✓ add 3/98 revisions

CORRECTIVE MEASURES STUDY REPORT

prepared for

BORDEN HOLDINGS COMPANY
FORMER RESIN FACILITY
BAINBRIDGE, NEW YORK
NCD 000 691 865

FEBRUARY 1997

(WITH APRIL 1998 REVISIONS)

TMG

Environmental and
Applied Earth Science
Consultants

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CHEROKEE ENVIRONMENTAL RISK MANAGEMENT
FORMER BORDEN RESIN FACILITY
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STATEMENT OF ENGINEERING DIVISION

In accordance with Condition VIII of Order on Consent No. A7-0121-87-09, I certify that this Corrective Measures Study has been prepared by me in accordance with good engineering practices.

Signature:

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1.0 INTRODUCTION

1.1 Purpose

This report documents the findings of a Corrective Measures Study (CMS) performed for Borden's former resin plant in Bainbridge, New York. The purpose of the CMS is to evaluate corrective action alternatives to address environmental contamination at the site.

1.2 Site History

From the 1940s until 1981, Borden, Inc. owned and operated a synthetic resin manufacturing facility in Bainbridge, New York. Products produced at the facility included phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde, and polymerized vinyl acetate resins. The location of the facility is illustrated on Figure 1. An aerial photograph of the facility is provided on Figure 2.

From 1981 to the present, the facility has been inoperative, and has undergone various environmental investigation and restoration activities. All buildings at the facility have been razed except for a warehouse and an office building. The office building is slated to be demolished in the coming months, and the warehouse is currently leased.

1.2.1 Environmental Sampling Data - The CMS has been developed based primarily on environmental sampling data presented in two reports.

In July 1992, Borden, Inc. submitted a comprehensive report entitled "Draft RCRA Facility Investigation (RFI) Report." This report included a description of historic waste management practices, solid waste management units (SWMUs), the environmental setting (e.g., geology, hydrogeology), and corrective actions completed to date. It also included a summary of all available environmental sampling data collected at the site. The locations of SWMUs addressed in the report are illustrated on Figure 3. The major environmental contaminants and contaminated media found at the site are:

1) volatile organic compounds (VOCs), formaldehyde, and phenol in groundwater, and

2) polychlorinated biphenyls (PCBs) in soils and sewer sediments.

Due to data gaps identified in the Draft RFI Report, it was necessary to expand the environmental sampling program. After a second RFI investigation, a "Phase II RFI Report" was submitted in August 1996. In NYSDEC's letter dated December 9, 1996, the agency approved the Phase II RFI Report and requested the submission of this CMS report.

It should be noted that groundwater monitoring data from November 1996, being more recent and comprehensive than the Phase II RFI data, are utilized herein to evaluate groundwater corrective actions.

1.2.2 <u>Corrective Actions Completed to Date</u> - Since the facility was closed in 1981, numerous interim corrective actions have been completed. A chronology of interim corrective actions by SWMU is provided in Table 1. As documented in this chronology, a total of 2,400 tons of waste resin and contaminated media and 6.75 million gallons of groundwater have been treated and/or disposed of as of December 1996.

2.0 CORRECTIVE ACTIONS ADDRESSING GROUNDWATER CONTAMINATION

In a phased approach, over 40 groundwater monitoring wells have been installed at the site since 1981. In addition to previous sampling events, most wells were sampled on a semi-annual or quarterly basis between 1993 and November 1996. Therefore, an abundance of data exists from which to characterize groundwater contamination at the Bainbridge site.

As demonstrated in the Phase II RFI Report, the only groundwater contamination requiring corrective action occurs in the Phenol Recovery Area (PRA).

2.1 Description of Current Conditions

2.1.1 PRA Hydrogeology and Groundwater Contamination - Figure 4 illustrates the locations of 19 monitoring wells, sumps, and piezometers within the PRA and vicinity. Also illustrated on Figure 4 are former and current waste management units within the PRA. Based upon the nature and extent of groundwater contamination, groundwater contamination is attributed to historic releases from the former surface impoundments and phenol recovery unit. A pump-and-treat system is currently being utilized to address contaminated groundwater.

Figures 5 and 6 illustrate water table contours and flow lines under pumping and non-pumping conditions, respectively. The water table occurs at approximately five feet below grade. Under natural hydrogeologic conditions (Figure 6) groundwater from the PRA discharges into Beatty Creek to the east. Under pumping conditions (Figure 5), groundwater is captured in the vicinity of Sump 1.

Table 2 provides a summary of organics analyses from the most recent and comprehensive groundwater sampling event (November 1996). All PRA monitoring wells and sumps were sampled, and the parameter list was expanded to include tentatively identified compounds (TICs) for VOCs and semi-volatiles. As illustrated in Table 2, the following contaminants are found in excess of state groundwater standards:

Benzene (0.012 ppm at MW-15)
Toluene (330 ppm at MW-29)
Phenolics (102 ppm at MW-29)
1,2-, 1,4-Dichlorobenzene (0.0076 at MW-28)

(Values in parentheses are maximum concentrations in the PRA.)

The following observations are also pertinent:

1) By far the highest contaminant concentrations are found at MW-29. MW-29 is located between former phenol recovery unit and former wastewater surface impoundments. Because the contaminant levels are orders of magnitude higher at MW-29 relative to surrounding groundwater sample locations, it appears that overlying contaminated soils are a localized continuing source of groundwater contamination.

2) Groundwater standards are exceeded only to a nominal degree at downgradient wells MW-15 and MW-27, immediately upgradient of Beatty Creek. This indicates that contaminant levels are attenuated before groundwater discharges to the creek.

3) Contaminant concentrations are significantly less in deep wells (MW-15D and MW-29D) relative to adjacent shallow wells. This confirms a primary horizontal contaminant flowpath, as one would expect adjacent to a receiving stream (i.e., Beatty Creek).

4) A number of TICs were identified in the PRA. The highest levels were at MW-15 (2 ppm). Most of the TICs at MW-15 were unidentifiable utilizing a mass spectrometer library search.

The extent of the PRA plume in excess of groundwater standards is illustrated on Figure 7 (shaded area).

