_h value used for this area was 11 ft/day (4×10^{-3} cm/s) and falls within the higher end of the k_h values observed in the vicinity of monitoring wells in the area. The



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MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK

ONE YEAR CAPTURE ZONES IN NORTHERN DRUM STORAGE AND SPILL CONTAINMENT TANK AREAS

MALCOLM PIRNIE	Date	Figure No.
	06/94	5-1A

bottom of the aquifer was set at 320 feet AMSL, which is about the average elevation of the top of the lodgement till in the area.

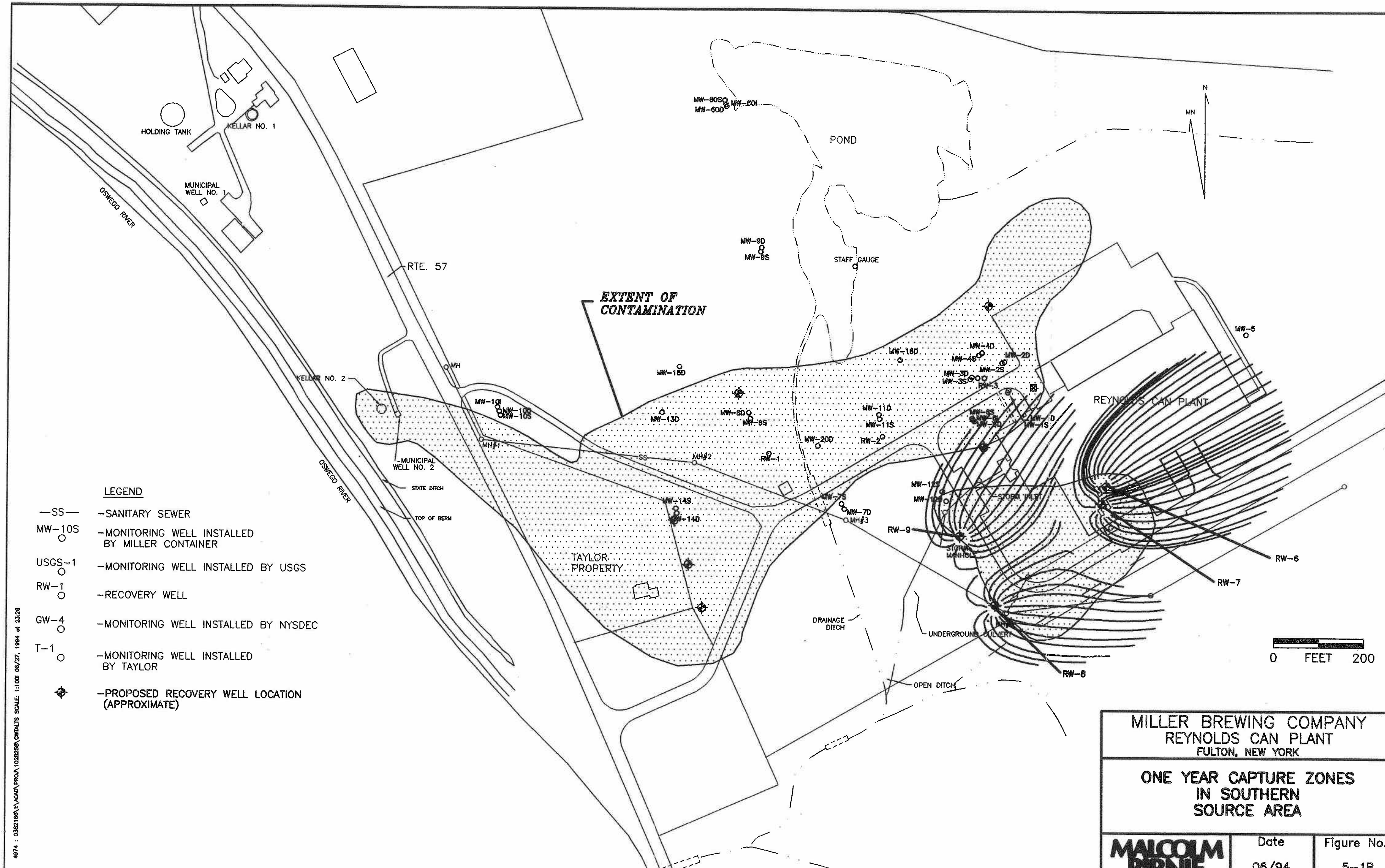
Four recovery wells were added for the pumping simulation. Two of these wells were located near existing monitoring wells MW-58S and MW-59S (RW-6 and RW-7, respectively), to simulate using these wells as recovery wells. The remaining two recovery wells (RW-8 and RW-9) were placed at strategic locations downgradient of the source area to cut off contaminant plume migration from the area. The pumping rate selected for the model at each of these wells was 14,400 gpd (10 gpm); however, the yield of RW-8 and RW-9 may be higher (10 to 20 gpm) with proper well-construction techniques.

Results

The existing conditions model was in general agreement with observed heads in wells that are not affected by pumping at existing wells. The predictive model showed drawdown cones that appear reasonable in extent and depth based on the observed gradient and hydraulic conductivity of the area. The one-year capture zones are shown on Figure 5-1B, and are much larger than those predicted by the model for the Northern Drum Storage Area and Former Spill Containment Tank Area (Figure 5-1A). This is due to the relatively higher hydraulic conductivity of the southern area. The capture zone of the northernmost simulated well (RW-9) extends further northward than would be expected if the proposed recovery well in the vicinity of MW-6S,I,D (RW-5) was installed and pumping. The reason for this is that the southern area model does not consider the effects of pumping at the northern wells. An attempt was made to model both the northern area and southern area together; however, there were not enough data on the distribution of hydraulic conductivity in the area between the northern and southern areas (below the Can Plant) to obtain reliable results from the "combined" model.

Area East of the Taylor Property in the Vicinity of MW-21S and MW-14D

Grid orientation and spacing, and boundary conditions for this area were the same as for the other modeled areas. Constant head values used for the left and right boundaries were 353 (Oswego River elevation) and 357 feet AMSL, respectively. Because no large buildings or other impermeable surfaces are present in the modeled area, recharge was



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FULTON, NEW YORK

ONE YEAR CAPTURE ZONES IN SOUTHERN SOURCE AREA

MALCOLM PIRNIE

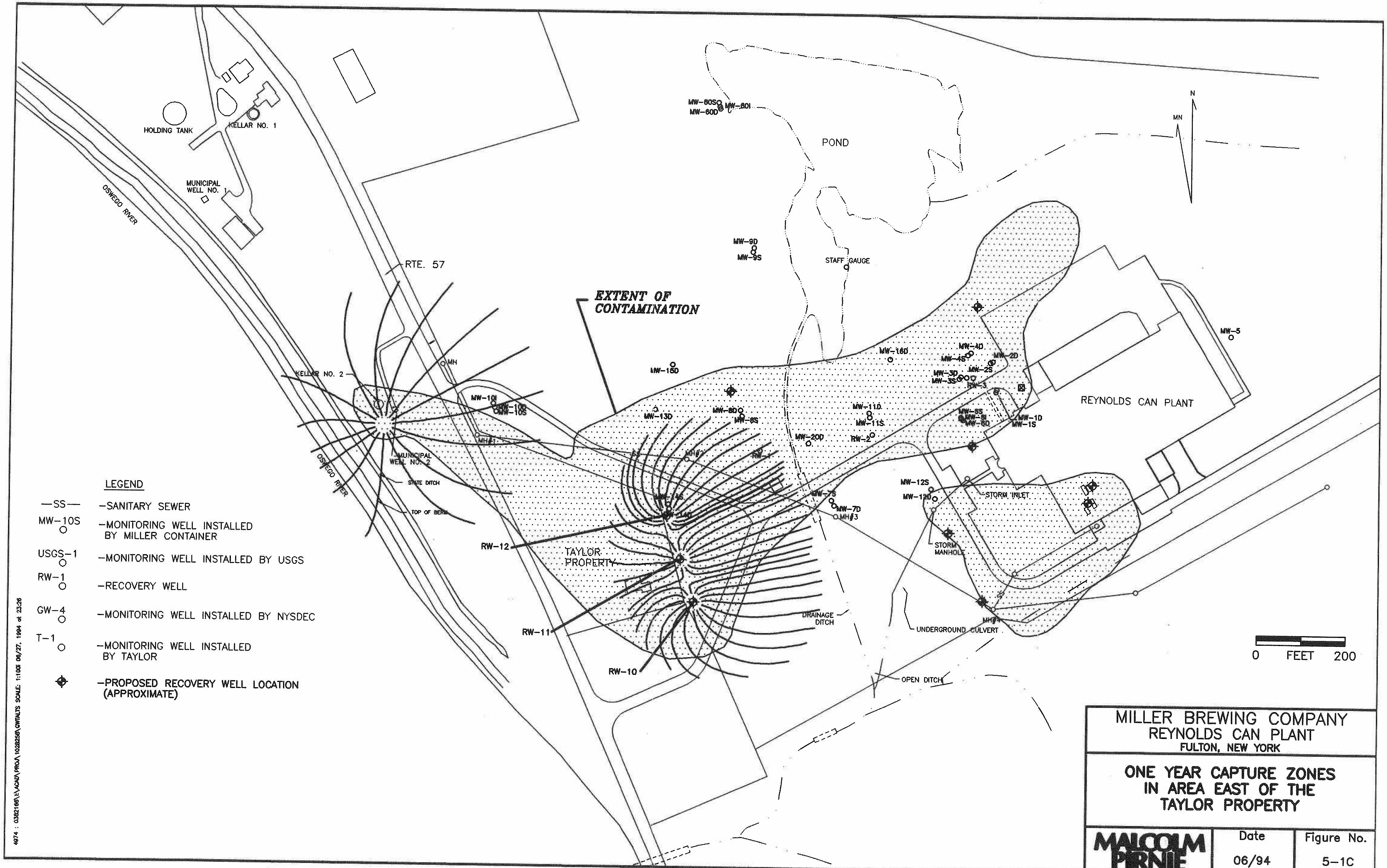
Date	Figure No.
06/94	5-1B

applied equally to the entire area. The recharge rate used in this area was 0.01 ft/day (4 in/month). This rate is within the range of rates measured at the nearby Fulton Water Works (1991-1993 were reviewed and are contained in Appendix B). This area of the site may receive more recharge than other areas because surface drainage was not improved, as was the case near the Can Plant.

The existing conditions model was slightly more complex than the first two modeled areas. One added complexity was the presence of the Municipal Water Works well pair K-2/M-2. Because this well pair withdraws a relatively large quantity of water from the modeled aquifer, and because minimizing contaminant migration toward this well pair is a priority, it was included in the model developed for this area. These wells were modeled as one pumping well in the simulation because the two wells fell in the same model cell. The pumping rate used for the pumping well simulating K-2/M-2 was 136,800 gpd (95 gpm), which is the approximate average combined pumping rate for the wells. A second complexity was the presence of a "till ridge" in the subsurface, located just east of the Taylor property. To simulate the effects of the till ridge, the aquifer thickness of an area approximating the ridge was decreased. This was accomplished in the model by increasing the elevation of the aquifer base from 290 to 330 feet AMSL in the area of the till ridge. A final complexity was a marked change in hydraulic conductivity across the modeled area. The hydraulic conductivity is observed to increase dramatically along the river. To include this in the model, two areas of different hydraulic conductivity were defined. Along the river, the k_h value used was about 28 ft/day (1×10^{-2} cm/s). For the rest of the modeled area, a k_h value of about 14 ft/day (5×10^{-3} cm/s) was used. These values are consistent with conductivities calculated from slug tests performed in monitoring wells in these areas.

The predictive portion of the modeling task in this area was designed to take advantage of the buried till ridge, which is oriented perpendicular to ground water flow and occurs between the southern source area and K-2/M-2. For the model, three wells pumping at a rate of 21,600 gpd (15 gpm) each were located along the western side of the top of the ridge. The locations of the recovery wells (RW-10, RW-11, and RW-12) are shown on Figure 5-1C. The advantages associated with the location of the recovery wells along the till ridge are as follows:

- The decreased saturated thickness and the lower hydraulic conductivity along the till ridge relative to the area between the till ridge and the Oswego River result in lower transmissivity along the ridge.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HOLDING TANK
KELLAR NO. 1
MUNICIPAL WELL NO. 1
OSWEGO RIVER
RTE. 57
KELLAR NO. 2
MUNICIPAL WELL NO. 2
STATE DITCH
TOP OF BERM
MH
EXTENT OF CONTAMINATION
POND
STAFF GAUGE
MW-60S
MW-60D
MW-60I
MW-9D
MW-9S
MW-15D
MW-13D
MW-8D
MW-8S
MW-16D
MW-4D
MW-4S
MW-2D
MW-2S
MW-3D
MW-3S
RW-3
MW-11D
MW-11S
MW-20D
RW-2
MW-1D
MW-1S
MW-10I
MW-10D
MW-10S
MW-7S
MW-7D
MH#3
MW-12S
MW-12D
STORM INLET
STORM MANHOLE
DRAINAGE DITCH
UNDERGROUND CULVERT
OPEN DITCH
TAYLOR PROPERTY
RW-10
RW-11
RW-12
REYNOLDS CAN PLANT
MW-5
N
MN
0 FEET 200
LEGEND
—SS— -SANITARY SEWER
MW-10S -MONITORING WELL INSTALLED BY MILLER CONTAINER
USGS-1 -MONITORING WELL INSTALLED BY USGS
RW-1 -RECOVERY WELL
GW-4 -MONITORING WELL INSTALLED BY NYSDEC
T-1 -MONITORING WELL INSTALLED BY TAYLOR
-PROPOSED RECOVERY WELL LOCATION (APPROXIMATE)
MILLER BREWING COMPANY
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FULTON, NEW YORK
ONE YEAR CAPTURE ZONES IN AREA EAST OF THE TAYLOR PROPERTY
MALCOLM PIRNIE
Date 06/94
Figure No. 5-1C

- Since the transmissivity is lower along the ridge, the volume of ground water required to be pumped to cutoff the migration of the plume from this area can be minimized. The closer the recovery wells are located to the Oswego River, the greater will be the saturated thickness, hydraulic conductivity, and, therefore, transmissivity.
- The lower required pumping rates will result in less "competition" for the water available in this area. Since municipal wells M-2 and K-2 receive a percentage of their supply from this area, lower quantities of water removed as part of the remediation will mean more water available for M-2 and K-2.
- A significant portion of the most contaminated part of the plume will be addressed with the recovery wells situated along the till ridge.
- The City of Fulton Water Treatment Facility was designed to treat the types of ground water contaminants found in the area of the Taylor property and east of the Taylor property in the vicinity of MW-21S and MW-14D at concentrations that exceed those detected in that area to below a detection limit of 0.5 ug/l.
- A property access agreement would not be necessary if the recovery wells remain on Reynolds Metals Company property.

Results

The heads predicted by the existing conditions model were in general agreement with observed heads in the area, except for the northwest portion of the modeled area. This area has lower than predicted heads due to the influence of another municipal well, K-1. The effects of K-1 do not influence contaminant migration in the source area located east of the Taylor property as long as K-2/M-2 remain in operation, so it was not considered important to try to incorporate the effects of pumping at K-1 in the model.

Heads predicted by the pumping simulation appear reasonable based on our knowledge of the site. The capture zones predicted for the wells are shown on Figure 5-1C. The simulation suggests that three wells pumping at 15 gpm each and located along the till ridge would prevent further migration of contamination west of the wells toward the K-2/M-2 well pair.

Area North of RW-1

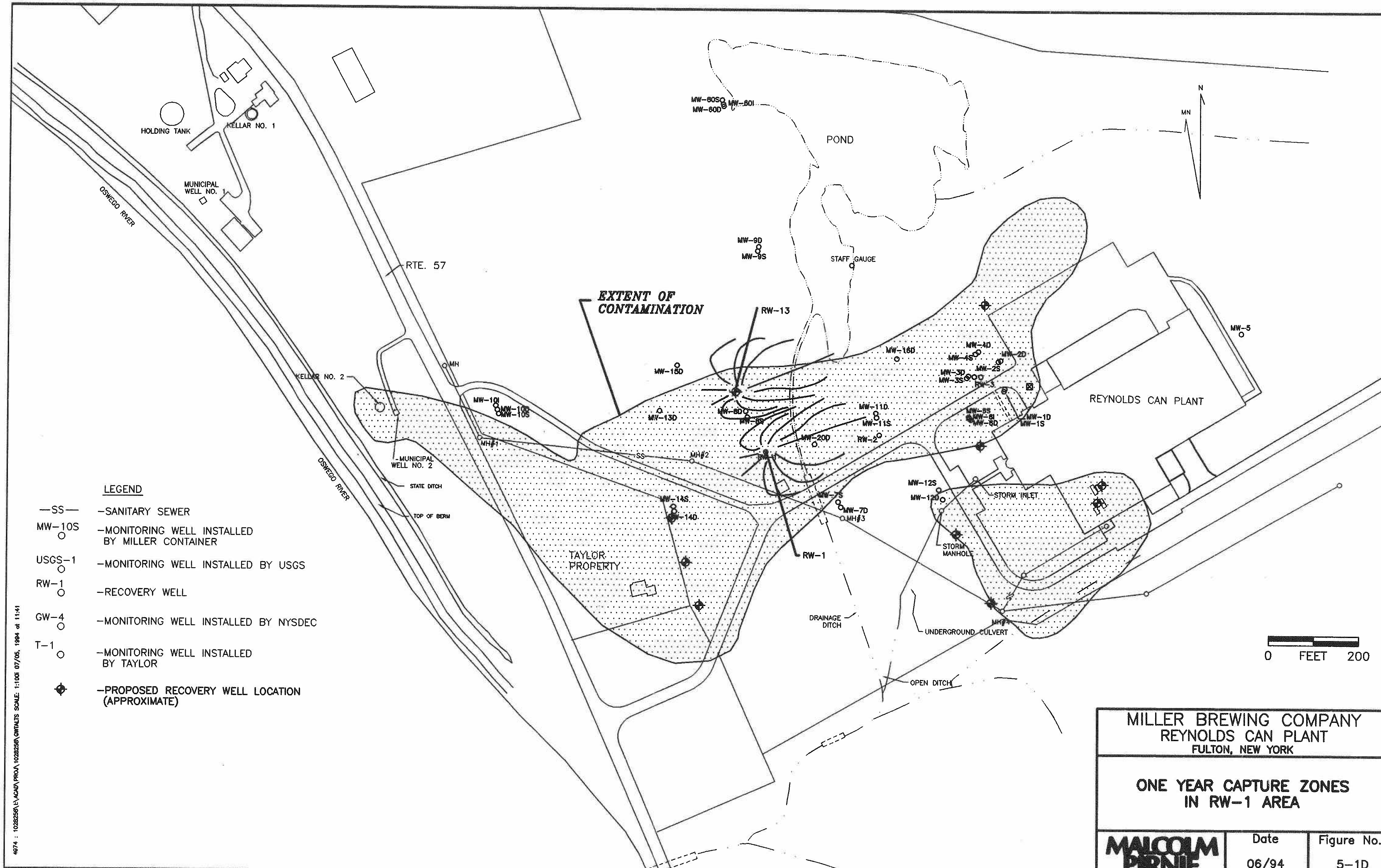
Estimating the effect of an additional pumping well (or wells) in the area was accomplished using the image-well theory. This method assumes that the drawdown cone developed by a new pumping well will have similar dimensions to the cone developed by existing well RW-1. On a map, the contoured drawdown cone developed by RW-1 is simply positioned where another pumping well is proposed. At the point where contours from the proposed well and RW-1 overlap, the drawdown will be cumulative, i.e., the sum of the two individual contours. The result is a map predicting the effect of adding another pumping well that is pumping at the same rate as RW-1. A measure of conservatism is built into this method because the yield at RW-1 is greater than the present pumping rate of seven to eight gpm. If both wells were pumped at a greater rate, the area of capture would be greater.