Table 3 summarizes the results of inorganics analyses (dissolved oxygen, nitrate, sulfate, and iron). These parameters were analyzed to determine whether natural (intrinsic) biodegradation by aerobic or anaerobic microbes is occurring. Figures 8, 9, 10 and 11 illustrate inorganic constituent concentrations and isopleths. The significance of these figures is discussed in Section 2.3.3.

2.1.2 Status of Interim Remedial Measures - As an interim remedial measure (IRM), a pump-and-treat system was installed in the PRA and has been operating since July 1995 (Figure 12). Groundwater is collected from a french drain at Sump 1 and pumped to a 400,000 gallon above-ground tank. As the tank is filling, aeration is provided by a 100 cfm blower. In addition to aeration, the system utilizes indigenous microbe populations and nutrient levels to achieve requisite treatment levels.

Groundwater is treated batchwise. When the tank is full, groundwater collection is interrupted and a sample of treated water is collected and analyzed. Upon confirmation that treatment requirements are achieved, the tank is discharged as a batch to the creek and/or spray field. Groundwater collection is then resumed.

Table 4 is a summary of IRM batch treatment data to date. Approximately two million gallons were treated and discharged between June 1995 and December 1996. The average collection rate was 13 gpm.

Table 2 includes a summary of influent analytical results from November 1996. Table 4 includes a summary of major constituent concentrations in the influent. Based upon the average total influent concentration of 14.5 ppm, approximately 242 pounds of contaminants were removed from the saturated zone between June 1995 and December 1996.

2.1.3 Exposure Scenarios - As demonstrated in the Phase I and Phase II RFI, PRA groundwater contamination is discharging into the adjacent Beatty Creek as baseflow, except during periods of active groundwater collection (Figures 5 and 6). Nevertheless, as discussed in the following sections, there are no known current or future populations or ecosystems potentially exposed to significant levels of PRA groundwater contamination.

2.1.3.1 Current and Future Human Exposure Scenarios - The first set of potential human receptors of groundwater contamination is users of local groundwater. Since there are no groundwater production wells within the contaminant plume, there are no current receptors of groundwater contamination. Furthermore, since the site vicinity is serviced by the local water utility, there are no reasonable future users of contaminated groundwater.

The second set of potential human receptors are Beatty Creek surface water users. During the Phase I RFI (i.e., before IRM), surface water sample SW-3 was collected from the creek adjacent to the groundwater contaminant plume. (See Phase I RFI Report Figure 4-19 and Table 4-44). All organic constituents (PCBs, phenolics, VOCs, and formaldehyde) were below the analytical quantitation limit. Therefore, although groundwater from the contaminated area was discharging to the creek as baseflow at the time of sampling, surface water was determined to be free from contamination.

2.1.3.2 Current and Future Environmental Impact

It is recognized that pollutant concentrations which are less than quantifiable may nonetheless be harmful to ecosystems. In order to evaluate whether contaminated baseflow is adversely impacting Beatty Creek, an environmental impact assessment was performed in

August 1996. The assessment consisted of the sampling, identification, and characterization of benthic macroinvertebrates in the stream bed in the area of baseflow discharge. The results were reported in the document "Phenol Recovery Area Groundwater Contamination: Options for Corrective Action" (September 1996). The results demonstrate that most of the organisms collected (e.g., mayfly nymphs) are not tolerant of pollution. Therefore, the assessment revealed no adverse environmental impacts on Beatty Creek.

2.2 Corrective Action Objectives

NYSDEC has promulgated groundwater standards which specify maximum allowable concentrations of toxic substances in groundwater (6 NYCRR 703.5). Therefore, the corrective action objectives for contaminated groundwater at the site are the State groundwater standards. These standards are provided with analytical results in Table 2.

Note that in the future, NYSDEC may develop procedures for risk-based alternative cleanup levels (ACLs). If so, these procedures can be utilized to develop ACLs for the Bainbridge site.

2.3 Corrective Action Alternatives

This section discusses corrective action technology alternatives able to achieve the corrective action objectives for groundwater contamination. (Corrective actions to address contaminated soil in the vicinity of MW-29 are discussed in Section 3.0). In addition to effectiveness, the following characteristics are pertinent for selecting the most appropriate technology:

- level of development (e.g., pilot scale versus full scale)
- demonstrated performance record

- construction, operation, maintenance, and monitoring requirements
- time frame to achieve objectives
- life-cycle cost

There are relatively few technologies with a proven performance record for groundwater contamination. The U.S.EPA has established only two "presumptive remedies" for groundwater contamination. (A "presumptive remedy" is presumed to be appropriate based upon being the predominant remedy-of-choice at Superfund sites.) The presumptive remedies for groundwater contamination are pump-and-treat and air sparging.

Experience gained during IRM at the Bainbridge site demonstrates that pump-and-treat utilizing biological treatment is successful at meeting performance requirements. Therefore, biological treatment is an effective treatment technology for the Bainbridge groundwater contaminants.

Biological treatment can be utilized at the site in one of three modes:

1) ex-situ (i.e., pump-and-treat),
2) in-situ (i.e., bioremediation by air sparging), or
3) intrinsic biodegradation.

These three alternatives are evaluated in the following sections.

2.3.1 <u>Ex-situ Biological Treatment</u> - Ex-situ biological treatment is the removal of contaminated groundwater and above-grade treatment of contamination in a biological reactor. This technology has proven successful at the site by consistently achieving discharge criteria during PRA IRM. A schematic diagram of the existing ex-situ treatment system is provided on Figure 12.

In addition to being a site-proven technology, this technology offers the following advantages:

1) minimal operator attention is required,
2) simplicity (only aeration is necessary),
3) a groundwater capture zone is created, minimizing contaminated baseflow to Beatty Creek, and
4) re-application of treated water stimulates biodegradation of in-situ unsaturated soil contamination.

This is the first year of winter operation, so the efficacy of the existing system in cold weather is not yet proven. Based upon the data generated to date, the system does achieve treatment requirements even in winter. Nevertheless, if the existing system does not consistently perform well in the cold weather, a smaller, insulated bioreactor can be installed for relatively little cost.

The greatest drawback of the existing system is the relatively long time anticipated to achieve groundwater clean-up objectives. Figure 13 illustrates the concentration trends of the three major contaminants at the most-contaminated monitoring well, MW-29. In general, there is no clear trend of declining concentrations during the first 1 1/2 years of IRM (i.e., since June 1995). Therefore, the time required to achieve cleanup objectives is expected to exceed ten years.

2.3.2 <u>In-Situ Bioremediation</u> - In-situ bioremediation is the in-place destruction of contaminants utilizing microorganisms. PRA groundwater contamination may be an ideal application for in-situ bioremediation due to the following site characteristics:

1) Treatment data collected during IRM demonstrate that all contaminants are highly biodegradable (i.e., to non-detectable concentrations). Treatment was achieved by adding only oxygen; the addition of microorganisms and nutrients was not necessary.

2) Deep monitoring well data (MW-29D and MW-15D) demonstrate that contamination is within 30 feet of the ground surface.

3) Aquifer and soil permeability are high due to the high fraction of coarse-grained sediments. Therefore, aeration of the subsurface is feasible.

Conceptually, the in-situ bioremediation system would be equivalent to an in-place (i.e., in-situ) bioreactor. Specifically, air sparging wells would be installed into the aquifer beneath the area of contamination. Oxygen (air) would be injected through the sparge wells to stimulate indigenous aerobic microorganisms. Since the contaminants are highly biodegradable, it will not be necessary to include a soil vapor extraction (SVE) system. Air sparging without the need for SVE is referred to as bioventing. A schematic diagram of an in-situ bioremediation system is provided on Figure 14.

In-situ bioremediation has significant advantages over ex-situ (i.e., pump-and-treat) biotreatment, including:

1) The total time required to achieve cleanup goals is expected to be significantly less (e.g., seven years), thus minimizing monitoring and O&M costs. This is because in-situ bioremediation addresses both absorbed and dissolved contamination, whereas ex-situ biotreatment addresses only dissolved contamination (i.e., groundwater contamination).

2) No effluent is generated, thus eliminating the need for effluent monitoring.

3) No water is generated, thus reducing the difficulty of winter operation (i.e., freeze damage, etc).

A disadvantage of in-situ remediation is that there is a potential for system failure due to biological or mineral plugging of the aquifer.

A second potential disadvantage of in-situ bioremediation is that it does not provide hydraulic control of groundwater contamination. That is, it will not mitigate continued baseflow of groundwater from the PRA to the creek. This concern can be addressed by constructing a treatment barrier between the contaminant plume and the creek. The treatment barrier will be a dense configuration of sparge wells which will fully bio-treat groundwater prior to it's discharge as baseflow. This is a reasonable option at the Bainbridge site because as previously demonstrated in Section 2.1.3, baseflow even under untreated and uncontrolled conditions has not adversely affected the water quality of the creek.

2.3.3 Intrinsic Biodegradation - Intrinsic biodegradation is the natural cleanup of contamination in the environment due to the unaided action of naturally occurring microbes. Evidence that intrinsic biodegradation is occurring at a particular site includes:

1) A trend of decreasing contaminant concentrations with time and/or distance from the source due to contaminant consumption (as food) by microbes,

2) reduced dissolved oxygen concentrations in the contaminated zone due to utilization by aerobic microbes,

3) reduced nitrate and sulfate concentrations in the contaminant zone due to utilization by anaerobic bacteria, and

4) increased/decreased dissolved iron concentrations in the contaminant zone due to utilization by iron reducing/oxidizing bacteria.

Figure 13 illustrates the concentration trends for the three major organic constituents at the most contaminated groundwater sample location (MW-29). Between January 1992 and June 1995 (i.e., prior to IRM), there was no trend of decreasing concentrations for these constituents. Therefore, the concentration trends do not indicate that intrinsic biodegradation is occurring. On the other hand, the plume configuration (Figure 7) indicates that contaminant levels decrease away from the source area, suggesting intrinsic biodegradation may be occurring.

Figures 8, 9, and 10 illustrate isopleths for dissolved oxygen, nitrate, and sulfate, respectively. In general, these constituents are depleted in the area of groundwater contamination relative to background levels (Figure 7). Therefore, the observation of oxygen depletion (Figure 8) indicates that aerobic intrinsic biodegradation is occurring. The observation of depleted nitrate and sulfate (Figures 9 and 10) indicates that anaerobic intrinsic biodegradation is occurring.

Figure 11 illustrates the concentrations of total iron in groundwater. There is no clear trend for iron in the area of groundwater contamination relative to background levels. This may be attributable to the fact that samples were unfiltered, and iron concentration may be more a function of sample turbidity than biodegradation. Therefore, future samples for iron should be filtered.

Based upon the above data, it has been demonstrated that aerobic and anaerobic intrinsic biodegradation is occurring at the Bainbridge site. Therefore, intrinsic biodegradation is a viable corrective action alternative for the site.

Intrinsic biodegradation offers the following advantages:

1) it is a proven technology,

2) capital and <u>annual</u> operation, maintenance, and monitoring costs are low relative to in-situ and ex-situ alternatives,

3) there is no concern for freeze-damage, spills, etc.

The major disadvantage of this alternative is that it is expected to take a considerably longer time to achieve corrective action goals (e.g., 30 years) relative to the alternatives.

A second disadvantage of intrinsic biodegradation is that it does not provide hydraulic control of groundwater contamination. That is, contaminated groundwater will continue to discharge as baseflow to the creek. At the Bainbridge site, this is not a serious limitation because, as demonstrated in Section 2.1.3, contaminated baseflow is not adversely impacting the water quality of the creek.

2.4 Recommended Corrective Measure for Groundwater Contamination

The three alternatives for corrective measures addressing groundwater (i.e., ex-situ pump-and-treat, in-situ bioremediation, and intrinsic biodegradation) are all proven technologies which are appropriate for site conditions and groundwater contaminants. Furthermore, they are all comparable in terms of the following selection criteria:

1) reliability,
2) constructability,
3) construction and operational safety,
4) short- and long-term environmental protection,
5) short- and long-term human health protection, and
6) institutional requirements (e.g., permits).

All alternatives are considered comparably protective of human health and the environment because there are no known current or potential receptors of contamination (Section 2.1.3).