A capture zone for the predicted well was estimated using a seepage velocity estimate of 150 feet per year (k_h = 3 x 10^{-3} cm/s, n_e = 0.22, hydraulic gradient (I) = 0.01). The gradient was obtained from measurements made near RW-1 from the most recent site-wide potentiometric surface map. The capture zone (Figure 5-1D) shows that this proposed well would capture the contamination that appears to be bypassing well RW-1 to the north.

Findings

The numerical modeling effort has suggested that plume control may be possible using ten new recovery wells in combination with the three existing recovery wells. A measure of conservatism was built in to each model by selecting conservative values for estimated parameters, when plausible; however, conditions in the subsurface are more complex than represented by the models. Therefore, the pumping rates and associated effects of additional pumping wells will differ from those predicted by the models. Because every effort was made to use reasonable assumptions and estimated values, the model results should be interpreted as providing the best available approximation of aquifer response to new stresses, without collecting more field data.

The pumping rates used for the proposed wells in the models represent conservative estimates based on the existing data for the site. Where possible, pumping rates were based on existing recovery well data. According to notes taken at the time of replacement of



MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK

ONE YEAR CAPTURE ZONES
IN RW-1 AREA

MALCOLM PIRNIE

Date	Figure No.
06/94	5-1D

recovery well RW-3, this well may be able to produce an average of 10 gpm, although it is currently only being pumped at a rate of about two gpm. Although the northern area model used rates of two gpm for RW-3 and the two simulated wells, maximum plume control may require pumping these three wells at their capacity, which may be around 10 gpm each with proper well-construction techniques. If the yield of pumping wells turns out to be considerably less than estimated, the capture zones developed by the wells will be smaller and additional wells may be necessary to accomplish the goals of the pumping.

5.2 EVALUATION/SELECTION OF GROUND WATER TREATMENT AND DISCHARGE OPTIONS

5.2.1 Treatment Facility Option

Since ground water extraction/treatment/discharge will be part of the final remedial action undertaken in both areas of the site, either one central facility will be constructed to house the ground water treatment system for both operable units, or two separate facilities will be constructed. Based on preliminary discussions, the location of a central treatment facility could be adjacent to the southeast section of the Can Plant. If separate systems are determined to be more feasible, their preliminary locations would be in the vicinity of the current air stripper building (northern operable unit) and adjacent to the southeast section of the Can Plant (southern operable unit).

Construction of one central treatment facility would be more cost effective in terms of both capital and operating/monitoring costs. It would eliminate the need for identical systems in two locations. Centralizing the treatment system would allow one operator to more effectively supervise and maintain the ground water treatment system. Combining systems would also allow adjustment to the production rates of pumps in either operable unit (perhaps including shutdown) without adversely affecting the treatment system. Low flow in a stripping column can increase the rate of scaling which reduces mass transfer efficiency. Low or no flow in liquid phase carbon adsorbers can result in biological slime formation which reduces the effectiveness of the carbon once it is returned to service.

Thus, the treatment option in the extraction/treatment/discharge alternatives which will be evaluated in detail will include treatment at a central, or combined, facility.

5.2.2 Treatment Technology

Based on the results of the technology screening conducted in Section 3.0 and expected ground water influent contaminant concentrations, the following ground water treatment technologies were evaluated for implementation at the Can Plant site:

1. Air stripping (tower/diffused bubble) with activated carbon on the stripper air and water effluent, off-site carbon regeneration
2. Air stripping (tower/diffused bubble) with activated carbon on the stripper air and water effluent, on-site vapor phase carbon regeneration
3. Steam stripping
4. Liquid phase carbon adsorption by itself
5. Advanced oxidation followed by air stripping, with activated carbon on the water effluent

Initial evaluation of the implementability and costs of steam stripping and liquid phase carbon adsorption alone ruled out both of these options. Steam stripping requires a steam-generation facility, and construction of the required plant would not be cost effective. Capital costs associated with the steam stripper itself would also be much greater than those of the other technologies evaluated. Direct treatment of the extracted ground water with carbon also would not be cost effective. Because of the presence of high quantities of chlorinated VOCs, carbon usage would be approximately three times greater than the combined vapor and liquid phase usage associated with the stripping options.

Initial evaluation of the three other ground water treatment options indicated that they appeared to be feasible, thus a more detailed analysis was performed. The relative advantages and disadvantages of each of the three are described below.

Option 1 - Air Stripping with Activated Carbon Treatment on Stripper Air and Water Effluent. This alternative involves removal of the majority of the VOC contamination from the collected ground water through either a packed column or low profile air stripper. Activated carbon will be required on the stripper air emissions due to the anticipated exceedance of NYS Annual Guidance Concentration (AGC) limits for TTCE. Post treatment with activated carbon will be required for the ground water as well, since the ketones (i.e., acetone and MIBK) are highly soluble in water and are generally unaffected by the stripping process.

This process is advantageous in that it has a relatively low capital cost and involves fairly simple unit processes, reducing operational complexity. However, the annual operation and maintenance (O&M) costs for off-site regeneration of the activated carbon is significant, accounting for approximately $360,000 - $400,000/year of the total annual O & M expense. Since ground water concentrations typically drop off after several months of operation in a pump and treat system, it may be possible to remove the vapor-phase carbon from service after some time, thereby reducing the carbon regeneration cost by 50%. In addition, this process transfers contamination from one media to another, and therefore ranks low on the NYSDEC hierarchy of preference for remedial actions.

Although the capital difference between a packed column and low profile (shallow tray) air stripper is not appreciable, the strippers have distinct advantages/disadvantages:

- Shallow tray strippers can be maintained within a building or enclosure, reducing visibility and chances for freezing in cold weather. These strippers are also easily cleaned - the trays are simply unsnapped and lifted apart to allow pressure spray removal of scale, oxidation, biological growth, etc. Furthermore, they are pre-packaged units having standard NEMA control panels, alarm interlocks, and an internal sump with level controls. However, the units are somewhat limited in terms of material of construction. Poly units are available for small applications, but the high flow rate from the site will necessitate a larger unit fabricated of steel (316 stainless) or some other form of corrosion resistant metal such as titanium (available at an increased cost).

- Packed tower air strippers do not offer the low profile and maintenance advantages of the shallow tray stripper; however, they can be constructed of epoxy-coated aluminum or other highly corrosion resistant materials, and can be filled with polyethylene packing. In addition, a packed column stripper will have a lower air flow requirement (1500 CFM in comparison to 2400 CFM for the shallow tray unit), allowing for reduced vapor-phase carbon regeneration (approximately $40,000 per year less than the shallow tray stripper).

Option 1 costs (central treatment):

Capital	$1,220,738
Annual O&M	$ 544,150
Present Worth (30 yr)	$7,346,669

Option 2 - Air Stripping with Activated Carbon Treatment on Stripper Air and Water Effluent, with On-Site Regeneration of Vapor-Phase Carbon. This option is identical to Option 1; however, the vapor-phase activated carbon is continuously regenerated on-site by way of a rotating carbon bed which adsorbs contaminants from the stripper air on one side while the other side is regenerated with steam. Based on the opinions of experts in the carbon adsorption field, the concentrations of volatiles in the air stream will not be significant enough to warrant solvent recovery from the regenerate (which is the traditional means for handling this waste), thus the steam and dilute VOCs will be carried through a natural-gas fired incinerator on-site.

This process is advantageous in that it has a relatively low annual O&M cost due to the elimination of off-site regeneration of the vapor-phase carbon. However, the cost for the on-site regeneration equipment makes this the most costly of the three alternatives in terms of capital expense. In addition, the process of obtaining the necessary regulatory authorization for on-site incineration of the regenerate may be a disadvantage.

Option 2 costs (central treatment):

Capital	$1,423,238
Annual O&M	$ 394,150
Present Worth (30 yr)	$5,860,499

Option 5 - Advanced Oxidation Followed by Air Stripping with Activated Carbon Treatment on Stripper Water Effluent. This alternative is similar to Option 1 above; however, the vapor-phase carbon is eliminated by the AOP unit, which will be the initial process in the treatment scheme. The AOP unit will utilize UV light and hydrogen peroxide to form hydroxyl radicals, that will in turn destroy the TTCE and the majority of other compounds which are strictly regulated from an emissions standpoint. The VOCs which are relatively unaffected by AOP (primarily the single-bonded halogenated aliphatics, and, to a lesser degree, the ketones) will be stripped through either a packed column or low profile air stripper. Post-treatment with activated carbon will also be required for the ground water, since the ketones will generally pass-through the stripper as well.

This process is advantageous in that the annual O&M costs are less than those for Option 1 due to the elimination of off-site regeneration of the vapor-phase activated carbon. While the AOP unit will still cost $80,000 - $90,000 per year annually to operate (over 50% of which is attributable to power costs), this is significantly less than the $160,000 to $200,000 per year associated with off-site regeneration of vapor-phase carbon. However, the AOP unit will require a capital purchase of approximately $130,000 in comparison to the $38,000 capital expense for vapor-phase carbon. The AOP unit also provides distinct process advantages: (i) it is a destructive operation, achieving the highest possible ranking on the NYSDEC hierarchy of preference for remedial actions; (ii) it utilizes lamps which emit UV light at an intensity greater than that typically used for disinfection, hence bacteria are destroyed and the potential for fouling of the stripper is reduced; (iii) it relies on the addition of hydrogen peroxide to the water, which raises the dissolved oxygen content of the effluent to help reduce any BOD problems; (iv) the unit is pre-packaged and contains all necessary controls and alarm interlocks; (v) some heat is imparted to the water by the UV lamps, which increases stripper efficiency and reduces potential freeze-up; (vi) in addition to the current VOCs which are a concern from an air emissions standpoint, the process is extremely efficient with respect to destruction of vinyl chloride (a compound which is strictly regulated by the NYSDEC Division of Air Resources and a breakdown product of TTCE and TCE), whereas activated carbon has a low affinity for vinyl chloride; and (vii) since the unit will effectively be acting as an air emissions control device which operates in the water phase ahead of the stripper, the uncertainty associated with contaminant breakthrough on vapor-phase carbon emission controls will be eliminated. Disadvantages to the AOP process include: (i) the destruction of chlorinated organics produces chloride ions which will contribute to the corrosion problems already experienced at the site; (ii) the process efficiency is hampered by turbidity, oil and grease, and other parameters which may hinder the penetration of UV light through the water column, thus it is necessary to maintain efficient filtration and oil/water separation processes where these parameters will be of concern; and (iii) although the unit is fully automated, it will require a higher degree of maintenance and spot-checking than carbon.

Option 5 costs (central treatment):

Capital	$1,399,140
Annual O&M	$ 421,750
Present Worth (30 yr)	$6,147,117

Based on MPI's analysis of ground water treatment technologies, the option of "air stripping with carbon on the air and water effluent (and on-site regeneration of the vapor phase carbon)" will be included as the treatment technology in the combined alternatives evaluated in the next section. This technology had the lowest present worth cost. Although the capital costs were greater than those for the other two treatment technologies analyzed in detail, annual O&M costs would be less.

As previously stated, ground water concentrations typically drop off after several months of operation in a pump and treat system, and it may be possible to remove the carbon from service after some time. Since preliminary estimates indicate that carbon treatment of the ground water will be necessary because of the presence of ketones, and treatment of the air will be necessary due to the estimated level of TTCE emissions, discontinuing the use of carbon should be possible when the levels of these contaminants drop off to acceptable levels in the stripper effluents. Also, when VOC contaminant levels in the extracted ground water fall below the required discharge limitations, direct discharge without treatment should be possible.

5.2.3 Discharge Option

Disposal options for the treated ground water include discharge to the sanitary sewer and discharge to surface water (Oswego River). The relative advantages and disadvantages of each option are outlined below.

Discharge to Sanitary Sewer

Tying into the sanitary sewer near the WWTF, south of and adjacent to the Can Plant, would require the installation of less discharge pipe than would be required if the water were discharged to the Oswego River. This would represent an initial cost savings over the surface water discharge option. Another advantage may be gained if the Fulton WWTP requires pretreatment of the discharge to less stringent levels, allowing the efficiency of the treatment system to be reduced.

It is not certain, however, if the sanitary sewer would have adequate capacity to accept the flow. In addition, the water may actually be too clean for the WWTP to accept at the estimated flow. BOD levels in the treated water would be expected to be low, and discharging to the sewer may dilute the WWTP influent BOD. Coordination with both the NYSDEC and City of Fulton would also be required to revise the existing wastewater discharge permit requirements. This process could be lengthy.

Discharge to the Oswego River

Discharging to the Oswego River would require the installation of more pipe than the option of sanitary sewer discharge. However, the river could accept the flow, and there would tend to be less-complex permitting requirements. There would be less coordination with other agencies. In addition, since the remedial work would be performed under an Order on Consent, SPDES requirements would have to be met, but the actual permitting process would be minimized. The difference in capital costs between discharging to the sanitary sewer and discharging to the Oswego River would most likely be reduced due to the costs incurred through sanitary sewer discharge permitting and coordination.

Based on MPI's analysis of the ground water discharge options, surface water discharge will be included as the discharge option in the combined alternatives evaluated in the next section.

5.3 COMBINED ALTERNATIVES

Based on the ground water recovery modeling and evaluation of treatment and discharge options, the ground water extraction/treatment/discharge options will be defined as follows for the detailed evaluation:

- ground water extraction using 13 recovery wells - four installed in the southern operable unit and nine installed in the northern operable unit
- ground water treatment at a central treatment facility located in the southern area of the site, employing air stripping with carbon on the air and water effluent (and off-site regeneration of the vapor phase carbon)
- treated ground water discharge to the Oswego River

Considering this refinement of the ground water extraction/treatment/discharge alternatives, all alternatives surviving the preliminary screening were combined into "combined alternatives" to address remediation of the site as a whole. These combined alternatives will be analyzed in detail in Section 6.0. Listed below are the alternatives surviving preliminary screening and the new combined alternatives which will be brought through detailed analysis.

Alternatives Surviving Preliminary Screening:

Southern Operable Unit Soil

1. No action
6. Vapor extraction
7. In-situ bioremediation
8. In-situ soil flushing

Southern Operable Unit Ground Water

1. No action
3. Extraction/treatment/discharge
4. Extraction/treatment/discharge with reapplication/bioremediation
5. Extraction/treatment/discharge with air sparging/vapor extraction

Northern Operable Unit Ground Water

1. No further action
4. Extraction/treatment/discharge (larger pump/treat system)
5. Extraction/treatment/discharge with air sparging/vapor extraction

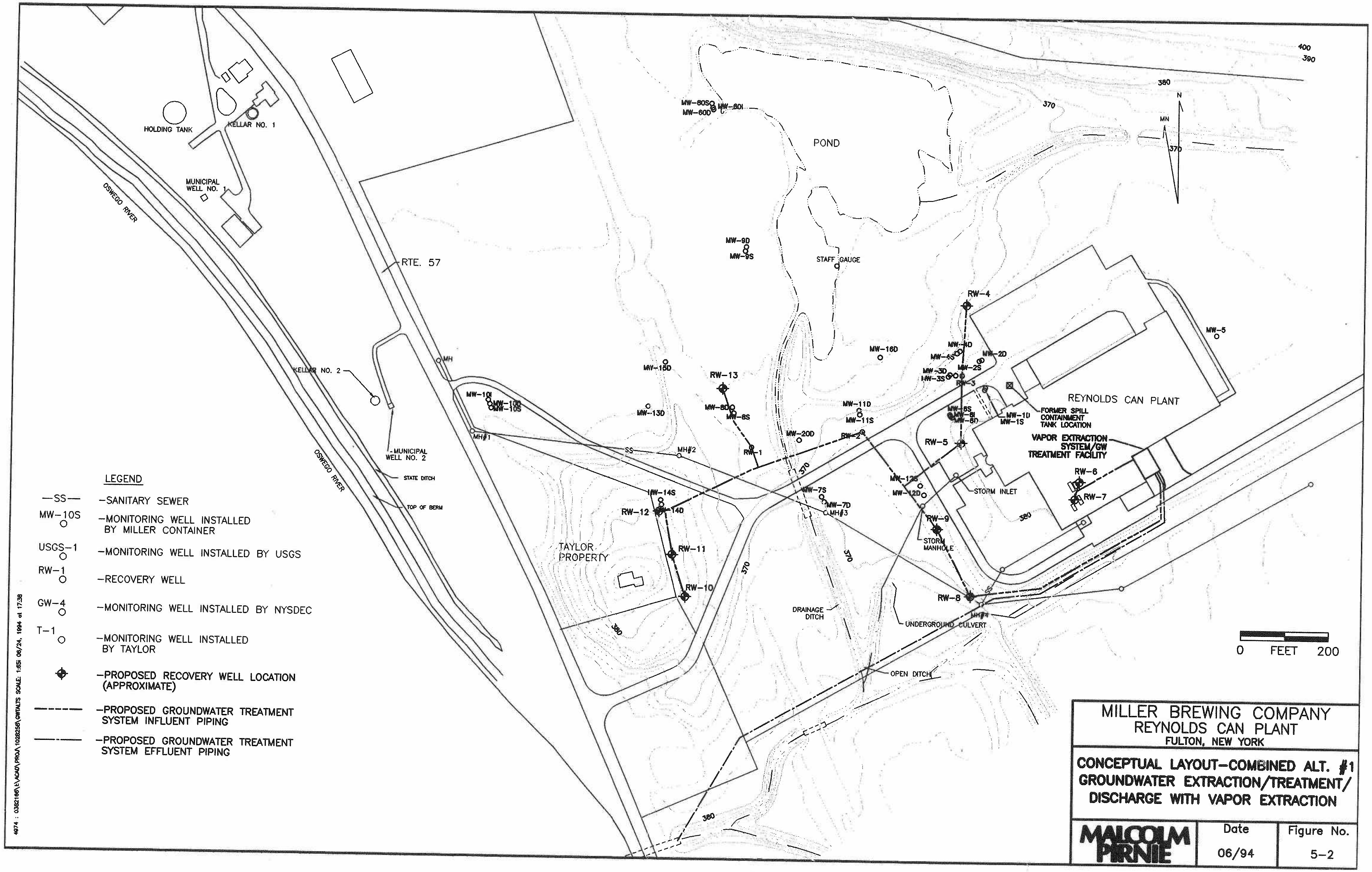
Combined Alternatives to be Analyzed in Detail:

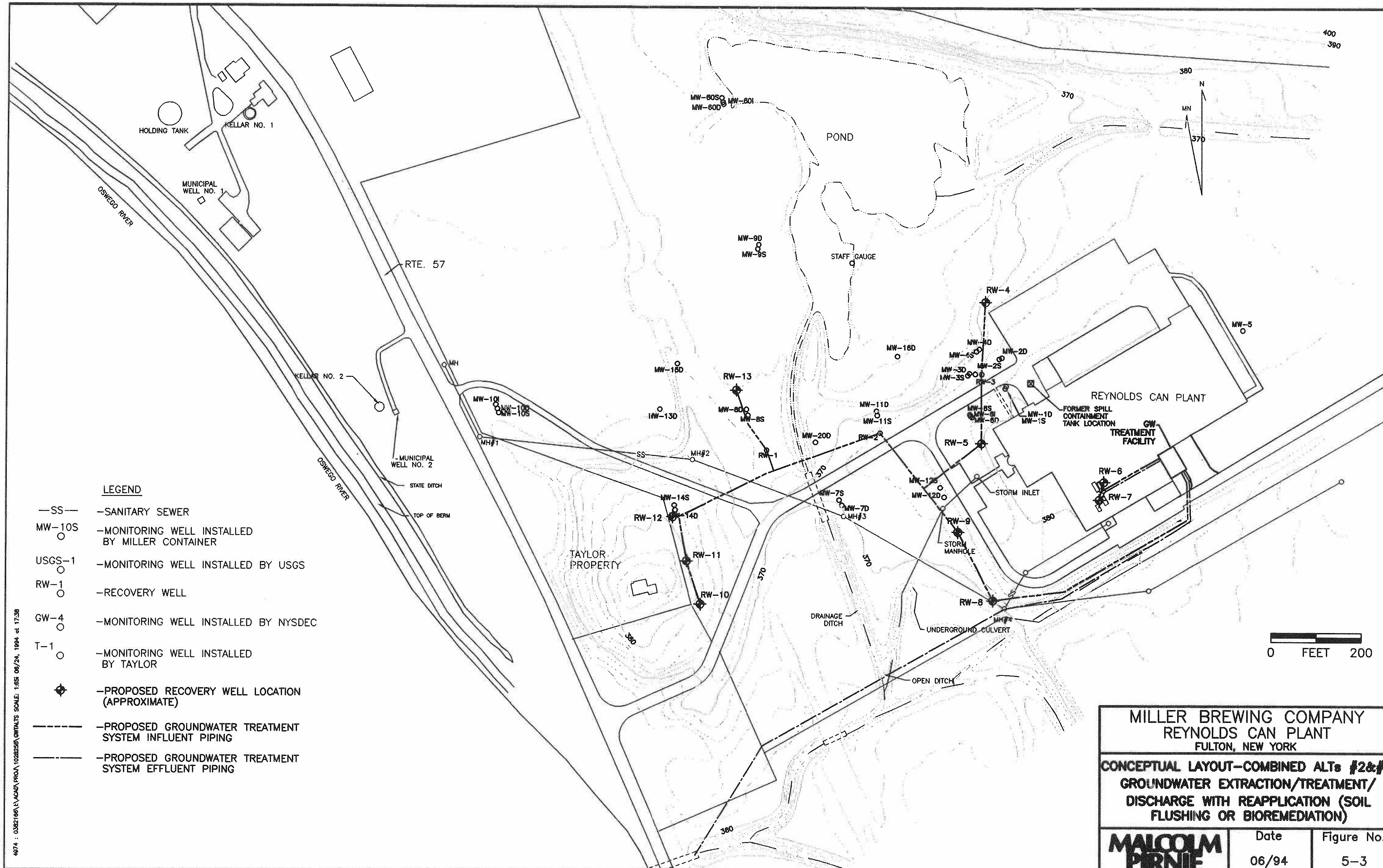
1. Extraction/central treatment/direct discharge and vapor extraction
2. Extraction/central treatment/direct discharge and reapplication/soil flushing
3. Extraction/central treatment/direct discharge and reapplication/bioremediation
4. Extraction/central treatment/direct discharge and air sparging/vapor extraction
5. No further action

Conceptual layouts of the four combined action alternatives (Alternatives 1 - 4) are contained in the following figures:

Figure 5-2	Alternative 1 (Vapor extraction)
Figure 5-3	Alternatives 2 (Soil flushing) and 3 (Bioremediation)
Figure 5-4	Alternative 4 (Air sparging)

The conceptual layouts of Alternatives 2 and 3 are very similar, thus the plan shown in Figure 5-3 represents that for soil flushing as well as bioremediation.


4974 : 0382166\E:\ACAD\PROJ\1028256\GWTALTS SCALE: 1:65i 06/24, 1994 at 17:38
HOLDING TANK
KELLAR NO. 1
MUNICIPAL WELL NO. 1
OSWEGO RIVER
RTE. 57
KELLAR NO. 2
MUNICIPAL WELL NO. 2
STATE DITCH
TOP OF BERM
POND
STAFF GAUGE
TAYLOR PROPERTY
DRAINAGE DITCH
OPEN DITCH
UNDERGROUND CULVERT
STORM INLET
STORM MANHOLE
REYNOLDS CAN PLANT
FORMER SPILL CONTAINMENT TANK LOCATION
VAPOR EXTRACTION SYSTEM/GW TREATMENT FACILITY
RW-1 RW-2 RW-3 RW-4 RW-5 RW-6 RW-7 RW-8 RW-9 RW-10 RW-11 RW-12 RW-13
MW-5 MW-9D MW-9S MW-11D MW-11S MW-13D MW-14S MW-14D MW-16D MW-18D MW-20D
0 FEET 200
LEGEND
—SS— -SANITARY SEWER
MW-10S -MONITORING WELL INSTALLED BY MILLER CONTAINER
USGS-1 -MONITORING WELL INSTALLED BY USGS
RW-1 -RECOVERY WELL
GW-4 -MONITORING WELL INSTALLED BY NYSDEC
T-1 -MONITORING WELL INSTALLED BY TAYLOR
-PROPOSED RECOVERY WELL LOCATION (APPROXIMATE)
-PROPOSED GROUNDWATER TREATMENT SYSTEM INFLUENT PIPING
-PROPOSED GROUNDWATER TREATMENT SYSTEM EFFLUENT PIPING
MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK
CONCEPTUAL LAYOUT-COMBINED ALT. #1 GROUNDWATER EXTRACTION/TREATMENT/ DISCHARGE WITH VAPOR EXTRACTION
MALCOLM PIRNIE
Date 06/94
Figure No. 5-2

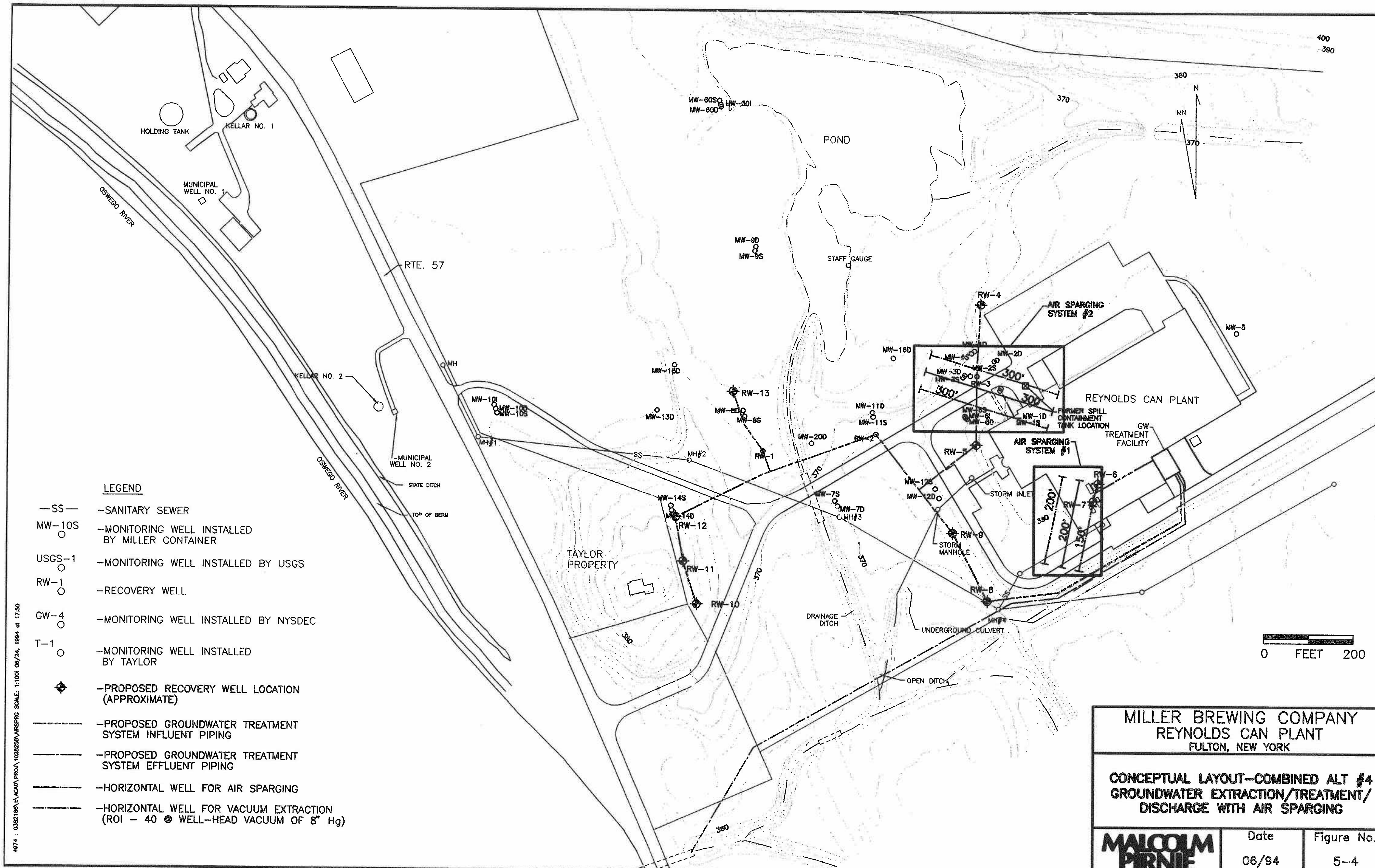


MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK

CONCEPTUAL LAYOUT-COMBINED ALTs #2&#3 GROUNDWATER EXTRACTION/TREATMENT/ DISCHARGE WITH REAPPLICATION (SOIL FLUSHING OR BIOREMEDIATION)

MALCOLM PIRNIE

Date	Figure No.
06/94	5-3


4974 : 0382166\I:\ACAD\PROJ\1028256\AIRSPRG SCALE: 1:100 06/24, 1994 at 17:50
LEGEND
—SS— -SANITARY SEWER
MW-10S -MONITORING WELL INSTALLED BY MILLER CONTAINER
USGS-1 -MONITORING WELL INSTALLED BY USGS
RW-1 -RECOVERY WELL
GW-4 -MONITORING WELL INSTALLED BY NYSDEC
T-1 -MONITORING WELL INSTALLED BY TAYLOR
-PROPOSED RECOVERY WELL LOCATION (APPROXIMATE)
-PROPOSED GROUNDWATER TREATMENT SYSTEM INFLUENT PIPING
-PROPOSED GROUNDWATER TREATMENT SYSTEM EFFLUENT PIPING
-HORIZONTAL WELL FOR AIR SPARGING
-HORIZONTAL WELL FOR VACUUM EXTRACTION (ROI - 40 @ WELL-HEAD VACUUM OF 8" Hg)
HOLDING TANK
KELLAR NO. 1
MUNICIPAL WELL NO. 1
OSWEGO RIVER
RTE. 57
KELLAR NO. 2
MUNICIPAL WELL NO. 2
STATE DITCH
TOP OF BERM
TAYLOR PROPERTY
POND
STAFF GAUGE
REYNOLDS CAN PLANT
AIR SPARGING SYSTEM #2
AIR SPARGING SYSTEM #1
FORMER SPILL CONTAINMENT TANK LOCATION
GW-TREATMENT FACILITY
STORM INLET
STORM MANHOLE
DRAINAGE DITCH
UNDERGROUND CULVERT
OPEN DITCH
0 FEET 200
MILLER BREWING COMPANY
REYNOLDS CAN PLANT
FULTON, NEW YORK
CONCEPTUAL LAYOUT-COMBINED ALT #4
GROUNDWATER EXTRACTION/TREATMENT/
DISCHARGE WITH AIR SPARGING
MALCOLM PIRNIE
Date 06/94
Figure No. 5-4

6.0 DETAILED ANALYSIS OF COMBINED REMEDIAL ACTION ALTERNATIVES

The detailed analysis of alternatives evaluates each of the combined alternatives presented in Section 5.0 against specific criteria. The analysis includes the following items:

- Identification of the alternative
- An assessment and summary profile of each alternative against the following seven evaluation criteria:
  (1) compliance with SCGs/ARARs
  (2) overall protection of human health and the environment
  (3) short-term effectiveness
  (4) long-term effectiveness and permanence
  (5) reduction in toxicity, mobility, or volume
  (6) implementability
  (7) cost
- A comparative analysis among the alternatives to assess the relative performance of each alternative with respect to each of the seven evaluation criteria.

Each of the criteria are discussed briefly in the paragraphs that follow.

The evaluation of **compliance with SCGs/ARARs** involves review of the chemical-specific, action-specific, and location-specific SCGs/ARARs to determine if the implementation of the alternative would result in compliance with all appropriate SCGs/ARARs. A list of SCGs/ARARs used in the evaluation of alternatives is contained in Appendix A.

The **overall protection of human health and the environment** criterion evaluates each alternative based on whether adequate protection to possible risks associated with the site is addressed. Any short-term or cross-media impacts are also considered in this portion of the FS.

Short-term effectiveness addresses the effects of the alternative during the construction and implementation phase until remedial action objectives are met. The following items are considered in the short-term effectiveness evaluation.

- protection of the community during remediation,
- protection of workers during remediation,
- environmental impacts, and
- time until remedial action objectives are achieved.

The **long-term effectiveness and permanence** criterion evaluates each alternative based on its ability to eliminate significant threats to public health and the environment. Long-term effectiveness is a measure of the risks remaining at the site once the remedial action objectives are met. The long-term criteria for evaluating effectiveness include

- magnitude of residual risk remaining from untreated waste or treatment residuals at the conclusion of remedial activities, and
- adequacy and reliability of controls.

The **reduction of toxicity, mobility, or volume** through treatment evaluation addresses the statutory preference for alternatives that involve treatment technologies that significantly and permanently reduce toxicity, mobility, or volume of the hazardous substances as their principal element. This criterion is satisfied when treatment is used to reduce the "principal threats at a site". The following items are used to conduct this portion of the detailed analysis.

- treatment process used and media treated,
- amount of hazardous materials treated or destroyed,
- degree of reduction in toxicity, mobility, and volume,
- degree to which treatment is irreversible, and
- residuals remaining after treatment.

Implementability refers to both the administrative and technical feasibility of implementing a remedial alternative. Administrative feasibility includes activities involving project compliance with local, state, and federal agencies. Examples of administrative issues would include (but would not be limited to) obtaining applicable permits or rights-of-way for construction activities. Technical feasibility refers to the ability to construct and operate a technology and the reliability of a technology. Other items that are considered part of the implementability evaluation include the availability of services and materials. These include the availability of treatment, storage capacity, and disposal services; availability of equipment and specialists; and, the availability of the technology. The ease of undertaking additional remedial action, if warranted, is also evaluated.

The **cost** criterion involves a calculation of estimated present worth for each alternative. Costs to be considered in the evaluation include both direct and indirect capital costs and O & M costs. Cost estimates were based on experience from installation or use of similar equipment, and were supplemented by references such as the Means Building Construction Cost Data and vendors. Costs were calculated for each alternative assuming that operation of the entire treatment system required for each alternative would continue for the specified amount of time. However, operation of some treatment system components (such as the oil/ground water separator) will not be required for the full length of time if it is found that certain aspects of treatment are not necessary for the continued achievement of discharge limitations. In addition, remedial action objectives may be reevaluated at some time in the future which could have an effect on the overall remediation time frames.

As discussed in the EPA CERCLA Guidance document, two additional criteria, state acceptance and community acceptance, will be later utilized during the formulation of the ROD for the site. A description of each alternative and a detailed discussion of the application of the seven initial criteria follow.

Consistent with assumptions made during the preliminary screening of remedial alternatives for the southern operable unit soil in Section 4.2, it is assumed for the detailed analysis that the perched water in the area beneath the Can Plant will be removed and oil recovery will be complete prior to the implementation of the soil remedial technology.

6.1 INDIVIDUAL ANALYSIS OF ALTERNATIVES

6.1.1 Alternative 1 - Extraction/Central Treatment/Direct Discharge and Vapor Extraction

Description of Alternative

Ground water would be withdrawn from all 13 recovery wells and piped to a central treatment facility located on the south side of the Can Plant. Flow from RW-6 and RW-7 would be in a separate influent pipe and directed to an oil/water separator prior to being combined with the flow from the rest of the site. Any recovered oil from these two wells would be discharged to a holding tank prior to final off-site disposal. Free-floating oils which may be present in RW-6 and RW-7 would be collected using separate product recovery pumps operating at the oil/ground water interface.

The combined ground water flow from the site would be collected in an equalization tank in the facility, then pumped through an air stripper with granular activated carbon polishing. The treated water would be routed to the Oswego River where it would be discharged in accordance with SPDES Permit requirements.

A vapor extraction system would also be housed in the treatment facility. Piping running from RW-6 and RW-7, which would be used as dual extraction wells, would be manifolded and connected to the vacuum extraction unit. The extraction unit would be comprised of a water knockout tank and vacuum pump. Vapors withdrawn from the two vacuum wells with the vacuum pump would be passed through a carbon adsorption system for VOC treatment prior to being discharged to the atmosphere.

Based on the results of the vapor extraction pilot test conducted south of the Can Plant and the estimated volume of contaminants beneath the building, an estimated clean-up time frame of one year was provided to MPI by the vapor extraction firm that performed the pilot test. It was also determined that, on a preliminary basis, carbon would be feasible for vapor treatment.

Evaluation of Criteria

Compliance with SCGs/ARARs: This alternative should lead to compliance with chemical-specific SCGs/ARARs. Action-specific SCGs/ARARs would include compliance with SPDES and air discharge limitations. There are no known location-specific SCGs/ARARs associated with this alternative.

Protection of health & environment: This alternative would provide for the protection of the municipal water supply since the ground water contaminant plume would be contained on the Can Plant site. Protection of the southern operable unit ground water would be provided through the implementation of vapor extraction. VOC-contaminant concentrations in the soils beneath the Can Plant would be reduced to levels considered to be protective of ground water quality for its best use.

Short-term effectiveness: There would be minimal short-term risks to on-site workers and the community based on the potential for fugitive emissions during installation of the ground water recovery wells and during remediation. Monitoring would be conducted and all on-site workers would wear the appropriate protective equipment. In addition, any risks posed during operation of the treatment system would be easily controlled through proper system operation, maintenance, and monitoring.

It is difficult to assess the time requirement associated with ground water pumping and treatment at the site. For the purpose of cost estimating, it was assumed to be 30 years. Based on the results of the vapor extraction pilot test and the estimated volume of contaminated soil beneath the Can Plant, it was estimated that vapor extraction would be completed within one year.

Long-term effectiveness and permanence: This alternative would involve on-site treatment. Although the ground water pump and treat technology would not be considered a permanent remedy, it would be effective in containing the plumes. Vapor extraction would provide for a permanent reduction in the volume of contamination present in the soil beneath the Can Plant. The vapors withdrawn would most likely be treated with carbon, which, in turn, would be thermally regenerated. This would destroy the volatile compounds removed from the air stream. Initial start-up testing would be required to verify the effectiveness of vapor extraction beneath the building.

Although remedial action objectives for the southern operable unit soil would be expected to met within one year of alternative implementation, ground water pump and treat would most likely be required for a great period of time before ground water objectives are met. Provided remedial action objectives are eventually met for the ground water, little contamination would be left at the site and little to no long-term operation, maintenance, and monitoring would be required.

Reduction of toxicity, mobility, or volume: Implementation of the ground water pump and treat option of this alternative would significantly reduce the migration of contaminants from the site. This would result in the reduction in mobility of contaminants as well as volume. Treatment by vapor extraction would significantly reduce the contaminant source. Treatment of the southern operable unit soil by use of a vapor extraction system would result in irreversible and permanent reduction of VOCs in the soil. It would also promote biodegradation of any residual oil in the soil. The only significant treatment residual that would remain following treatment would be vapor phase and liquid phase carbon used to treat the air and water streams. The vapor phase carbon would be regenerated on-site, and the recovered contaminants would be incinerated. The liquid phase carbon would be taken off-site for regeneration.