Therefore, the primary criteria for selecting the most appropriate alternative at the Bainbridge site are:

1) time required to achieve corrective action goals,
2) operation and maintenance requirements,

3) monitoring requirements, and
4) life-cycle costs.

Table 5 provides a summary of selection criteria values for the three alternatives. In addition to the three stand-alone alternatives, an additional alternative of combining ex-situ and in-situ biotreatment is considered. For each alternative, selection criteria values (e.g., time required) have been estimated based upon experience with the technologies at similar sites.

Based upon a review of Table 5, it is apparent that the best alternative in terms of minimizing life-cycle cost and O&M requirements is in-situ bioremediation. The "time required" advantage of combining in-situ/ex-situ technologies is considered insignificant (i.e., one year). Therefore, in-situ bioremediation is the preferred corrective measure alternative for groundwater contamination at the Bainbridge site.

The effectiveness of in-situ bioremediation will be judged by two criteria:

1) Prevent off-site migration of contaminants, and
2) Reduction of contaminant mass in the plume.

A pilot test will be performed on a portion of the plume to determine if in-situ bioremediation is effective at reducing contaminants and preventing plume migration in the test area. If the pilot test appears to be successful, the bioremediation system will be expanded to address the remainder of the plume. The expanded system will then be tested to confirm its effectiveness in the expanded area.

The in-situ bioremediation system will be considered the final remedy once Cherokee has successfully demonstrated to the Department during the pilot test and the final testing, that the stated objectives can be achieved. The Interim Corrective Measures (ICM) pump and treat system will continue to operate until the final remedy is implemented. Once the final remedy is operating and testing has been conducted, the ICM pump and treat system will be shut down but will remain in an operable condition (in shut down mode). If down time exists for an extended period of time during operation of the final remedy, the ICM pump and treat system will be turned on. Department approval will be received before dismantling the current pump and treat system.

If in-situ bioremediation is not capable of preventing off-site migration of contaminants, Cherokee shall submit a proposal for corrective measures that will prevent off-site migration of contaminants through hydraulic containment. Hydraulic containment is defined as adequate gradient reversal to prevent off-site migration of contaminants above applicable state standards. Criteria will be established to make this determination.

If in-situ bioremediation fails to reduce contaminant mass, Cherokee shall submit a proposal for enhancing the implemented system, or alternate corrective measures.

Criteria for determining the feasibility of the technology at each stage of implementation and a schedule will be included in the Corrective Measures Implementation Plan.

3.0 CORRECTIVE ACTIONS ADDRESSING SOIL CONTAMINATION

In a phased approach, soil samples were collected from over 400 locations throughout the site since 1981. As demonstrated in the RFI Reports, soil contamination can be characterized as follows:

1) Near-surface soils (<10 feet) are contaminated with PCBs in the PCB Area, Bone Yard, River Lagoon, and Trenches in the Land Application Area (Figure 3).

2) Unsaturated soils in the Phenol Recovery Area (PRA) are contaminated with phenolics and VOCs below soil ingestion risk levels, but above impact-to-groundwater levels.

3.1 Description of Current Conditions

3.1.1 Soil in the PCB Area - The PCB Area is the former location of the Therminol Heater. PCBs released from the Therminol Heater subsequently migrated or were transported to other locations throughout the site. As illustrated in Table 1, a total of approximately 500 tons of PCB-contaminated soil and concrete have been excavated from the PCB Area to date. Based upon post-excavation sampling, PCB concentrations of in-place soils are illustrated on Figure 15.

The soils at the bottom of the excavation are tight silt, and vertical profile sampling demonstrates that no vertical migration of PCBs has occurred beneath the former chimney stack foundation. Near surface soils (<3 feet) include a large fraction of rubble (e.g., bricks, concrete).

The water table occurs at approximately two feet below grade, thus accounting for the standing water within the existing excavation.

3.1.2 Soil in the Bone Yard - The Bone Yard was an area used to stage and discard the plant's waste materials and equipment. PCB contamination is attributed to disposal of PCB-contaminated sewer sediment and/or gravel from the PCB Area. In general, the soils are predominantly silt, and the water table occurs at approximately two feet below grade.

As illustrated in Table 1, approximately 275 tons of buried waste and soil were excavated in 1981. However, these corrective actions were directed primarily at off-spec resins, not PCBs.

Based upon a grid sampling program, current PCB contamination in the Bone Yard is illustrated on Figure 16. The numbers presented at each boring location are the highest PCB concentration within the ten foot sampling zone. The shaded areas represent the areas wherein PCBs exceed 25 ppm within the Bone Yard.

3.1.3 Soil in the River Lagoon - The River Lagoon was a surface impoundment used as a component of the plant's wastewater treatment system. In 1983, the River Lagoon was re-graded with berm material and re-vegetated. No waste has been removed from this area to date. Soils are predominantly silt and the water table occurs at approximately six feet below grade.

Based upon the results of a grid sampling program, the distribution of PCB contamination in the River Lagoon is illustrated on Figure 17. The numbers at each boring location represent the highest PCB concentration within the 10 foot sampling zone. The shaded areas represent areas wherein PCBs exceed one ppm within the River Lagoon.

3.1.4 Soil in the Trenches in the Land Application Area - Trenches in the Land Application Area ("Trenches") were used to dispose of biosolids from the wastewater treatment tanks during winter months. No waste has been removed from the

Trenches to date. Soils consist predominantly of silt, although particle size ranges to cobbles. The water table occurs at approximately four to six feet below grade.

Based upon the results of a grid sampling program, the distribution of PCB contamination within the trenches is illustrated on Figures 18 and 19. The numbers at the boring locations represent the highest PCB concentrations within the 10 foot sampling zone. Shaded areas represent areas where PCBs exceed 25 ppm within the Trenches.

3.1.5 Soil in the Phenol Recovery Area - The Phenol Recovery Area (PRA) is the former location of the plant's wastewater treatment systems. Soil samples were collected from the PRA during both the initial and Phase II RFI. Phase II RFI data were quantitative and demonstrated that soil contaminant levels for phenolics and VOCs do not exceed U.S.EPA's soil ingestion risk-based criteria. Soil contaminant levels do exceed impact-to-groundwater criteria and are therefore a likely continuing source of groundwater contamination (Section 2.0).