Implementability: Implementation of this alternative would be relatively straight forward. Assuming that utilizing RW-6 and RW-7 as vacuum wells provides adequate coverage for vapor extraction in the southern operable unit, boring through the floor in the plant would be limited to the installation of vacuum piezometers. Gaining access, however, could cause minor delays. Once remedial-action objectives were met with this alternative, no future remedial actions would be anticipated.

Coordination with the NYSDEC would be required to obtain the necessary air and water discharge limitations. The technologies employed under this alternative would be commercially available, and a sufficient number of vendors would be available.

Cost: Costs associated with this alternative would include costs for recovery well installation, treatment facility equipment and construction, and routine operations and maintenance. The 30 year present worth cost is estimated to be $5,985,502 with a capital cost of $1,502,400 and an annual O&M cost of $394,200. Additional O&M costs of $48,900 would be incurred during the first year of system operation for vapor extraction system operation, maintenance, and monitoring. Cost details are provided in Table 6-1.

6.1.2 Alternative 2 - Extraction/Central Treatment/Direct Discharge and Reapplication/Soil Flushing

<u>Description of Alternative</u>

The ground water portion of this alternative would be the same as previously described for Alternative 1. Ground water from the 13 recovery wells would be piped to a central facility, where it would be treated then discharged to the Oswego River. However, instead of implementing vapor extraction to remediate the southern operable unit soils, a portion of the treated water from the ground water treatment system would be directed back

TABLE 6-1
PRESENT WORTH COST ANALYSIS
COMBINED ALTERNATIVE 1
Extraction/Central Treatment/Direct Discharge and Vapor Extraction

GW EXTRACTION/CENTRAL TREATMENT/DIRECT DISCHARGE COSTS:	
ITEM/DESCRIPTION	TOTAL COST ($)
CAPITAL EXPENSE	
Treatment System Equipment & Building	$443,500
Contractor's Treat Sys. Labor (Install., Plumb., Elec.) OH & Profit @ 50%	$221,800
Drilling Cost – Recovery Well Install & Labor	$114,500
Extraction Process Piping, Pumps, Controls – Labor & Materials	$215,500
Discharge Piping – Labor & Materials	$59,000
TOTAL CAPITAL & LABOR	$1,054,300
Engineering & Contingency @ 35%	$369,000
TOTAL	$1,423,300
ANNUAL O&M	
Electrical @ $0.07/Kw-hr	$48,700
Liquid Phase Carbon Regeneration Fees	$200,000
Estimated Regenerate Steam Incineration	$50,000
Bag Filter Replacement	$7,000
Oil Disposal	$12,000
Trouble-Shooting, Sampling and Reporting Labor	$51,500
Analytical Costs	$23,000
Service/Parts	$2,000
TOTAL ANNUAL O&M	$394,200
5 Year Total Present Worth (I=8%)	$2,997,222
10 Year Total Present Worth (I=8%)	$4,068,421
20 Year Total Present Worth (I=8%)	$5,293,595
30 Year Total Present Worth (I=8%)	$5,861,125

VAPOR EXTRACTION COSTS:	
CAPITAL EXPENSE	
Treatment System Equipment	$27,600
Contractors' Labor (Install, Plumb., Elec.) OH & Profit @ 50%	$13,800
Piezometer installation	$6,000
Start Up Testing	$11,200
TOTAL CAPITAL & LABOR	$58,600
Engineering (20%)	$11,700
Contingency Allowances (15%)	$8,800
TOTAL	$79,100
ANNUAL O & M	
Operating Labor Costs	$15,600
Maintenance Materials Filters, oil for blower	$100
Auxiliary Materials and Energy Electricity for blower @ $0.07/kw hr.	$1,500
Disposal of Carbon	$4,500
Sampling/Analytical Costs	$16,000
Quarterly Reports	$11,200
TOTAL ANNUAL O & M	$48,900
1 Year Total Present Worth (i = 8%)	$124,377

TOTAL PRESENT WORTH – COMBINED ALTERNATIVE 1	
30 Year Total Present Worth (i = 8%)	$5,985,502

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into soils beneath the Can Plant. The water would be collected after being flushed through the contaminated soils and pumped to the ground water remediation facility for treatment. The decommissioned underground tanks located inside the WWTF could serve as reapplication and collection points. This alternative would require only the installation of additional piping from the treatment system to the underground tanks, as well as the installation of any required controls.

To implement this alternative, initial testing would be required. Fate and transport mechanisms would have to be evaluated, a detailed characterization of the soil, and an assessment of the contaminant distribution in the vicinity of the tanks would be required. Although water would not dissolve many of the specific contaminants detected in the soil beneath the Can Plant, it would act as a flushing agent for some of the contaminants. To determine the cost of this alternative, it was estimated that soil flushing would be performed for a period of five years, and that ground water remediation would require 30 years.

Evaluation of Criteria

Compliance with SCGs/ARARs: This alternative should lead to compliance with chemical-specific SCGs/ARARs, although a great amount of time would be required to achieve ground water SCGs/ARARs. Action-specific SCGs/ARARs would include compliance with SPDES and air discharge limitations. There are no known location-specific SCGs/ARARs associated with this alternative.

Protection of health and environment: This alternative would provide for the protection of the municipal water supply since the ground water contaminant plume would be contained on the Can Plant site. Protection of the southern operable unit ground water would be provided through the implementation of soil flushing, provided VOC contaminant concentrations in the soils beneath the Can Plant are reduced to levels considered to be protective of ground water quality for its best use.

Short-term effectiveness: Short-term risks to on-site workers and the community would be due to fugitive emissions during installation of the ground water recovery wells and during remediation. However, these risks are considered to be minimal. Monitoring would be conducted and all on-site workers would wear the appropriate protective equipment. In addition, any risks posed during operation of the treatment system would be easily controlled through proper system operation, maintenance, and monitoring.

It is difficult to assess the time requirement associated with ground water treatment at the site. For cost-estimating purposes, it was assumed that ground water treatment would be required for 30 years and soil remediation would be completed in five years.

Long-term effectiveness and permanence: This alternative would involve on-site treatment. Although the ground water pump and treat technology would not be considered a permanent remedy, it would be effective in containing the plumes. Soil flushing is assumed to be effective; however, this technology has not been demonstrated for this site. Initial testing would be required to determine the applicability of the technology. If proven to be effective, flushing would provide for a permanent reduction in the volume of contamination present in the soil beneath the Can Plant.

Although remedial action objectives for the southern operable unit soil would be expected to be met within a relatively short time frame, ground water pump and treat would most likely be required for a great period of time before ground water objectives are met. Provided remedial-action objectives are eventually met for the ground water, little contamination would be left at the site and little to no long-term operation, maintenance, and monitoring would be required. Limited sampling of the soil beneath the Can Plant and ground water would eventually be required to confirm that remedial-action objectives were met.

Reduction of toxicity, mobility, or volume: Implementation of the ground water pump and treat option of this alternative would significantly reduce the migration of contaminants from the site. This would result in the reduction in mobility of contaminants as well as volume. Treatment by soil flushing would significantly reduce the contaminant source. Treatment of the southern operable unit soil by use of a soil-flushing system would result in irreversible and permanent reduction of VOCs in the soil. The only significant residual that would remain following treatment would be liquid phase carbon used to treat the water effluent from the air stripper and vapor phase carbon used to treat the air effluent. The vapor phase carbon would be regenerated on-site, and the recovered contaminants would be incinerated. The liquid phase carbon would be taken off-site for regeneration.

Implementability: Implementation of this alternative would be relatively straight forward. If the underground tanks in the WWTF prove to be effective as reapplication and recovery points for soil flushing in the southern operable unit, intrusive activities in the Can Plant would be limited. However, some future remedial actions may be necessary if access to all contaminants cannot be gained by flushing.

Coordination with the NYSDEC would be required to obtain the necessary air and water discharge limitations. The technologies employed under this alternative would be commercially available, and a sufficient number of vendors would be available.

Cost: Costs associated with this alternative would include costs for recovery well installation, treatment facility equipment and construction, and routine operations and maintenance. The 30 year present-worth cost is estimated to be $5,942,864. Capital costs were estimated at $1,471,900, and annual O&M costs of $402,500 would be anticipated during the first five years of system operation (while soil flushing is being implemented). Annual O&M costs for the ground water pump and treat system alone would be expected to be approximately $394,200. This would represent the annual O&M costs incurred following the completion of soil flushing. Cost details are provided in Table 6-2.

6.1.3 Alternative 3 - Extraction/Central Treatment/Direct Discharge and Reapplication/Bioremediation

<u>Description of Alternative</u>

This alternative would be very similar to Alternative 2, which involves reapplication of some of the treated ground water to the southern operable unit subsurface soils to induce contaminant removal. Ground water from the 13 recovery wells would be piped to a central facility, where it would be treated and discharged to the Oswego River. As with Alternative 2, a portion of the treated water would be reapplied to the southern operable unit soils.

TABLE 6-2
PRESENT WORTH COST ANALYSIS
COMBINED ALTERNATIVE 2
Extraction/Central Treatment/Direct Discharge and Reapplication/Soil Flushing

GW EXTRACTION/CENTRAL TREATMENT/DIRECT DISCHARGE COSTS:

ITEM/DESCRIPTION CAPITAL EXPENSE		TOTAL COST ($)
Treatment System Equipment & Building		$443,500
Contractor's Treat Sys. Labor (Install., Plumb., Elec.) OH & Profit @ 50%		$221,800
Drilling Cost – Recovery Well Install & Labor		$114,500
Extraction Process Piping, Pumps, Controls – Labor & Materials		$215,500
Discharge Piping – Labor & Materials		$59,000
TOTAL CAPITAL & LABOR		$1,054,300
Engineering & Contingency @ 35%		$369,000
TOTAL		$1,423,300
ANNUAL O&M		
Electrical @ $0.07/Kw-hr		$48,700
Liquid Phase Carbon Regeneration Fees		$200,000
Estimated Regenerate Steam Incineration		$50,000
Bag Filter Replacement		$7,000
Oil Disposal		$12,000
Trouble-Shooting, Sampling and Reporting Labor		$51,500
Analytical Costs		$23,000
Service/Parts		$2,000
TOTAL ANNUAL O&M		$394,200
5 Year Total Present Worth (I=8%)		$2,997,222
10 Year Total Present Worth (I=8%)		$4,068,421
20 Year Total Present Worth (I=8%)		$5,293,595
30 Year Total Present Worth (I=8%)		$5,861,125

REAPPLICATION/SOIL FLUSHING COSTS:

CAPITAL EXPENSE		
Initial Testing		$15,000
System Construction – Labor and Materials		
Piping & Controls		$20,000
4 Recovery Pumps		$1,000
TOTAL CAPITAL & LABOR		$36,000
Engineering	20%	$7,200
Contingency Allowances	15%	$5,400
TOTAL		$48,600
ANNUAL O & M		
Electricity for pumps @ $0.07/kw-hr.		$1,400
Sampling/Analysis (2/month)		$4,800
Quarterly Reports		$2,100
TOTAL ANNUAL O & M		$8,300
5 Year Total Present Worth (i = 8%)		$81,739

TOTAL PRESENT WORTH – COMBINED ALTERNATIVE 2	
30 Year Total Present Worth (i = 8%)	$5,942,864

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However, the portion of the treated water directed back into soils beneath the Can Plant would undergo additional treatment before reapplication. Nutrients, and, if necessary, microorganisms, would be injected into the discharge water prior to its entry into the distribution tanks. This would serve to promote biodegradation of the soils surrounding the tanks. The injected water would be collected after being flushed through the contaminated soils and pumped to the ground water remediation facility for treatment. This alternative would require the installation of additional tanks, piping, and controls in the ground water treatment facility.

To implement this alternative, initial studies and testing would be required. Fate and transport mechanisms would have to be evaluated, and sampling would have to be conducted to identify naturally occurring organisms and any inhibiting conditions. Bench testing and pilot testing would also be required. To determine the cost of this alternative, it was estimated that bioremediation would be performed for a period of three years. This assumes that the biological treatment step added to the soil flushing option would decrease the soil remediation time frame. Ground water remediation was assumed to require 30 years.

Evaluation of Criteria

Compliance with SCGs/ARARs: This alternative should lead to compliance with chemical-specific SCGs/ARARs, although a great amount of time would be required to achieve ground water SCGs/ARARs. Action-specific SCGs/ARARs would include compliance with SPDES and air discharge limitations. It is assumed that SPDES limitations would also be applicable for the reapplication of the treated water to the soils since the area would be under the influence of pumping at the recovery wells. There are no known location-specific SCGs/ARARs associated with this alternative.

Protection of health and environment: This alternative would provide for the protection of the municipal water supply since the ground water contaminant plume would be contained on the Can Plant site. Protection of the southern operable unit ground water would be provided through the implementation of bioremediation, provided VOC contaminant concentrations in the soils beneath the Can Plant were reduced to levels considered to be protective of ground water quality for its best use.

Short-term effectiveness: Short-term risks to on-site workers and the community would be due to fugitive emissions during installation of the ground water recovery wells and during remediation. However, these risks are considered to be minimal. Monitoring would be conducted and all on-site workers would wear the appropriate protective equipment. In addition, any risks posed during operation of the treatment system would be easily controlled through proper system operation, maintenance, and monitoring.

As with the preceding alternatives, it is difficult to assess the time requirement associated with ground water treatment at the site. For cost estimating purposes, it was assumed that ground water remediation would be completed in 30 years. Soil remediation would be completed in approximately three years.

Long-term effectiveness and permanence: This alternative would involve on-site treatment. Although the ground water pump and treat technology would not be considered a permanent remedy, it would be effective in containing the plumes. Reapplication/bioremediation is assumed to be effective; however, this technology has not been demonstrated for this site. Initial testing would be required to determine the applicability of the technology. Initial testing would include the performance of bench and pilot tests. If proven to be effective, bioremediation would provide for a permanent reduction in the volume of contamination present in the soil beneath the Can Plant.

Although remedial-action objectives for the southern operable unit soil would be expected to be met within a relatively short time frame, ground water pump and treat would most likely be required for a great period of time before ground water objectives are met. Provided remedial-action objectives are eventually met for the ground water, little contamination would be left at the site and little to no long-term operation, maintenance, and monitoring would be required. Limited sampling of the soil beneath the Can Plant as well as site ground water would eventually be required to confirm that remedial-action objectives were met.

Reduction of toxicity, mobility, or volume: Implementation of the ground water pump and treat option of this alternative would significantly reduce the migration of contaminants from the site. This would result in the reduction in mobility of contaminants as well as volume. Treatment by bioremediation would significantly reduce the contaminant source. Treatment of the southern operable unit soil by use of a soil flushing/bioremediation system would result in irreversible and permanent reduction of VOCs in the soil. The only significant residual that would remain following treatment would be liquid phase carbon used to treat the water effluent from the air stripper and vapor phase carbon used to treat the air effluent. The vapor phase carbon would be regenerated on-site, and the recovered contaminants would be incinerated. The liquid phase carbon would be taken off-site for regeneration.

Implementability: Implementation of this alternative would be relatively straight forward. However, long pre-implementation study times are associated with bioremediation. Additional studies and testing would be required to determine the appropriateness of this alternative at the site. If the underground tanks in the WWTF prove to be effective as reapplication and recovery points for bioremediation in the southern operable unit, intrusive activities in the Can Plant would be limited.

Coordination with the NYSDEC would be required to obtain the necessary air and water discharge limitations. The technologies employed under this alternative would be commercially available, and a sufficient number of vendors would be available.

Cost: Costs associated with this alternative would include costs for recovery well installation, treatment facility equipment and construction, and routine operations and maintenance. The 30 year present-worth cost is estimated to be $6,248,835. Capital costs were estimated at $1,553,300, and annual O&M costs of $494,200 would be anticipated during the first three years of system operation (while reapplication/bioremediation is being implemented). Annual O&M costs for the ground water pump and treat system after this time would be approximately $394,200. Cost details are provided in Table 6-3.

TABLE 6-3
PRESENT WORTH COST ANALYSIS
COMBINED ALTERNATIVE 3
Extraction/Central Treatment/Direct Discharge and Reapplication/Bioremediation

GW EXTRACTION/CENTRAL TREATMENT/DIRECT DISCHARGE COSTS:

ITEM/DESCRIPTION	TOTAL COST ($)
CAPITAL EXPENSE	
Treatment System Equipment & Building	$443,500
Contractor's Treat Sys. Labor (Install., Plumb., Elec.) OH & Profit @ 50%	$221,800
Drilling Cost – Recovery Well Install & Labor	$114,500
Extraction Process Piping, Pumps, Controls – Labor & Materials	$215,500
Discharge Piping – Labor & Materials	$59,000
TOTAL CAPITAL & LABOR	$1,054,300
Engineering & Contingency @ 35%	$369,000
TOTAL	$1,423,300
ANNUAL O&M	
Electrical @ $0.07/Kw-hr	$48,700
Liquid Phase Carbon Regeneration Fees	$200,000
Estimated Regenerate Steam Incineration	$50,000
Bag Filter Replacement	$7,000
Oil Disposal	$12,000
Trouble-Shooting, Sampling and Reporting Labor	$51,500
Analytical Costs	$23,000
Service/Parts	$2,000
TOTAL ANNUAL O&M	$394,200
5 Year Total Present Worth (I=8%)	$2,997,222
10 Year Total Present Worth (I=8%)	$4,068,421
20 Year Total Present Worth (I=8%)	$5,293,595
30 Year Total Present Worth (I=8%)	$5,861,125

REAPPLICATION/BIOREMEDIATION COSTS:

CAPITAL EXPENSE	
Initial Studies/Testing	$100,000
–Additional hydrogeologic investigations	
–Fate and Transport Analysis	
–Sampling to identify naturally occurring organisms and any inhibiting conditions	
–Bench testing	
–Pilot testing	
Construction of facilities	$30,000
TOTAL	$130,000
ANNUAL O & M	
Operations and Maintenance	$50,000
Monitoring	$50,000
Total Annual O & M	$100,000
3 year Total Present Worth (i = 8%)	$387,710

TOTAL PRESENT WORTH – COMBINED ALTERNATIVE 3	
30 Year Total Present Worth (i = 8)	$6,248,835

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6.1.4 Alternative 4 - Extraction/Central Treatment/Direct Discharge and Air Sparging/Vapor Extraction

Description of Alternative

Contaminated soils in the areas where air sparging is undertaken would be remediated through vapor extraction. A ground water pump and treat system would be installed at the site as previously described for Alternatives 1 through 3. All water recovered from the site would be treated with an air stripper followed by carbon polishing. The treated water would then be discharged to the Oswego River in accordance with SPDES requirements.

Two air sparging systems would also be constructed at the site. The systems would be located in the general vicinities of highest concentration ground water contamination. The first system would be installed in the area southwest of the Can Plant, in the area of the southern operable unit soil. The second system would be constructed north of the Can Plant, in the area of the former spill containment tank. Both systems would utilize horizontal wells in order to maximize sparging and recovery effectiveness. The sparging wells would be installed below the ground water table, while the vapor extraction wells would be located above the ground water, in the vadose zone.

The sparging gas used would most likely be nitrogen. Use of nitrogen would minimize the precipitation of inorganics from the ground water which could clog the sparging wells. The nitrogen gas would be injected into the ground water, and contaminated vapors would be recovered through the vapor extraction wells. The vapors would be routed through a carbon adsorption system prior to being discharged or reinjected.

Bench scale and pilot testing would be required prior to implementing this alternative. One or two vertical sparging wells could be installed and operated as part of a pilot test to determine the effectiveness of air sparging at the site. Based on preliminary estimates, the air sparging system would be expected to run for approximately five years. Although it is not known exactly what the ground water clean-up time frame would be if air sparging were implemented, MPI assumed for the purpose of cost estimating that ground water remedial action objectives would be achieved in 20 years.

Evaluation of Criteria

Compliance with SCGs/ARARs: This alternative should lead to compliance with chemical-specific SCGs/ARARs. Action-specific SCGs/ARARs would include compliance with SPDES and air discharge limitations. There are no known location-specific SCGs/ARARs associated with this alternative.

Protection of health and environment: This alternative would provide for the protection of the municipal water supply since contaminant migration off site would be minimized. Protection of the southern operable unit ground water would be provided through the implementation of vapor extraction. VOC-contaminant concentrations in the soils beneath the Can Plant would be reduced to levels considered to be protective of ground water quality for its best use.

Short-term effectiveness: Short-term risks to on-site workers and the community would be due to fugitive emissions during installation of the ground water recovery wells, air sparging wells, and vapor extraction wells, as well as during remediation activities. However, these risks are considered to be minimal. Monitoring would be conducted and all on-site workers would wear the appropriate protective equipment. In addition, any risks posed during operation of the treatment system would be easily controlled through proper system operation, maintenance, and monitoring.

It is difficult to assess the time requirement associated with ground water treatment at the site. However, it was assumed that five years of air sparging operation would provide a ground water clean-up time frame of 20 years.

Long-term effectiveness and permanence: This alternative would involve on-site treatment. Although the ground water pump and treat technology would not be considered a permanent remedy, it would be effective in containing the plumes. Air sparging/vapor extraction would provide for a permanent reduction in the volume of contamination present in the soil beneath the Can Plant as well as in the site ground water. The vapors withdrawn would most likely be treated with carbon, which, in turn, would be thermally regenerated. This would destroy the volatile compounds removed from the air stream. Bench scale and pilot testing would be required prior to implementing air sparging to verify the applicability of the technology.

Although remedial-action objectives for the southern operable unit soil would be expected to met within five years of alternative implementation, ground water pump and treat would be required for a greater period of time before ground water objectives are met. Provided remedial-action objectives are eventually met for the ground water, little contamination would be left at the site and little to no long-term operation, maintenance, and monitoring would be required.

Reduction of toxicity, mobility, or volume: Implementation of the ground water pump and treat option of this alternative would significantly reduce the migration of contaminants from the site. This would result in the reduction of contaminant mobility. Treatment by air sparging/vapor extraction would significantly reduce contaminant levels in the ground water and would provide for the irreversible and permanent reduction of VOCs in the soil, thus providing for contaminant source reduction. The only significant residual that would remain following treatment would be vapor phase and liquid phase carbon used to treat the air and water streams. The vapor phase carbon would be regenerated on-site, and the recovered contaminants would be incinerated. The liquid phase carbon would be taken off-site for regeneration.

Implementability: Due to the additional construction activities associated with this alternative, this would be the most difficult of the combined alternatives to implement. Pilot testing would also have to be performed to verify its effectiveness. However, based on the data collected to date, it appears that performance goals at the site would be met, and once met, no future remedial actions would be anticipated.

Coordination with the NYSDEC would be required to obtain the necessary air and water discharge limitations. The technologies employed under this alternative would be commercially available, and a sufficient number of vendors would be available.

Cost: Costs associated with this alternative would include costs for recovery-, sparging- and vacuum-well installation, as well as treatment facility equipment and construction, and routine operations and maintenance. Assuming that the ground water is remediated in 20 years, the 20 year present worth cost of this alternative was estimated at $7,062,065, with a capital cost of $2,081,400. Annual O&M costs of $672,300 would be incurred during the first five years of system operation. Following the completion of air sparging, O&M costs for the ground water pump and treat system would be approximately $394,200. Cost details are provided in Table 6-4.

6.1.5 Alternative 5 - No Further Action

Description of Alternative

This alternative would involve taking no action to remediate the contaminated media in the southern operable unit. The recovery well/treatment system currently in operation in the northern operable unit would remain in operation. Ground water would continue to be recovered with recovery wells RW-1, RW-2, and RW-3, and treated with the air stripper prior to being discharged to the sanitary sewer/WWTP. Due to the age of the three wells, however, their replacement may be necessary. No further action would be taken. Inclusion of this no-action, or no-further-action, alternative is required by the NCP.

Evaluation of Criteria

Compliance with SCGs/ARARs: Ground water standards at the site have been exceeded. In addition, exceedances in ground water downgradient from the site have been attributed to site contamination. Although implementation of this alternative would not be expected to lead to compliance with chemical-specific SCGs/ARARs, action-specific SCGs/ARARs would continue to be met. Action-specific SCGs/ARARs include sewer use permit and air discharge limitations. There are no known location-specific SCGs/ARARs associated with this alternative.

Protection of health and environment: In the Human Health Risk Assessment, no pathways of concern were identified as possible exposure scenarios for the southern or northern operable unit media requiring remediation. Since ground water

TABLE 6-4
PRESENT WORTH COST ANALYSIS
COMBINED ALTERNATIVE 4
Extraction/Central Treatment/Direct Discharge and Air Sparging/Vapor Extraction

GW EXTRACTION/CENTRAL TREATMENT/DIRECT DISCHARGE COSTS:

ITEM/DESCRIPTION	TOTAL COST ($)
CAPITAL EXPENSE	
Treatment System Equipment & Building	$443,500
Contractor's Treat Sys. Labor (Install., Plumb., Elec.) OH & Profit @ 50%	$221,800
Drilling Cost – Recovery Well Install & Labor	$114,500
Extraction Process Piping, Pumps, Controls – Labor & Materials	$215,500
Discharge Piping – Labor & Materials	$59,000
TOTAL CAPITAL & LABOR	$1,054,300
Engineering & Contingency @ 35%	$369,000
TOTAL	$1,423,300
ANNUAL O&M	
Electrical @ $0.07/Kw-hr	$48,700
Liquid Phase Carbon Regeneration Fees	$200,000
Estimated Regenerate Steam Incineration	$50,000
Bag Filter Replacement	$7,000
Oil Disposal	$12,000
Trouble-Shooting, Sampling and Reporting Labor	$51,500
Analytical Costs	$23,000
Service/Parts	$2,000
TOTAL ANNUAL O&M	$394,200
5 Year Total Present Worth (I=8%)	$2,997,222
10 Year Total Present Worth (I=8%)	$4,068,421
20 Year Total Present Worth (I=8%)	$5,293,595
30 Year Total Present Worth (I=8%)	$5,861,125

AIR SPARGING COSTS:

CAPITAL EXPENSE		
Equipment & Construction Labor		$125,000
Carbon (2 @ 1,600 lbs/each)		$17,500
N2 Equipment – Mob/Demob		$25,000
Soil & Drill Cutting Disposal (75 cy haz. & 75 cy non-haz.)		$30,000
Bench Scale Testing & Pilot Test		$50,000
Drilling Cost – Horizontal Wells – install & labor		$240,000
TOTAL CAPITAL & LABOR		$487,500
Engineering	20%	$97,500
Contingency Allowances	15%	$73,100
TOTAL		$658,100
ANNUAL O & M		
Operations & Maintenance		$24,000
Electrical @ $0.07/kW hr		$184,000
Condensate Disposal		$1,000
Carbon Regeneration (1/yr.)		$9,600
N2 Equipment Rental (16,700 cfh)		$55,300
Air Stream Sample Analysis		$4,200
TOTAL ANNUAL O & M		$278,100
5 Year Total Present Worth (i = 8%)		$1,768,470

TOTAL PRESENT WORTH – COMBINED ALTERNATIVE 4	
20 Year Total Present Worth (i = 8%)	$7,062,065

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downgradient from the site is currently undergoing treatment prior to distribution in the municipal supply, a risk assessment of present and future use of the ground water was not considered necessary. However, contamination would remain at the site, and unrestricted use of the land and water would not be possible.

Short-term effectiveness: As explained above, no pathways of concern were identified as possible exposure scenarios for the media requiring remediation. Thus, if no further remedial action is undertaken, no short-term risks would be posed to the community. However, risks would continue to be posed to the environment due to the presence of contaminants in the soil and ground water at the site. In addition, remedial-action objectives would not be met with this alternative since contaminant levels would not be reduced to their respective SCGs/ARARs and there would be no mechanism in place to fully contain the plume on site. This means that the current recovery/treatment system would operate for an indefinite period of time.

Long-term effectiveness and permanence: This remedy would not be considered permanent. This alternative would involve only a minimal amount of treatment to destroy or separate the contamination at the Can Plant site, and would not be effective in containing the plumes. Operation of the ground water treatment system at the municipal wells would be required to continue. In addition, all hazardous waste would remain in the southern operable unit media.

Reduction of toxicity, mobility, or volume: The no-further-action alternative would provide for very little reduction in the toxicity, mobility, and volume of the contaminants at the site. A portion of the ground water contaminant plume would continue to migrate off-site toward the municipal wells. In addition, no reduction in contaminant mobility and volume would be achieved in the southern operable unit ground water, and the contaminant source in the southern operable unit would not be reduced.

Implementability: This alternative is easily implemented since it involves only continued operation of the existing recovery/treatment system. The alternative would not be difficult to construct, no delays would be expected, and minimal coordination would be necessary.

Cost: The cost of implementing this alternative would be relatively minimal and would only include costs for recovery well replacement and system O & M. Well replacement costs, or capital costs, were estimated at $15,000. Annual O & M costs were estimated at $99,000 and would include costs incurred by the system operator, as well as costs for system cleaning, electricity, and sampling and analysis. Although operation of the treatment system in the northern operable unit would be expected to continue beyond 30 years, the 30 year present worth cost was estimated at $1,129,522.

6.2 COMPARATIVE ANALYSIS OF ALTERNATIVES/RECOMMENDED REMEDIAL ACTION

A comparative analysis among the combined alternatives was conducted. The purpose of the analysis was to evaluate the performance of each alternative relative to one another to identify key advantages and disadvantages of each. A discussion of the analysis against each of the seven criteria is presented below.

Compliance with SCGs/ARARs: This evaluation involved review of whether the combined alternatives would meet the chemical-specific, action-specific, and location-specific SCGs/ARARs. As previously discussed, there are no known location-specific SCGs/ARARs associated with this site.

It is anticipated that the first four alternatives would meet chemical-specific and action-specific SCGs/ARARs. Action-specific SCGs/ARARs would include compliance with SPDES and air discharge limitations.

The no-further-action alternative (Alternative 5) would not be expected to achieve chemical-specific SCGs/ARARs since little action would be taken to clean up the soil or ground water at the site. Action-specific SCGs/ARARs which would have to be met with the no-further-action alternative include sewer use permit and air discharge limits.

Protection of health and environment: As previously discussed, no pathways of concern were identified in the Human Health Risk Assessment as possible exposure scenarios for the southern or northern operable unit media requiring remediation. This assumes that treatment of the ground water at the municipal wells prior to distribution will continue. However, implementing any of the first four alternatives would provide for additional protection of the municipal water supply through plume control and remediation. If no further action were taken, off-site plume migration would continue and operation of the municipal well treatment system would continue indefinitely.

All alternatives except for no further action would also provide for contaminant source remediation and control in the southern operable unit. Initial testing, which would include conducting a pilot test, would be required prior to implementing any of Alternatives 2 through 4 to verify the effectiveness of the proposed actions on the contaminated soil beneath the Can Plant. Results of the vapor extraction pilot test conducted at the site indicated this technology would be effective, and the data collected could be used as the basis for full-scale system design. However, initial start-up testing would be required to verify the effectiveness of the system since pilot testing was performed outside the building, in the Southern Drum Storage Area.

Short-term effectiveness: For Alternatives 1 through 4, short-term risks to on-site workers and the community would be due to fugitive emissions during installation of the required wells and during remediation. However, these risks would be minimized through monitoring and the use of appropriate protective equipment by all on-site workers. In addition, any risks posed during operation of the treatment system would be easily controlled through proper system operation, maintenance, and monitoring. A health and safety plan would be developed prior to implementation of any alternative.

The no-further-action alternative would not result in any increased risk (above present levels) to human health and the environment in the southern operable unit. Any risks posed to on-site workers during recovery well replacement in the northern operable unit would be minimal and easily controlled.

The period of time required for ground water treatment under Alternatives 1, 2, and 3 would be similar; however, soil remedial goals would be expected to be met sooner with vapor extraction than with soil flushing or bioremediation. This is based on the relative effectiveness of each technology on the contaminants present below the Can Plant.

Although pilot testing has not been conducted to determine the effectiveness of air sparging at the Can Plant site, the time required to implement the air-sparging alternative (Alternative 4) may be less than that of the other combined alternatives examined.

The time required to implement the no-further-action alternative, or the time required to achieve the remedial-action goals, would be much greater than for any of the alternatives evaluated.

Long-term effectiveness and permanence: The first four alternatives would involve on-site treatment. Although the ground water pump and treat technology common to the four alternatives would not be considered a permanent remedy, it would be effective in containing the plumes. The soil remedial technologies and air sparging are assumed to be effective; however, soil flushing, bioremediation, and air sparging have not been demonstrated for the site. Initial testing would be required to determine the applicability of these technologies. Initial testing would include the performance of bench and pilot tests. If proven to be effective, the soil treatment technologies would provide for permanent reduction in the volume of contamination present in the soil beneath the southern end of the Can Plant.

Although remedial-action objectives for the southern operable unit soil would be expected to be met within a relatively short time frame by implementing any of Alternatives 1 through 4, ground water pump and treat would most likely be required for a great period of time before ground water objectives are met. Provided remedial action objectives are eventually met for the ground water, little contamination would be left at the site and little to no long-term operation, maintenance, and monitoring would be required. Limited sampling of the soil beneath the Can Plant as well as site ground water would eventually be required to confirm that remedial-action objectives were met.

Under the no-further-action alternative, little treatment of the contaminated media at the site would occur. Thus, contamination would remain on-site, and the continued existence of the contaminant source in the southern operable unit would mean the risk of future contaminant releases to the ground water in that area. This alternative would not be effective in reducing contamination at the site and would not be permanent. Off-site treatment at the municipal wells would continue indefinitely.

Reduction of toxicity, mobility, or volume: Alternatives 1 through 4 incorporate elements of destruction (bioremediation), treatment, and control and isolation technologies. Implementation of these alternatives would provide for a reduction in contaminant toxicity, mobility, or volume at the site. Alternative 5 (no further action) would only slightly reduce the mobility and volume of contamination present in the northern operable unit ground water. Contaminant toxicity, mobility, or volume would not be reduced in the southern operable unit.

Implementability: The most easily implemented alternative would be no further action. Although this alternative would not be reliable and some future remedial action would be necessary, it would be easily constructed, delays would not be likely, and minimal coordination would be required.

Alternative 1, which includes vapor extraction treatment of the southern operable unit soil, would require the installation of vacuum piezometers in the vicinity of the Can Plant WWTF to measure the effectiveness of the system. However, use of two of the existing monitoring wells/recovery wells as vacuum wells would limit the intrusive activities performed in the area. Vapor extraction has been shown to be a proven and reliable technology, and results of the pilot test conducted in the Southern Drum Storage Area indicated it would be an effective technology at the site.

Soil flushing and bioremediation would be slightly more difficult to implement. Pilot testing would be required to prove their effectiveness. In addition, some future remedial actions may be necessary if access to all contaminants cannot be gained by the water flushed into the area and the soil continues to act as a ground water contaminant source. Air sparging would be the most difficult alternative to implement due to the additional construction required. Again, pilot testing would be required. This alternative would, however, be expected to achieve performance goals and no future remedial actions would be anticipated.

Cost: The most cost effective alternative would be the no-further-action alternative, with a 30 year present worth cost of $1,129,522. Of the other four alternatives, the combined alternative involving soil flushing was determined to be the most cost effective. The 30 year present worth cost is estimated to be $5,942,864. Capital costs were estimated at $1,471,900, and annual O&M costs of $402,500 would be anticipated during the first five years of system operation (while soil flushing is being implemented). Annual O&M costs for the ground water pump and treat system after that time would be expected to be approximately $394,200. This would be the most cost effective action alternative since very little construction, in addition to the ground water treatment facility, would be necessary. Also, operation, and maintenance of the soil flushing system would be minimal.

Ground water extraction/treatment/discharge with vapor extraction would be the next most cost effective alternative. Construction costs would be higher than the soil flushing alternative, as would maintenance and monitoring costs. The 30 year present worth cost of this alternative was estimated to be $5,985,502.

The relatively high costs associated with the initial studies and testing required for bioremediation make this combined alternative less cost effective than vapor extraction. The 30 year present worth cost would be approximately $6,248,835.

It appears that the air sparging alternative would be the most costly to implement, with a 20 year present worth cost of $7,062,065. Capital costs of $2,081,400 would be expected. Annual O&M costs of $672,300 would be incurred during the first five years of system operation. Following the completion of air sparging, O&M costs for the ground water pump and treat system would be approximately $394,200. This alternative would have the highest capital and O&M costs of the alternatives analyzed.

Recommended Remedial Action: Based on the results of the detailed analysis of alternatives for the remediation of the Can Plant site, the recommended alternative is ground water extraction/central treatment/direct discharge, and vapor extraction treatment of the southern operable unit soils. Although this alternative would be slightly more costly than the combined alternative of soil flushing, it would be expected to be more effective and implementable, as previously described.

APPENDICES

APPENDIX A

Standards, Criteria and Guidelines/ Applicable or Relevant and Appropriate Requirements

Soil Clean-up Levels/
Action Levels

REYNOLDS CAN PLANT SITE
SOUTHERN OPERABLE UNIT SOIL
CONTAMINANT CONCENTRATIONS AND CLEAN-UP LEVELS

COMPOUND	RANGE OF DETECTED CONCENTRATIONS (μg/kg)	SOIL CLEAN-UP LEVEL (ppb)*	"CONTAINED-IN" ACTION LEVEL (μg/kg)*
1,1-Dichloroethane	3-180	358	8000000
c-1,2-Dichloroethylene	750	585	800000
Methylene Chloride	8-700	251	93000
Tetrachloroethylene	12-5700	4350**	14000
1,1,1-Trichloroethane	17-7000	1816	7000000
Trichloroethylene	12-12000	1505	64000
Benzene	800	139	24000
Toluene	92-460	3585	20000000
Acetone	22-81	263	8000000
1,1-Dichloroethylene	5	777	12000
Methyl Isobutyl Ketone	14-67	2270	4000000
Methyl Butyl Ketone	8-220	1673	***
Methyl Amyl Ketone	45-2900	***	***
4-Methyl-2-Pentanol	11	***	***
alpha-Pinene	20	***	***
Phenanthrene	39	50,000	***
Hepta Methyl Ketone	810	***	***

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Notes:

* Soil clean-up levels were determined in accordance with the NYSDEC Technical and Administrative Guidance Memorandum on Determination of Clean-Up Levels, dated January 24, 1994, and are based on a soil percent organic carbon content of 2.39%. This value is the average organic content of the soil in the southern operable unit, as determined through soil sampling and analysis.

"Contained-in" action levels are levels which hazardous constituent concentrations in soil containing hazardous constituents from listed hazardous waste identified in 6 NYCRR Part 371 are to be brought down to in order for the soil to be classified as non-hazardous. Source: NYSDEC TAGM, "Contained-In" Criteria for Environmental Media, dated November 30, 1992.

** Limit calculated using partition coefficient (Koc) of 364ml/g, which was obtained from Exhibit A-1 of the USEPA Superfund Public Health Evaluation Manual. Although this manual is recommended in the NYSDEC Guidance Memorandum as the source from which Koc values should be obtained, the value of 364 ml/g differs from the one used by the NYSDEC (277 ml/g) in determining their recommended clean-up objective.

*** No ground water/drinking water standard exists for this compound, thus no soil clean-up level can be calculated and/or no "contained-in" action level has been established.