Initial RFI data were qualitative (i.e., based upon soil vapor space screening with a photoionization detector). These data are illustrated on Figure 20 along with the locations of former wastewater treatment components. As illustrated on Figure 20, the highest soil contamination levels are found adjacent to the former phenol recovery unit. This is also the location of the highest groundwater contamination (i.e., at MW-29, see Figure 7). Therefore, it appears that soil contamination in the immediate area of the former phenol recovery unit is significantly impacting groundwater.

3.1.6 Current and Future Exposure Scenarios

3.1.6.1 Exposure to PCB Soils - Theoretically, human populations and ecosystems may be exposed to PCB-contaminated soil, groundwater, surface water, and sediments. RFI and quarterly monitoring demonstrate that PCBs have not been encountered to a significant degree in groundwater, surface water, or surface water sediments. Therefore, the primary current or potential exposure pathways are associated only with PCB-contaminated soils.

The primary exposure pathways for soils are anticipated to be dermal absorption and ingestion, and perhaps fugitive dust. Since the contaminated areas are currently vacant, unused, and relatively remote, these are not believed to be current, but rather potential pathways.

Additionally, due to seasonal flooding of the River Lagoon, soil in this area may be scoured and released into the Susquenhanna River.

3.1.6.2 Exposure to PRA Soils - As previously discussed, contamination levels in PRA soil do not exceed U.S.EPA's soil ingestion exposure guidance levels. Therefore, they do not pose a direct risk to human populations. On the other hand, they do exceed impact-to-groundwater guidance levels, and are therefore likely to be a continuing source of groundwater contamination, especially in the vicinity of MW-29.

3.2 Corrective Action Objectives

The objective of remediation of contaminated soils in the PRA is to eliminate them as a continuing source of groundwater contamination.

The objective of remediation of PCB soils is to achieve regulatory cleanup requirements and to otherwise protect human health and the environment.

PCBs released to the environment after the 1987 are regulated by the TSCA PCB Spill Cleanup Policy. However, the same TSCA cleanup requirements may be utilized for historic (pre-1987) PCB releases as well. Excavation and disposal of PCB soils conducted at the Bainbridge site to date have utilized the

TSCA cleanup requirements.

3.2.1 <u>Current TSCA Cleanup Requirements</u> - Current TSCA cleanup policy allows for two general cleanup scenarios applicable to the Bainbridge site:

1) If the site is maintained as a "restricted access" site (i.e, industrial landuse and fencing) soil must be cleaned to 25 ppm PCBs (40 CFR 761.125 (c)(3)(v)).

2) If the site is maintained as an "unrestricted access" site, soil is to be cleaned to 10 ppm PCBs and excavations backfilled with clean soil (761.125 (c) (4) (v)).

Ten ppm PCBs is the cleanup level utilized for Bainbridge IRM activities and is the highest concentration generally allowed by NYSDEC to remain in place without institutional controls (e.g., deed restriction).

3.2.2 <u>Proposed TSCA Cleanup Requirements</u> - On December 6, 1994, EPA proposed revised TSCA regulations addressing PCBs. One of the purposes of the revision is to specifically address historic (pre-1987) releases to the environment. As with the current TSCA regulation, land-use-specific cleanup requirements are specified:

1) For "high exposure areas" (e.g., unrestricted access), soil above one ppm PCBs is to be removed; or soil above 10 ppm is to be removed and soil above one ppm is to be capped (761.61(a)(4)(i)).

2) For "low exposure areas" (e.g., industrial facilities), soil above 25 ppm is to be removed; or soil above 50 ppm is to be removed and a fence and warning signs are to be maintained; or soil above 100 ppm is to be removed and soil above 25 ppm is to be capped (761.61(a)(4)(ii)).

3) Application may be made for alternative cleanup

requirements based upon a risk assessment (761.61 (c)).

The proposed rules are subject to change based upon public comments and EPA responses.

3.2.3 Site-Specific PCB Cleanup Objectives - Among the areas contaminated with PCBs at the Bainbridge site, the River Lagoon requires special consideration. Being on the bank of the Susquehanna, the River Lagoon is susceptible to active scouring of PCB soils by high water and ice. PCBs released into the aquatic environment of the Susquehanna could potentially bioaccumulate in the food chain. In order to mitigate this potential threat, NYSDEC Division of Fish and Wildlife has recommended a site-specific one ppm PCBs cleanup level for the River Lagoon.

There are two basic alternatives for cleanup objectives at the remainder of the Bainbridge site:

1) Remove PCBs above 10 ppm and backfill with clean soil. This approach is consistent with EPA's current PCB Spill Cleanup Policy for "unrestricted access" areas (i.e., the conservative approach).

2) Remove PCBs at a higher concentration (25, 50, or 100 ppm), restrict future land use, and maintain institutional controls (fencing, signs and/or caps). Only the 25 ppm alternative is currently available based upon current TSCA regulations and NYSDEC policy.

In order to evaluate the cost impacts of the two alternatives, relative life-cycle cost estimates were developed. In general, the costs were estimated based upon an estimate of the soil volumes to be removed (i.e., volumes above 10 and 25 ppm), the relative proportions requiring hazardous versus non-hazardous disposal, and actual disposal costs based upon PCB waste disposed of to date. The costs of implementing institutional controls for the 25 ppm cleanup alternative are minimal.

Based upon the relative life-cycle cost estimates, the potential cost savings of utilizing the 25 ppm cleanup objective are significant (e.g., 10-15 percent of project costs). Given that the 25 ppm cleanup objective (with institutional controls) is protective of human health and the environment, and that historic and future landuse of the site is industrial, the 25 ppm cleanup objective is appropriate for the remainder of the site.

In conclusion, one ppm is the soil cleanup objective in the River Lagoon. For the remainder of the site, 10 ppm is the soil cleanup objective for unrestricted use areas, and 25 ppm is the soil cleanup objective for restricted use areas.