Ground Water & Surface Water SCGs/ARARs

REYNOLDS CAN PLANT SITE
GROUND WATER AND SURFACE WATER SCGs/ARARs

Compound	Maximum Ground Water Concentration Detected (μg/l)		Standards, Criteria and Guidelines										
			Drinking Water		Ground Water			Surface Water					
								Class A		Class A, B, C			
	Southern Operable Unit	Northern Operable Unit	USEPA MCL	NYSDEC MCL	NYSDEC GA-S	NYSDEC GA-G	NYSDEC DIS-GA	NYSDEC AWQ-S	NYSDEC AWQ-G	NYSDEC AWQ-S	NYSDEC AWQ-G	USEPA FAC-AT	USEPA FAC-CT
Methylene chloride	2,800	4,200	—	5	5	—	—	—	5	—	—	—	—
1,1-Dichloroethylene	1,100	3,200	7	5	5	—	—	—	0.07	—	—	11,600L	—
1.1-Dichloroethane	3,000	1000	—	5	5	—	—	—	5	—	—		—
1,1,1-Trichloroethane	11,000	42,000	200	5	5	—	—	—	5	—	—	—	—
Trichloroethylene	2,000	810	5	5	5	—	10	—	3	—	11	45,000L	21,900L
Tetrachloroethylene	1,200	14,000	5	5	5	—	—	—	0.7	—	1	5,280L	840L
c-1,2-Dichloroethylene	52,000	690	70	5	5	—	—	—	5	—	—	11,600L	—
t-1,2-Dichloroethylene	21	110	100	5	5	—	—	—	5	—	—	11,600L	—
1,2-Dichloroethane	14	13	5	5	5	—	—	0.8	—	—	—	118,000L	20,000L
Carbon tetrachloride	410	—	5	5	5	—	5	—	0.4	—	—	35,200L	—
1,1,2-Trichloroethane	—	30	5	5	5	—	—	0.6	—	—	—	—	9,400L
1,2-Dichloropropane	—	4	5	5	5	—	—	0.5	—	—	—	23,000L	5,700L
Chloroform	—	40	100+	100+	7	—	7	7	—	—	—	28,900L	1,240L
Dibromochloromethane	—	59	100+	100+	—	50	—	—	50	—	—	—	—
Benzene	—	4	5	5	0.7	—	0.7	0.7	—	—	6	5,300L	—
Toluene	110	420	1000	5	5	—	—	—	5	—	—	17,500L	—
Ethylbenzene	150	2.1	700	5	5	—	—	—	5	—	—	32,000L	—
Xylenes, total	200	1500	10,000	—	—	—	—	—	—	—	—	—	—
Acetone	5,600	—	—	50	50	—	—	—	—	—	—	—	—
Methyl isobutyl ketone	2,400	89	—	50	—	—	—	—	—	—	—	—	—
Methyl ethyl ketone	25	—	—	50	—	50	—	—	50	—	—	—	—
Vinyl chloride	5.9	59	2	2	2	—	5.0	—	0.3	—	—	—	—
Dichlorodifluoromethane	—	26	—	—	—	—	—	—	—	—	—	—	—
Bromodichloromethane	—	1	100+	100+	—	50	—	—	50	—	—	—	—

F:\DOC_LIB\PROJ\1028258\GWSWSCG.WK1

NOTES:

All concentrations in ug/l.
— = indicates no concentration is available.
+ = Limit for total trihalomethanes
L = Insufficient data to develop criteria. Value presented is the L.O.E.L. – Lowest Observed Effect Level.
The basis for the standard or guidance value of Class A waters is for the protection of human health.
The basis for the standard or guidance value for Class A, B, C, and D waters is for protection of aquatic life.
Water classes:

A – Drinking water source
A, B, C – Fishing and fish propagation
D – Fishing and fish survival

References used:
Drinking Water – 10 NYSCRR Part 5-1.50 through 5-1.55 (NYS Maximum Contaminant Levels in Drinking Water)
– 40 CFR 141.11 and 40 CFR 141.61 through 141.62 (EPA Maximum Contaminant Levels in Drinking Water)
Ground Water – 6 NYSCRR Part 703.5 (NYSDEC GA – Standard)
– 6 NYSCRR Part 703.6 (NYSDEC Ground Water Discharge – GA Standard)
Surface Water – 6 NYSCRR Part 703.5 (NYSDEC Class C AWQ – Standard)
– EPA 440/5-86-001 (EPA Quality Criteria for Water 1986)

MCL = Maximum Contaminant Level
GA-S = Class GA Ground Water Standard
GA-G = Class GA Ground Water Guidance Value
DIS-GA = Class GA Ground Water Effluent Standard
AWQ-S = Ambient Water Quality Standard
AWQ-G = Ambient Water Quality Guidance Value
FAC-AT = Fresh Water Acute Criteria – Acute Toxicity
FAC-CT = Fresh Water Acute Criteria – Chronic Toxicity

APPENDIX B

MODEL BACKUP

MILLER GROUND WATER MODELING

Purpose

To aid in the selection of the number and locations of recovery wells to enhance capture and possibly speed cleanup of contaminated ground water at the Miller site.

Conceptual Model Development

A great deal of information about site hydrogeology is available and has been presented in the Remedial Investigation (RI) Report (Malcolm Pirnie, Inc., 1993). This information includes detailed boring logs from over 130 borings advanced at the site; decades of pumping data from production wells at the adjacent Fulton Municipal Water Works, including a recent pumping test of these wells (Malcolm Pirnie, Inc., 1992); six years of pumping data from three on-site recovery wells, including pumping test data (Malcolm Pirnie, Inc., 1988); head measurements and slug test data from over 120 site monitoring wells; and precipitation data collected at the Fulton Municipal Water Works (Florek, 1994). This information showed that the hydrogeology was somewhat variable across the site. The variability was great enough to make the entire site too complex to adequately model in two-dimensions. To simplify the field conditions, the site was divided into four areas that had similar hydrogeologic characteristics. A conceptual model was then formulated for each area.

Model Code Selection

The two-dimensional code selected to perform the modeling tasks was Flowpath (Franz and Guiguer, 1991), which is a block-centered, finite-difference, areal code. Flowpath was selected because head data from nested well couplets and triplets at the site show that, under non-pumping conditions, there is little change in head with depth in the modeled areas; therefore, flow is primarily horizontal, making the use of a two-dimensional model appropriate (Anderson and Woessner, 1992).

Northern Drum Storage Area Model

<u>Conceptual Model and Grid Design</u>

The northeast portion of the site consists of a thick layer of fine sand and silt, underlain by coarser, more permeable deposits of sand and gravel. These deposits are in turn underlain by dense, low-permeability lodgement till. Two recovery wells (RW-2 and RW-3) are currently withdrawing water from this area and are screened in the coarser deposits. The conceptual model for this area consisted simply of two geologic units: the sand and gravel deposits and the underlying till confining unit, which forms the base of the modeled aquifer (Figure B-1).

The water budget for the model was also simple. Initially, it was assumed that no pumping was occurring in the system. Therefore, the major inflow and outflow to the system occurred as flux at the constant head boundaries (discussed below). Recharge from precipitation was also included as an inflow to the system.

Head data at the site show that ground water flows from east to west across this portion of the site and the flow system is essentially unconfined. Head data from nested well couplets and triplets show that flow under non-pumping conditions is primarily horizontal. These data also show that the pond at the site has a negligible effect on flow patterns in the sand and gravel deposits. This may be due to the presence of a discontinuous clay layer that underlies much of the pond, but does not extend south and eastward from the pond into the area where pumping is planned.

The model grid is shown on Figure B-2. The grid was oriented so that the east and west edges were perpendicular to ground water flow. Such an orientation allows the north and south edges of the model grid to be hydraulic no-flow boundaries because they parallel ground water flow paths. The east and west edges of the model grid were interpreted to be constant head boundaries. This interpretation is consistent with the water budget discussed above (i.e., that most water entering and leaving this area of the site consists of flux across the site). The head values selected for the edges were 352 feet AMSL and 372 feet AMSL for the west and east edges, respectively. These values were obtained from the most recent potentiometric surface map prepared for the sand and gravel hydrostratigraphic unit (referred to in the RI Report and hereafter as the "deep zone"; see Figure B-3). The grid spacing at the center of the model, where pumping will be simulated, is finer than at the edges of the modeled area and is about 25 feet between nodes.

Selection of Estimated Parameters

The horizontal hydraulic conductivity of the modeled area, k_h, is shown by the results of the pumping test conducted at RW-3 and by slug tests performed in wells screening the deep zone to be relatively uniform across the Northern Drum Storage Area; therefore a single value of 0.85 ft/day (3×10^{-4} cm/s) was used for the entire model (Note: $k_{hx} = k_{hy}$). This value falls within the higher end of the range of hydraulic conductivities obtained from slug tests conducted in monitoring wells in the area and is also the value calculated for well MW-4D during the pumping test conducted at wells RW-1, RW-2, and RW-3 in 1988.

The elevation used to represent the bottom of the aquifer was 317 feet AMSL, which is the average elevation of the lodgement till surface in the area.

Recharge to the modeled aquifer was applied to all areas of the model except the area comprising the Can Plant structures and associated parking lots (Figure B-2). The recharge rate used was 7×10^{-4} ft/day (0.25 in/month). The rationale for using this value is presented in Section 5.0 of this report.

Model Calibration

The model was calibrated to a steady-state data set. The data set selected was the most recent potentiometric surface map for the deep zone at the site. Inspection of the entire hydraulic head data set for the site, which consists of monthly head measurements over the past seven years, shows: 1) that large seasonal fluctuations in water levels do not occur at the site, making the steady-state assumption reasonable, and 2) that the data set selected for calibration is representative of heads observed at the site over the past seven years.

The model was first run without any stresses (e.g. pumping) imposed on the system. The resulting heads calculated by the model were reasonable when compared to heads measured in the area in wells that are unaffected by the pumping at wells RW-2 and RW-3 (Figure B-4).

The model was further calibrated by adding a pumping well (applying a stress) to the system. The model assumes that pumping wells are fully penetrating. The pumping rate of the well was 2880 g/day (2 gpm), which is the rate that RW-3 is currently being pumped at. The drawdown cone predicted by the model was similar in depth and extent to the observed cone at RW-3 (Figure B-5). The agreement of the two model calibration runs with the site data set demonstrates that the model is capable of producing field-measured heads (i.e. that the model is calibrated).

Pumping Simulation

A number of model simulations were performed using different numbers and configurations of pumping wells. All of the simulations had two pumping wells, namely existing pumping wells RW-2 and RW-3. The only changes made were to the number and location of proposed pumping wells.

The capture zones for the simulation that provided the most favorable results, in terms of plume capture and number of pumping wells required, are shown in Figure 5-1a. The pumping rates used in the simulation were: RW-2 = 2160 g/day (1.5 gpm), RW-3 = 2880 g/day (2 gpm), simulated wells = 2880 g/day. The rates used for RW-2 and RW-3 are the actual pumping rates observed for those wells.

Southern Source Area

Model Setup

The conceptual model for this area is essentially the same as for the Northern Drum Storage Area (NDSA), as shown on Figure B-1. The main differences are that no pumping wells currently exist in this area, and slug test and boring data from monitoring wells in the area suggest that the hydraulic conductivity of the deep zone is considerably greater than in the NDSA. Grid orientation and spacing, boundary conditions, and recharge rates for this area were the same as for the NDSA. The model grid used is shown on Figure B-6. Constant head values used for the west and east boundaries were 352 and 373 feet AMSL, respectively. A second area of "no-recharge" was added to this model as shown on Figure B-6. This area is a paved parking lot for the adjacent brewery.

The k_h value used for this area was 11 ft/day (4 x 10^{-3} cm/s) and falls within the higher end of the k_h values observed in the vicinity of monitoring wells in the area. The bottom of the aquifer was set at 320 feet AMSL, which is about the average elevation of the top of the lodgement till in the area.

The model was first run without any stresses imposed on the system. The resulting heads calculated by the model were reasonable when compared to heads measured in the area in wells that are unaffected by the pumping at RW-3 (Figure B-7).

Pumping Simulation

As was the case with the pumping simulations in the NDSA, a number of model simulations were performed using different numbers and configurations of pumping wells.

The simulation which optimized plume capture and number of pumping wells (Figure 5-1b) consisted of four pumping wells. The pumping rate used for each of these wells was 14,400 gpd (10 gpm). This rate is considered reasonable based on available data. The drawdown cones predicted by this simulation (Figure B-8) appear reasonable in extent and depth based on the observed gradient and hydraulic conductivity of the area.

Area East of the Taylor Property

Conceptual Model and Grid Design

The conceptual model is somewhat more complex than for the areas previously discussed, as shown on Figure B-1. One added complexity is the presence of a till ridge near the center of the modeled area of the site. This ridge serves to reduce the aquifer thickness in the area. A second complexity is the observation that the hydraulic conductivity in the deep zone increases dramatically along the Oswego River. These factors were taken into account in the grid design and in selection of estimated parameters.

Grid orientation, spacing, and boundary conditions for this area were the same as for the other modeled areas. (The western constant head boundary consisted of the Oswego River.) The grid used is shown in Figure B-9. Constant head values used for the west and east boundaries were 353 (Oswego River elevation) and 357 feet AMSL, respectively.

The water budget for the model also had an added complexity. A production well pair from the Municipal Water Works (K2/M2) fell within the model grid. To account for the outflow from this well pair, a pumping well was added to the model grid. Only one well was used because the two wells are located close together; therefore, it is reasonable to assume they are acting as one larger well.

Recharge from precipitation was also included as an inflow to the system.

Selection of Estimated Parameters

Two areas of different hydraulic conductivity were defined (Figure B-9). Along the river, the k_h value used was about 28 ft/day (1×10^{-2} cm/s). For the rest of the modeled area, a k_h value of about 14 ft/day (5×10^{-3} cm/s) was used. These values are consistent with conductivities determined from a pumping test conducted at the municipal wells and from those calculated from slug tests performed in monitoring wells in the area.

To simulate the effects of the till ridge, the aquifer thickness of an area approximating the ridge was decreased (Figure B-9). This was accomplished in the model by increasing the elevation of the aquifer base from 290 (which is the average elevation of the lodgement till in the area where the till ridge is absent) to 330 feet AMSL in the area where the till ridge is present.

Because no large buildings or other impermeable surfaces are present in the modeled area, recharge was applied equally to the entire area. The recharge rate used in this area was 0.01 ft/day (4 in/month). The rationale for using this rate is provided in Section 5.0 of this report.

The pumping rate used for the pumping well simulating K2/M2 was 136,800 gpd (95 gpm), which is the average combined pumping rate for the wells.

Model Calibration

This model was calibrated in a similar manner, and using the same data set, as the previous two models. The initial simulation for this model was different from the other models because it included the pumping well simulating the K2/M2 well pair. The heads predicted by this simulation compared favorably with those observed at the site (Figure B-10), except in the northwest corner of the modeled area. In this area there is another production well, but it was not considered in this model because it has been shown by the pumping test conducted at the municipal wells to have a negligible impact on the area of concern for this model (the area south and east of K2/M2).

The agreement of the model calibration run with the site data set demonstrate that the model is calibrated.

Pumping Simulation

The predictive portion of the modeling task in this area was designed to take advantage of the till ridge, which is oriented perpendicular to ground water flow and occurs between the southern source area and K2/M2. Three wells pumping at a rate of 21,600 gpd (15 gpm) each were located on top of the ridge. The locations of the pumping wells are shown on Figure B-11.

Heads predicted by the pumping simulation appear reasonable based on our knowledge of the site.

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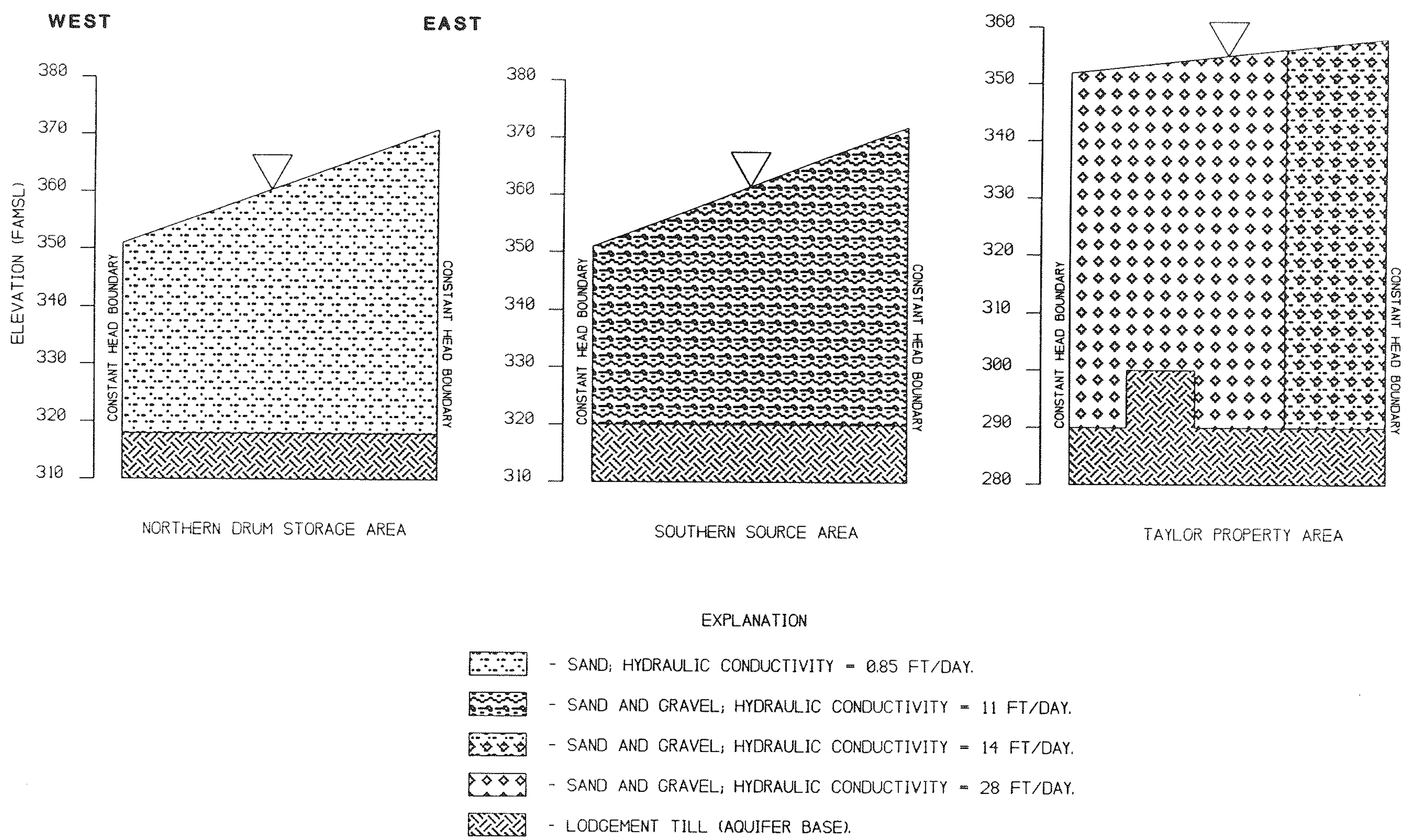