3.3 Quantity of PCB-Contaminated Soil to be Remediated

As previously discussed, the cleanup level for the River Lagoon is one ppm PCBs. The extent of PCB contamination in excess of one ppm is illustrated on Figure 21. The isopleths (Figure 21) constitute a mining map, indicating the depth to which the in-situ soils will have to be removed to achieve the cleanup objectives. Based upon the isopleths, it is estimated that 4,000 cubic yards of PCB soil will have to be removed from the River Lagoon. Assuming 1.5 tons per yard, the total mass to be removed is 6,000 tons. After removal of known soil contamination in excess of cleanup objectives, the in-situ soil levels will be confirmed to be below the cleanup objectives based upon a composite sampling program.

The cleanup level for the remainder of the site is 25 ppm PCBs. The extent of PCB contamination greater than 25 ppm at the PCB Area, Bone Yard and Trenches is illustrated on Figures 15, 22, 23, and 24. These figures provide mining maps of the PCB contaminated soils to be removed. Based upon the isopleths and assuming 1.5 tons per yard, the following estimated quantities of soil are to be removed:

PCB Area - 100 yds/150 tons
Bone Yard - 3,500 yds/5,250 tons
Trenches - 150 yds/225 tons

~~levels will be confirmed to be below the cleanup objectives based upon a composite sampling program.~~

~~The cleanup level for the remainder of the site is 10 ppm PCBs. The extent of PCB contamination greater than 10 ppm at the PCB Area, Bone Yard and Trenches are illustrated on Figures 15, 22, 23, and 24. These figures provide mining maps of the PCB contaminated soils to be removed. Based upon the isopleths and assuming 1.5 tons per yard, the following quantities of soil are to be removed:~~

~~PCB Area - 120 yds/180 tons~~
~~Bone Yard - 4,400 yds/6,600 tons~~
~~Trenches - 750 yds/1,125 tons~~

3.4 Corrective Action Alternatives

Given the limited extent of contaminated soil in the PRA, corrective action will consist of excavation of soil in the immediate vicinity of MW-29 (i.e., "hot spot" removal). Based upon previous removal experience, this soil will be disposed of as non-hazardous waste. The remaining, less-contaminated soil will be addressed by the in-situ bioremediation system (Section 2.4) and re-application of treated groundwater. If necessary based upon system monitoring and evaluation data, in-situ bioremediation may be modified (e.g., with nutrient application to soils).

The following sections discuss corrective action technology alternatives to address PCB soil contamination.

3.4.1 Selection Criteria - In addition to effectiveness, the following characteristics are pertinent for selecting the most appropriate technology:

- level of development (e.g., pilot scale versus full scale),
- demonstrated performance record,
- construction, operation, maintenance, and monitoring

requirements,
- time frame to achieve objectives, and
- life-cycle costs.

There are additional considerations for soil >50 ppm PCBs:

1) Current TSCA regulations specify treatment by incineration, disposal in a chemical waste landfill, or EPA approved alternative treatment which meets the performance standards for incineration (40 CFR 761.60(e)).

2) Proposed TSCA regulations (40 CFR 761.61) add self-implementing options of utilizing capping, non-chlorinated solvent washing, microencapsulation, or vitrification.

3.4.2 <u>Initial Screening of PCB-Soil Remediation Technologies</u>- For purposes of identifying and screening potential PCB-soil remediation technologies, two recent EPA documents were consulted:

1) "Technology Alternatives for the Remediation of PCB-Contaminated Soil and Sediment", and

2) Proposed 40 CFR 761 (TSCA Regulations) and preamble.

Based upon these documents, EPA has identified ten viable technologies for treatment and/or disposal of PCB soil. The technologies and EPA's assessment of their developmental status are presented in Table 6.

3.4.2.1 <u>Established Technologies</u> - Referring to Table 6, "established technologies" are those successfully employed full-scale at multiple sites and commercially available. Only chemical waste landfilling and incineration are currently established technologies for PCB soil.

3.4.2.2 Demonstrated Technologies - "Demonstrated technologies" are those employed at pilot- or full-scale at a limited number of sites. These include thermal desorption, chemical dehalogenation, solvent extraction and soil washing.

Solvent extraction has been identified in proposed 40 CFR 761.61 as a self implementing technology. According to EPA "the solvent washing process is the only currently available destruction or physical separation PCB disposal process considered generally effective in a variety of situations, commercially feasible at ambient temperatures (i.e., no external heat source), and safe enough to be conducted without prior approval" (See 59 FR 62797). Therefore, solvent extraction is considered a favored technology.

Soil washing is not a treatment technology, but rather a waste minimization technology. Since PCBs generally absorb to fine-grained particles, soil washing is used to separate fine from coarse-grained particles. The fine-grained fraction requires additional treatment or disposal, while the coarse-grained fraction may generally be returned to the site. The major limitation of the technology is that it is not cost-effective if greater than 30 percent of soils are clay or silt (i.e., fine-grained). Since the Bainbridge site soils are predominantly silt, soil washing is not an appropriate technology, and will be eliminated from further consideration.

3.4.2.3 Emerging and Unclassified Technologies classified as "emerging" have not yet been shown to effectively or consistently treat PCB-soil at pilot-scale. These include solidification/stabilization, bioremediation, and vitrification. Emerging technologies are generally eliminated at this stage of the technology screening process since they have not been proven. However, solidification/stabilization (micro-encapsulation) and vitrification have been proposed by EPA as self-implementing remedial technologies in proposed 40 CFR

761 (i.e., tacitly assumed to be effective). Therefore, they were given further consideration, as discussed below.

Despite proposing vitrification as a self-implementing technology, "EPA is concerned about additional issues such as the release of volatile products of incomplete combustion (PICs) especially when the process is conducted in-situ. If EPA cannot devise a procedure or prescribe a technology for addressing the issue of volatile PICs, vitrification will be deleted [as a self-implementing technology]" (see 59 FR 62797). Because EPA has identified PICs as a significant outstanding issue, vitrification is eliminated from further consideration for the Bainbridge site.

Solidification/stabilization (i.e., microencapsulation) is another U.S.EPA proposed self-implementing technology with the following restrictions:

1) to be implemented ex-situ,
2) utilizing Portland cement or lime/pozzolans,
3) if treatment standard is achieved (<50 ug/L TCLP), treated soil is to be landfilled off-site as non-hazardous waste.

In-situ solidification/stabilization is eliminated from further consideration due to the uncertain longterm stability of the waste. That is, PCBs may ultimately be released from the stabilized matrix due to weathering or other uncontrolled factors. Ex-situ stabilization is eliminated because it is not yet approved in the modified TSCA regulation.

Capping (unclassified) is another technology which has been identified in proposed 40 CFR 761 as a self-implementing technology. Capping is a viable alternative at the Bainbridge site, but as demonstrated in Section 3.2.3, it does not provide sufficient cost benefit relative to the increased liability and long-term maintenance and monitoring requirements. Therefore, capping will be eliminated from further consideration at the Bainbridge site.

3.4.2.4 Screening Results Summary - The results of the technology screening process are included in Table 6. Three technologies are favored based upon being classified as established, or identified as self-implementing in proposed 40 CFR 761 (excluding capping, stabilization, and vitrification). Favored technologies are landfilling, incineration, and solvent extraction. Two additional technologies (thermal desorption and chemical dehalogenation) will continue to be evaluated in the following sections.

3.5 Recommended Corrective Measure for PCB-Soil Contamination

The primary source for information to compare alternative technologies is U.S.EPA's Vendor Information System for Innovative Treatment Technologies (VISITT), a computerized database. Information was obtained by searching the vendor database utilizing the following search criteria:

1) Contaminant Group: PCBs,
2) Media: In-situ or ex-situ soil,
3) Status: Full scale, and
4) Utilization: United States or, New York specifically.

A summary of the database search results, minus technologies eliminated in the screening process, is provided in Table 7, including technologies, vendors, and reported cost ranges. Also included in Table 7 are verbal quotes from selected vendors reflecting site conditions (i.e., volume of waste, moisture content of soils, etc.).

As previously discussed, 2,400 tons of waste have been removed to date and disposed of at chemical waste landfills. Since actual operational and cost experience has been gained utilizing this technology, landfilling will serve as the baseline from which to compare alternative technologies.

Relative to landfilling, solvent extraction and thermal desorption appear to be cost competitive on a per ton basis. Incineration and chemical dehalogenation are cost prohibitive based upon the information available and are therefore eliminated from further consideration. In order to evaluate the relative costs of landfilling, solvent extraction and thermal desorption, the vendor quotes were utilized to developed life-cycle cost estimates. The estimates are based upon the cost per ton for treatment/disposal (Table 7), the estimated quantity to be treated/disposed (Section 3.3), the estimated relative proportion requiring hazardous versus non-hazardous disposal, and soil handling costs (excavation, stockpiling, and loading). The results of this evaluation are presented in Table 8. Also included in Table 8 are advantages and disadvantages of the remaining options.

As illustrated in Table 8, there is no current cost advantage to utilizing an alternative to off-site landfilling. Additionally, landfilling has the advantages of being the quickest and simplest remedy, and there are no permitting requirements. The only significant disadvantage is the long-term liability. However, given the quantity of soil disposed of to date utilizing off-site landfilling, long-term liability has already been incurred. For these reasons, it is anticipated that off-site landfilling will be utilized to dispose of PCB-soil at the Bainbridge site. An alternative may be re-considered in the future if significant technological advances or cost reductions arise.

4.0 CORRECTIVE ACTIONS ADDRESSING SEWER CONTAMINATION

The plant's wastewater sewers have been identified as having been conduits for the migration of PCBs from the PCB Area Therminal heater to the wastewater treatment plant (i.e., the PRA) and to the River Lagoon. An illustration of the plant's sewer layout is provided on Figure 25.

4.1 Description of Current Conditions

4.1.1 Dirty Water Sewers - The sewer section between the PCB Area and the wastewater treatment plant was referred to as the Dirty Water Sewer SWMU (Figure 3), and was removed as an IRM in 1991 (Table 1). As documented in the Draft RFI Report, post-excavation sampling demonstrated that PCBs above one ppm had been removed. Excavation spoils were landfilled as hazardous and non-hazardous waste, depending upon the results of characterization sampling. Therefore, the Dirty Water Sewer SWMU has been clean-closed.

4.1.2 River Lagoon Sewers - As illustrated on Figure 25, there were two sewer lines which ran from the plant to the River Lagoon. A western sewer line is comprised of 15" and 24" sections. The major part of the 24" section was previously removed due to collapsing and the resultant hazard to cattle and farm equipment. Approximately, 1,000 feet of the western sewer remains. Sediment and water samples collected from a manhole indicated PCB concentrations of 5.8 ppm and 0.00028 ppm, respectively. (The sewer is full of standing water at the manhole.) It should be noted that the water table is approximately five feet bgs, and the bottom of the manhole is approximately eight feet bgs. Therefore, it is likely that infiltrating groundwater will have to be addressed with any corrective actions.

The eastern sewer is comprised of a 15" line. Approximately 1,000 feet runs beside or underneath Beatty Creek, and 1,300 feet run across a cultivated field. Sediment and water samples collected from a manhole indicated PCB concentrations of 870 ppm and 0.0003 ppm, respectively. It should be noted that the manhole was fitted with an expanding plug to mitigate flow within the sewer. Given the placement of the sewer, infiltrating surface and groundwater will have to be addressed with any corrective actions.

4.1.3 Exposure Scenarios - Because it has been sealed at the discharge end, there are no known current exposures to PCB contamination in the western sewer. The only known potential exposure would be if the sewer was disturbed during future construction excavation.

Prior to plugging the manhole, infiltrated surface water flowed through the eastern sewer and discharged in a low area of the cultivated field (Figure 25). Although soil sampling in the field did not reveal significant levels of PCBs (see the Phase II RFI Report), continued discharge of contaminated water is a possible exposure scenario. As with the western section, future construction excavation may also inadvertently release PCBs to the environment.

4.2 Corrective Action Objectives

Two corrective action objectives have been identified for sewers:

1) Eliminate the potential for the discharge of PCB-contaminated water above the groundwater standard of 0.0001 ppm.

2) Remove sediments above the existing non-surface TSCA cleanup standard of 10 ppm PCBs.

4.3 Corrective Action Alternatives for Sewer Contamination

There are two basic options for addressing sewer contamination:

1) Excavation and removal of the sewer and sediment.

2) In-place cleaning of the sewer (i.e., removal of contaminated sediment and water only).