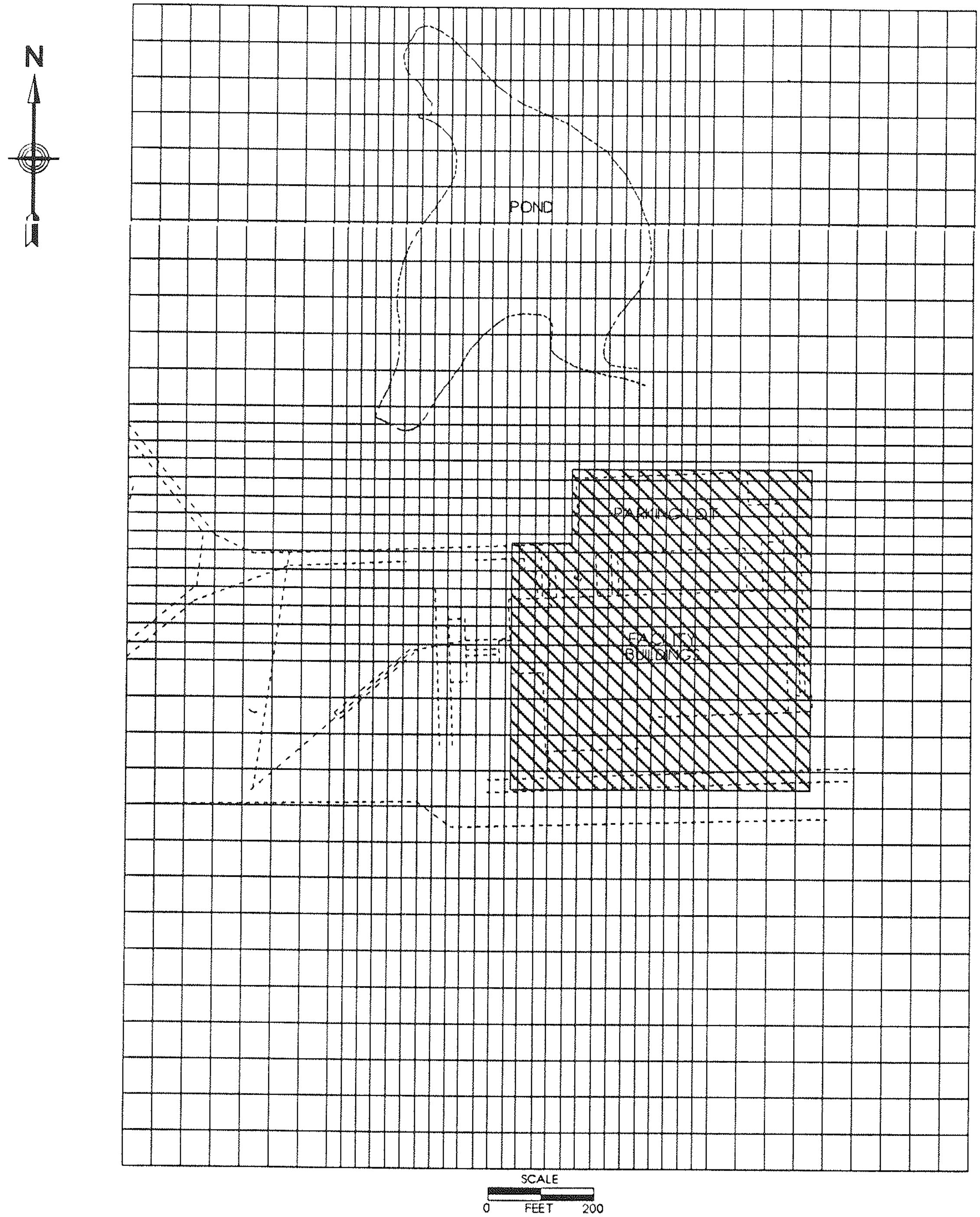
NO HORIZONTAL SCALE

MALCOLM PIRNIE

CONCEPTUAL MODELS FOR AREAS STUDIED

MALCOLM PIRNIE, INC.

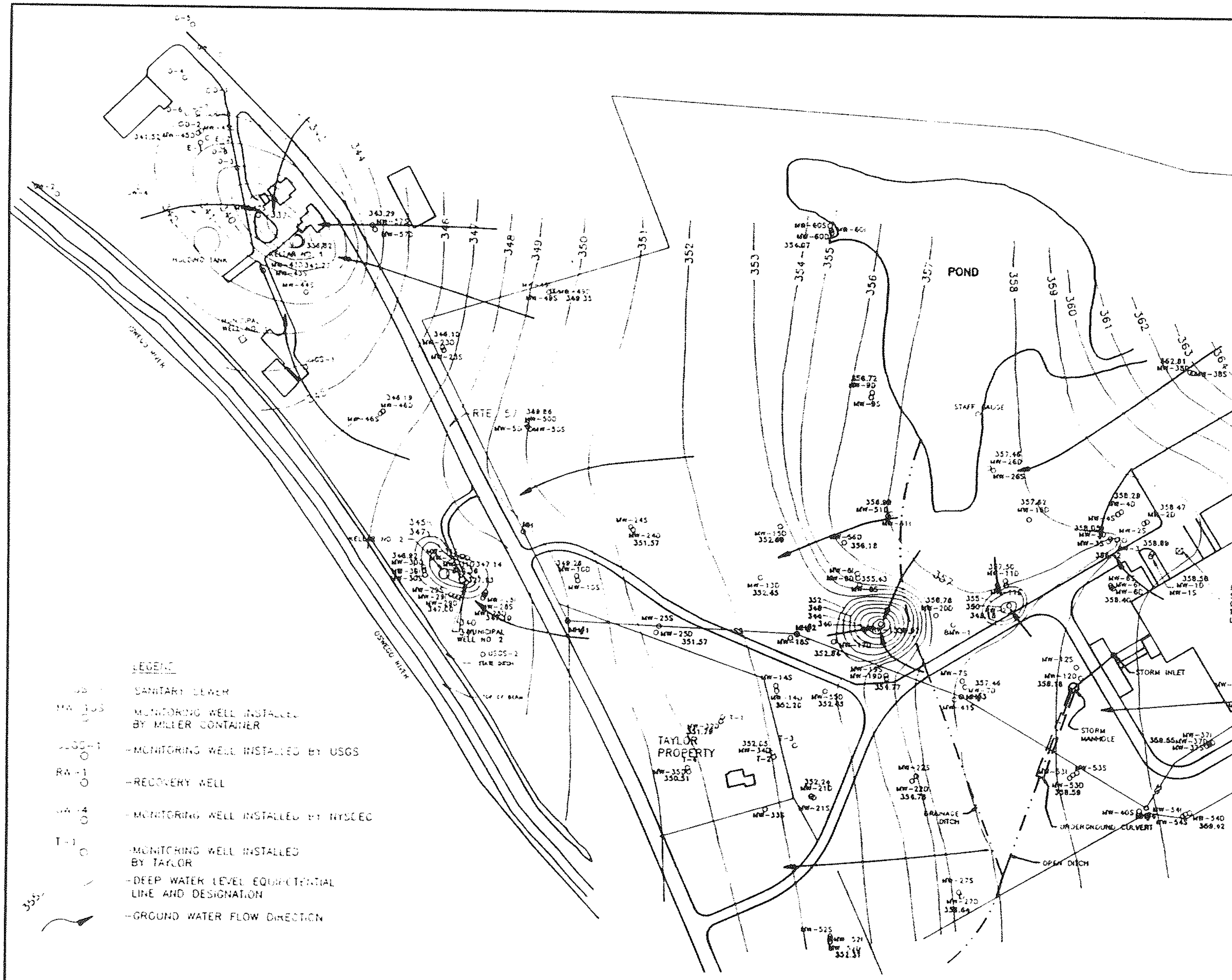
FIGURE B-1



EXPLANATION

- AREA WHERE NO RECHARGE WAS APPLIED.

MALCOLM PIRNIE	NORTHERN DRUM STORAGE AREA MODEL GRID	MALCOLM PIRNIE, INC.
		FIGURE B-2

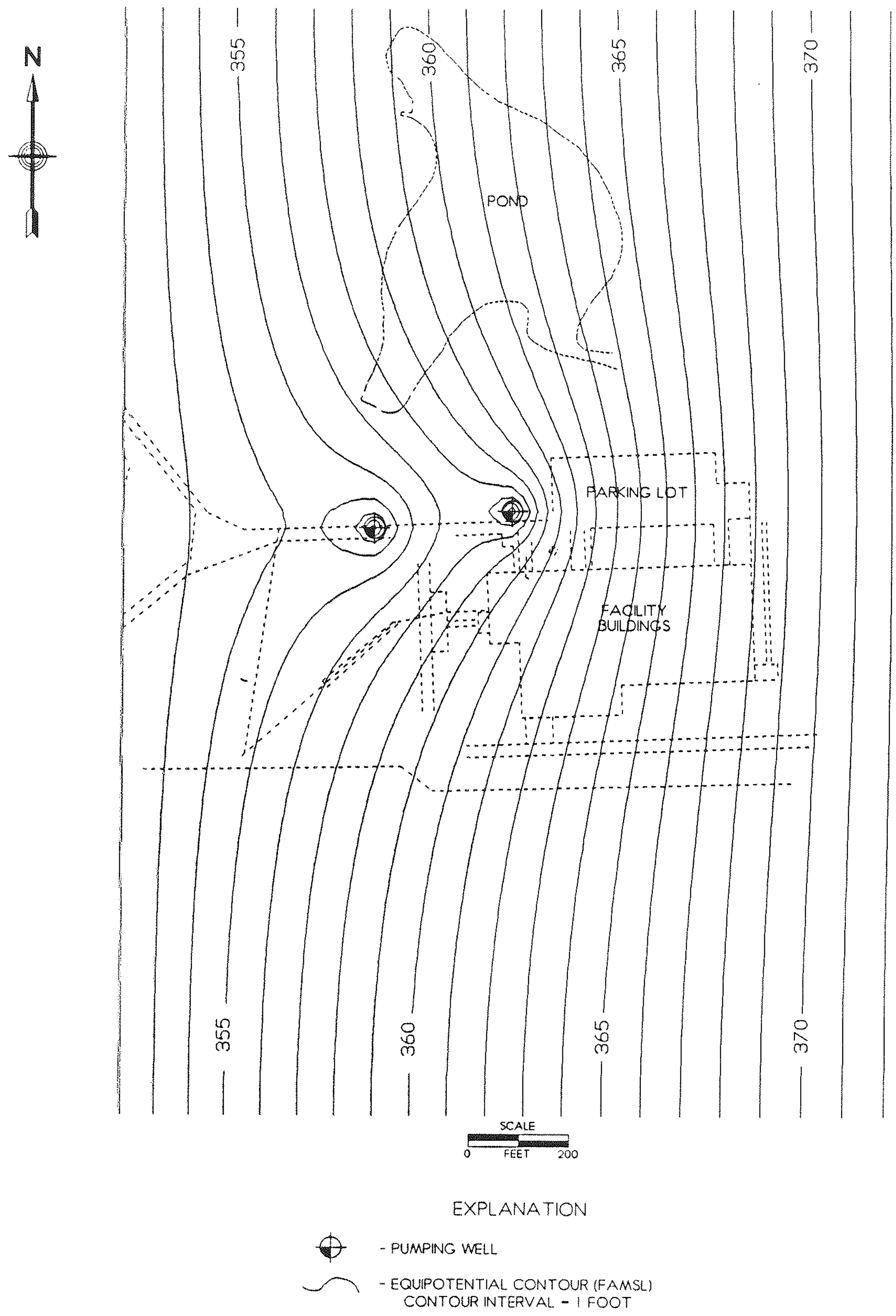


MILLER BREWING COMPANY
CONTAINER DIVISION
FULTON, NEW YORK

POTENTIOMETRIC SURFACE
DEEP ZONE – JANUARY 18, 1993

MALCOLM PIRNIE

Date	Figure No.
01/93	B-3

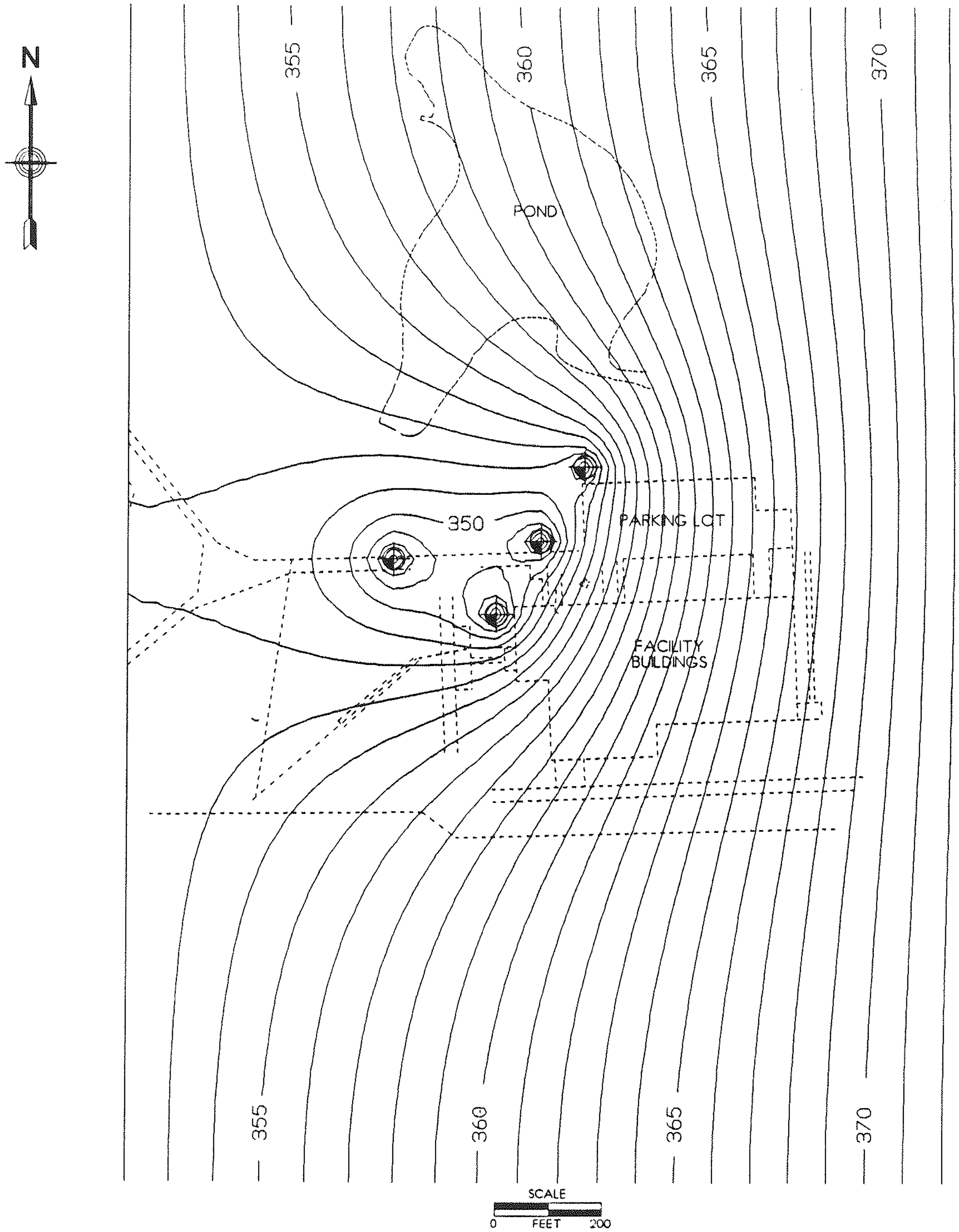


MALCOLM PIRNIE

NORTHERN DRUM STORAGE AREA
CONTOURED MODEL HEAD DATA --
CALIBRATION RUN

MALCOLM PIRNIE, INC.

FIGURE B-4



EXPLANATION

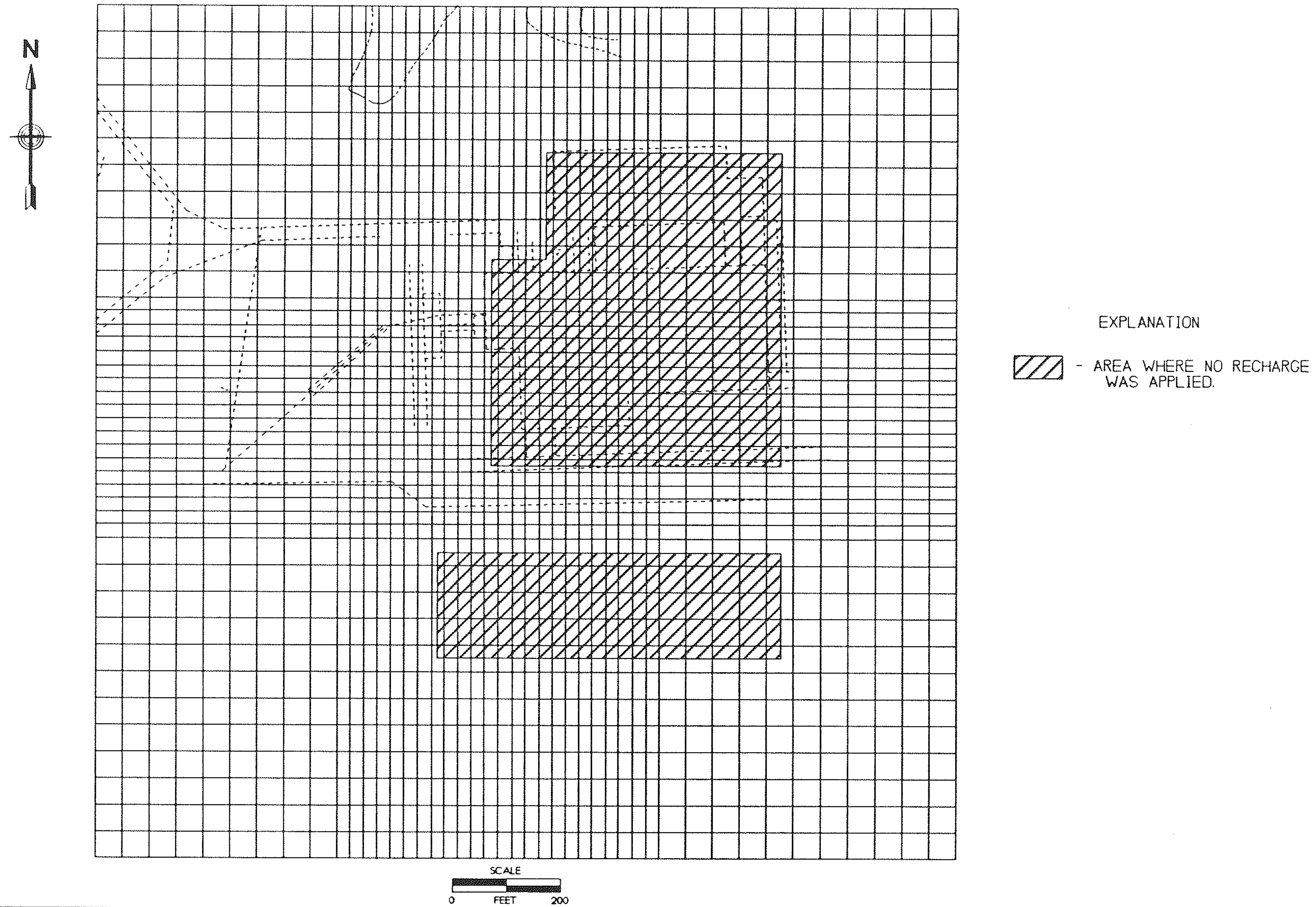
- PUMPING WELL
- EQUIPOTENTIAL CONTOUR (FAMSL)
CONTOUR INTERVAL = 1 FOOT

MALCOLM PIRNIE

NORTHERN DRUM STORAGE AREA
CONTOURED MODEL HEAD DATA --
RECOVERY WELL SIMULATION

MALCOLM PIRNIE, INC.