Excavation and removal was the technology successfully utilized on the Dirty Water Sewers. However, for a number of reasons excavation is not a desirable alternative for River Lagoon sewers:

1) Several sewer sections underlie railroad beds, State Route 7, and private property, making removal impossible without costly interruptions of traffic, etc.

2) Most of the sewer underlies the water table or stream bed. Excavation would necessitate significant dewatering activities. Additionally, preventing the release of sewer sediments to the environment during removal would be difficult.

3) Removal would increase the volume of waste to be treated or disposed of.

For these reasons, the more desirable alternative is in-place cleaning of the sewers. This is an established technology utilizing a detergent water jet. The material removed from the sewers will be gravity separated. The water fraction will be carbon treated on-site, as has been previously accomplished with similar PCB wastewater (Table 1). The sediment fraction will require off-site incineration, disposal in a chemical waste landfill, or alternative treatment by a U.S.EPA approved method.

The costs for sewer cleaning will include costs for installing access manholes, scoping, jetting, and waste transport, sampling, and treatment. Quotes will be obtained from at least three experienced and qualified contractors.

5.0 REFERENCES

1) Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities: Releases from Solid Waste Management Units (6 NYCRR 373-2.6), NYSDEC, January 14, 1995.

2) Surface Water and Groundwater Classifications and Standards (6 NYCRR 700-705), NYSDEC, August 31, 1991.

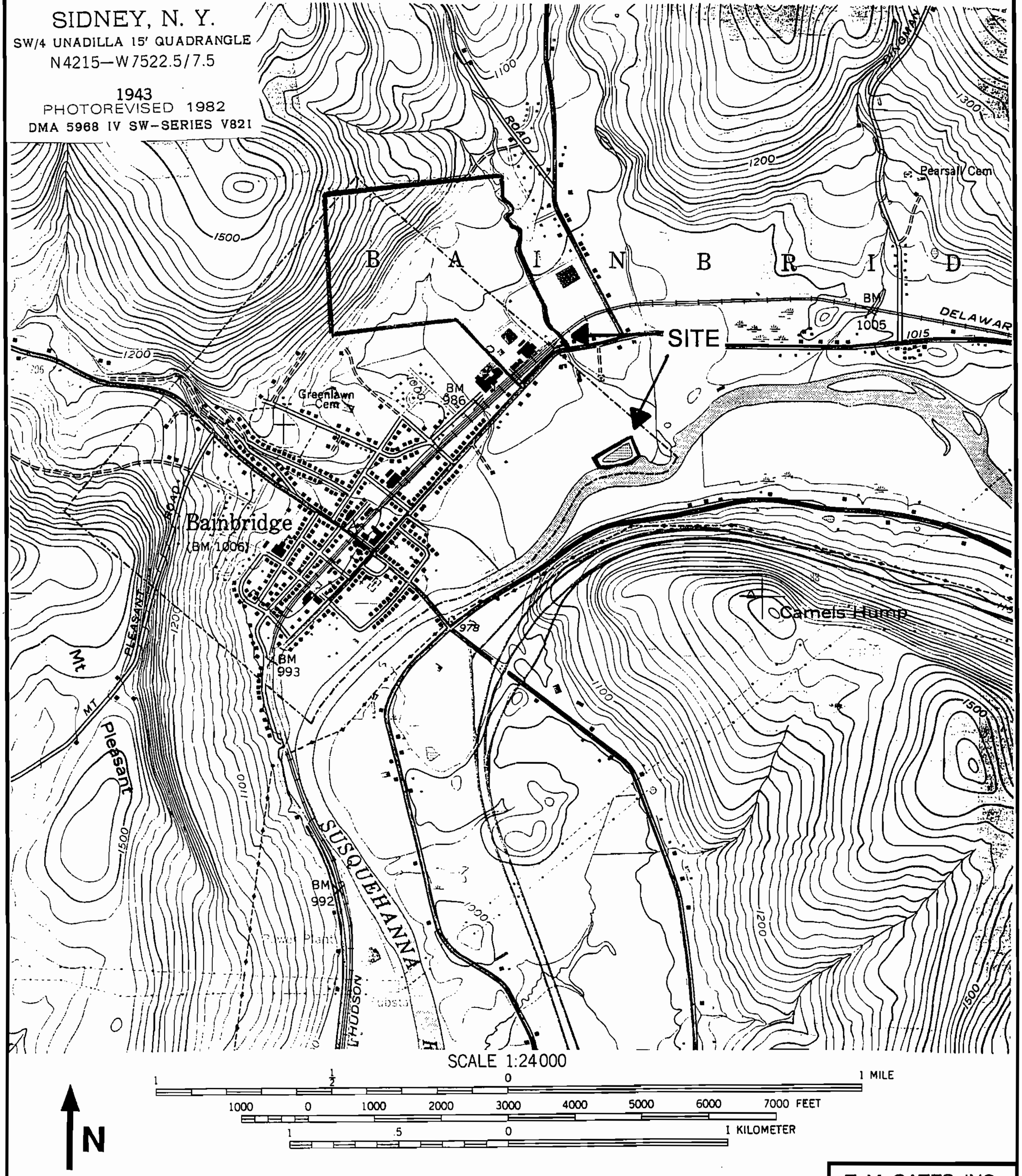
3) Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions (40 CFR 761), U.S.EPA, May 31, 1979 (amended July 10, 1984, June 27, 1988).

4) Disposal of Polychlorinated Biphenyls; Manufacturing, Processing, and Distribution in Commerce; Proposed Decision on Exemption Petitions; Proposed Rules, 59 FR 62788, December 6, 1994.

5) Technology Alternatives for the Remediation of PCB-Contaminated Soil and Sediment. EPA/540/5-93/506, U.S.EPA, October 1993.

6) Vendor Information System for Innovative Treatment Technologies (VISITT), Version 5.0, U.S.EPA Office of Solid Waste and Emergency Response, August 1996.

BORDEN, INC. - BAINBRIDGE, NEW YORK
FIGURE 1
SITE LOCATION



CONTOUR INTERVAL 20 FEET

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FIGURE 2
OBLIQUE ANGLE AERIAL PHOTOGRAPH

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