FIGURE B-5

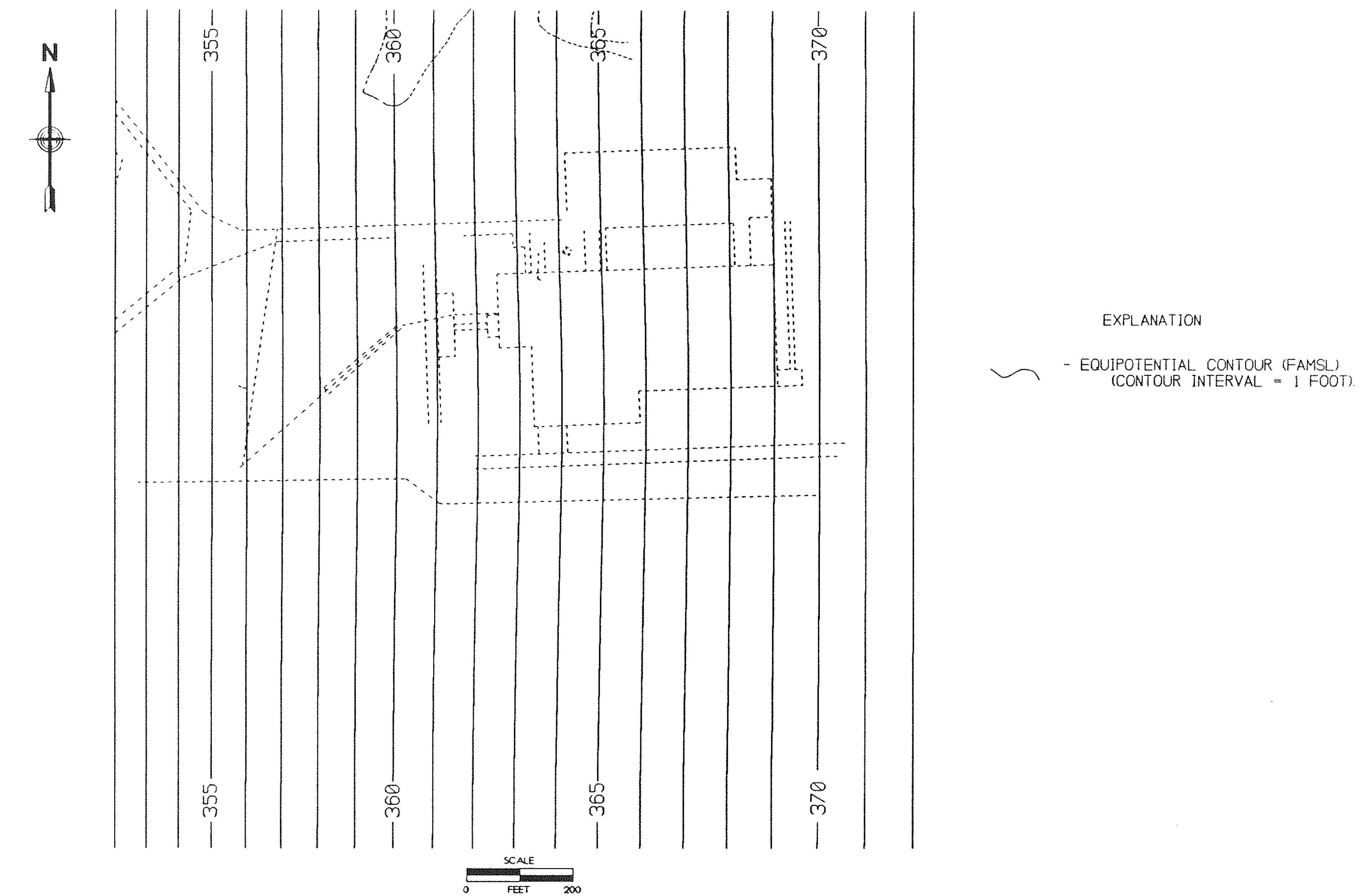


MALCOLM PIRNIE

SOUTHERN SOURCE AREA MODEL GRID

MALCOLM PIRNIE, INC.

FIGURE B-6

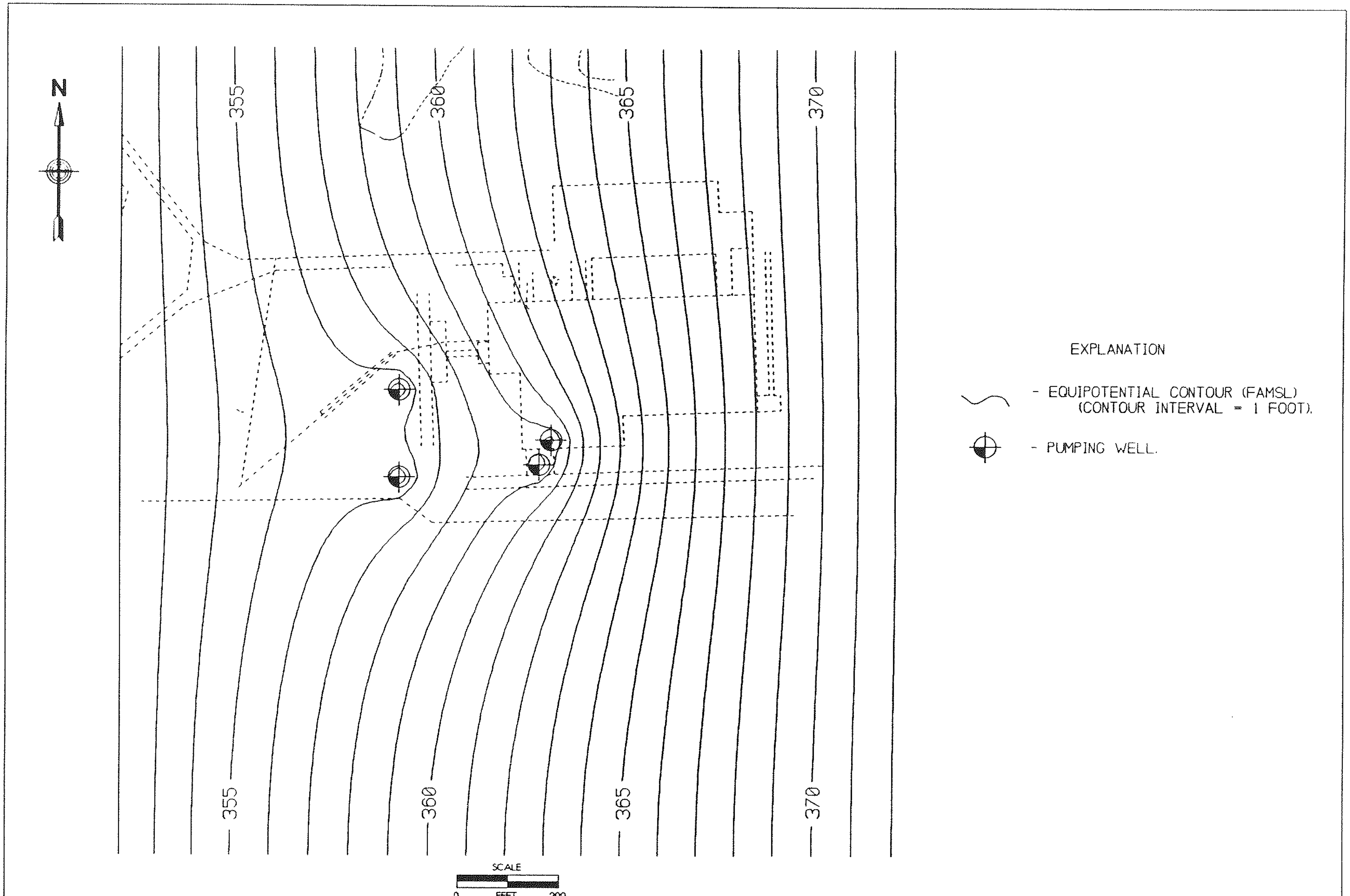


MALCOLM PIRNIE

SOUTHERN SOURCE AREA MODEL
CONTOURED MODEL HEAD DATA --
CALIBRATION RUN

MALCOLM PIRNIE, INC.

FIGURE B-7

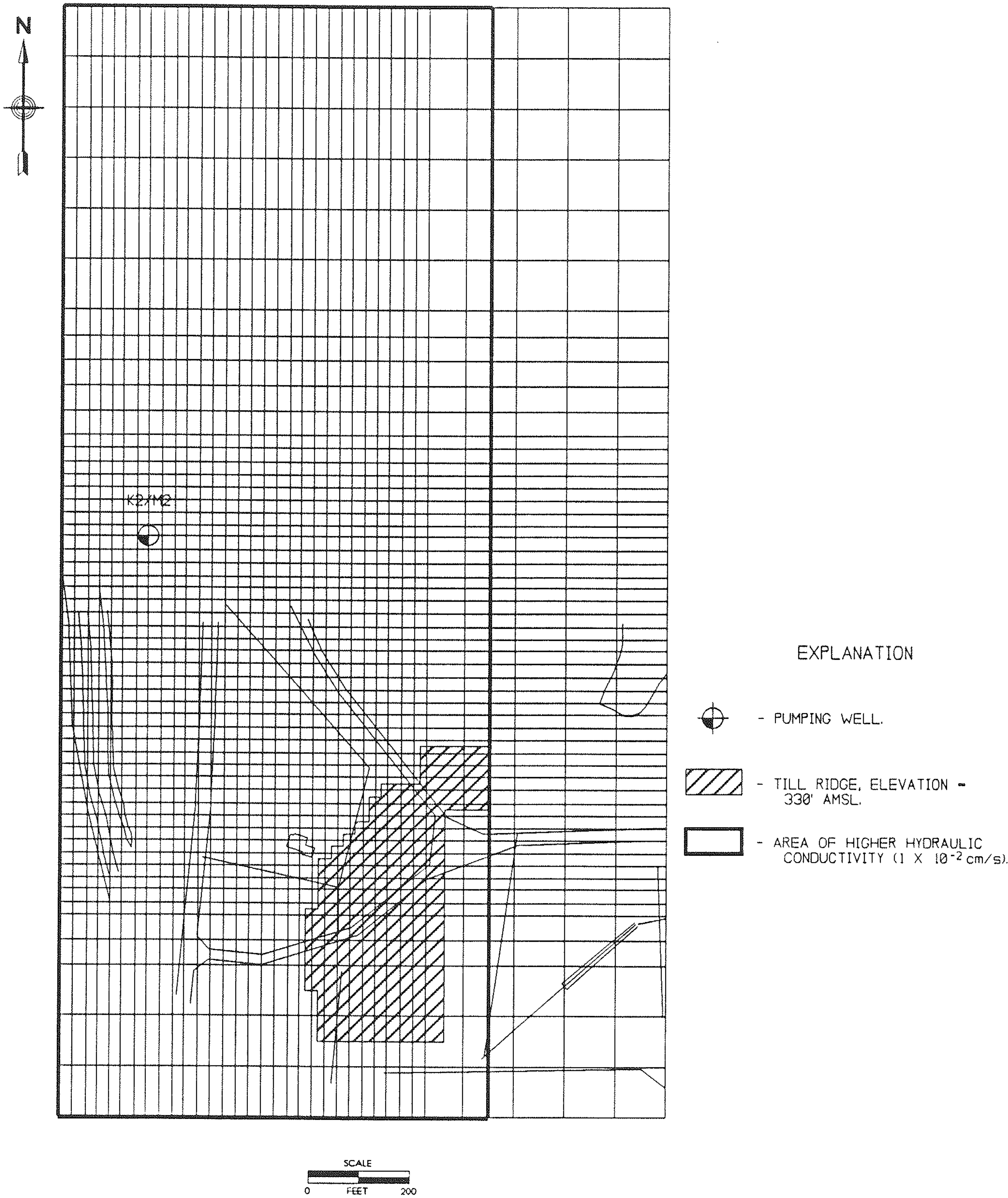


MALCOLM PIRNIE

SOUTHERN SOURCE AREA MODEL
CONTOURED MODEL HEAD DATA --
RECOVERY WELL SIMULATION

MALCOLM PIRNIE, INC.

FIGURE B-8

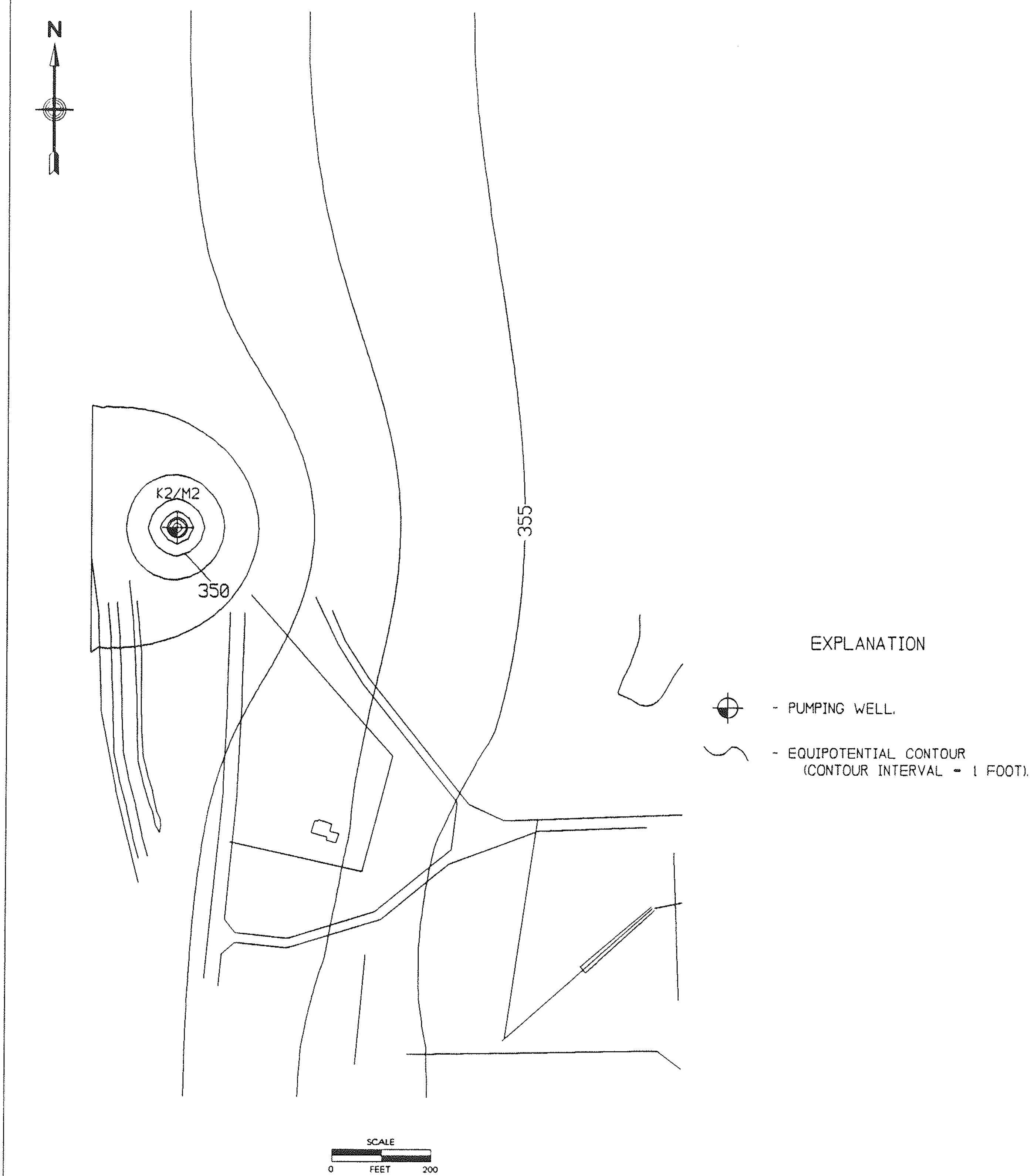


MALCOLM PIRNIE

TAYLOR PROPERTY AREA MODEL GRID

MALCOLM PIRNIE, INC.

FIGURE B-9

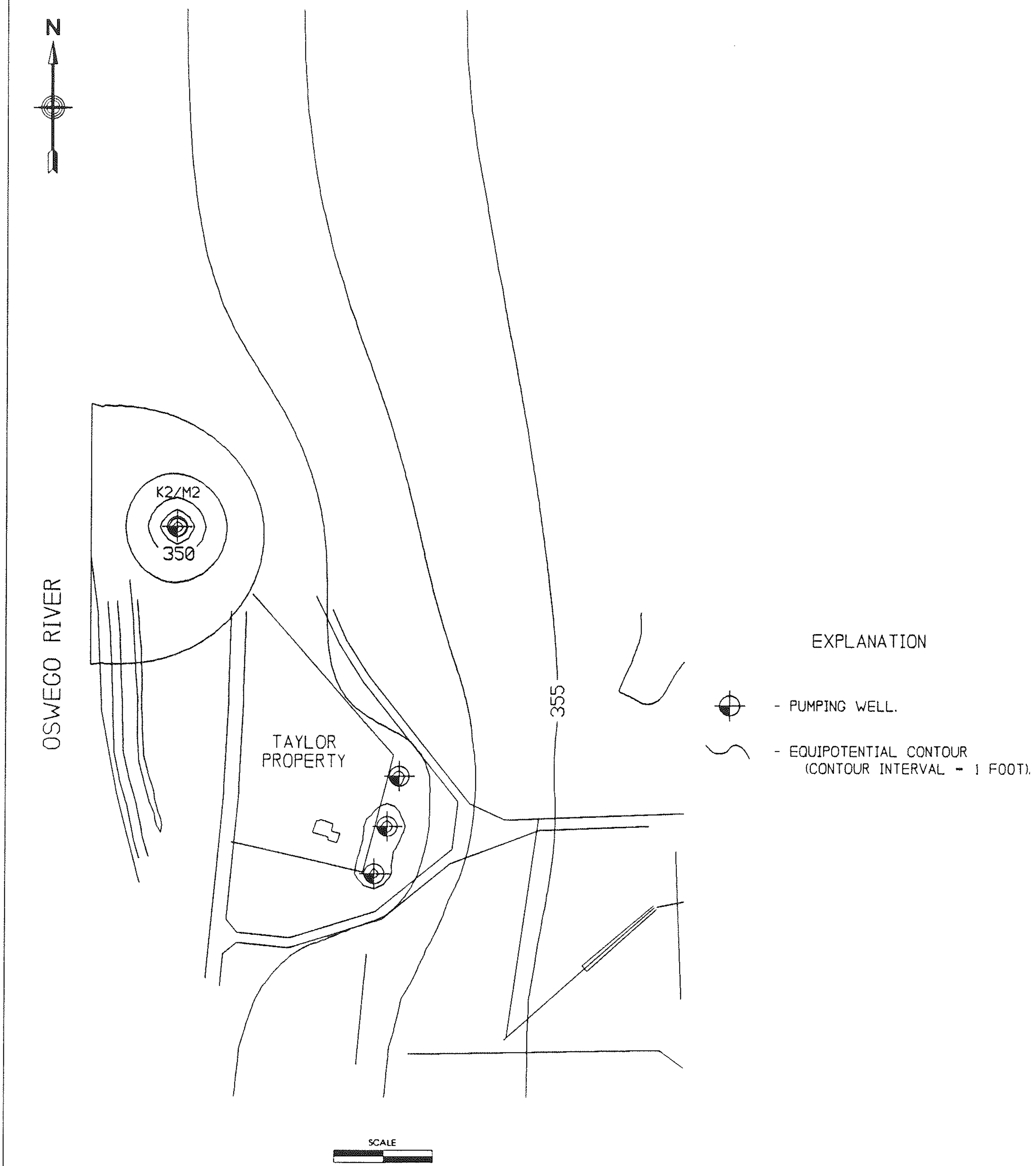


MALCOLM PIRNIE

TAYLOR PROPERTY AREA MODEL
CONTOURED MODEL HEAD DATA --
CALIBRATION RUN

MALCOLM PIRNIE, INC.

FIGURE B-10



MALCOLM PIRNIE

TAYLOR PROPERTY AREA MODEL
CONTOURED MODEL HEAD DATA --
RECOVERY WELL SIMULATION

MALCOLM PIRNIE, INC.

FIGURE B-11

MALCOLM PIRNIE

ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS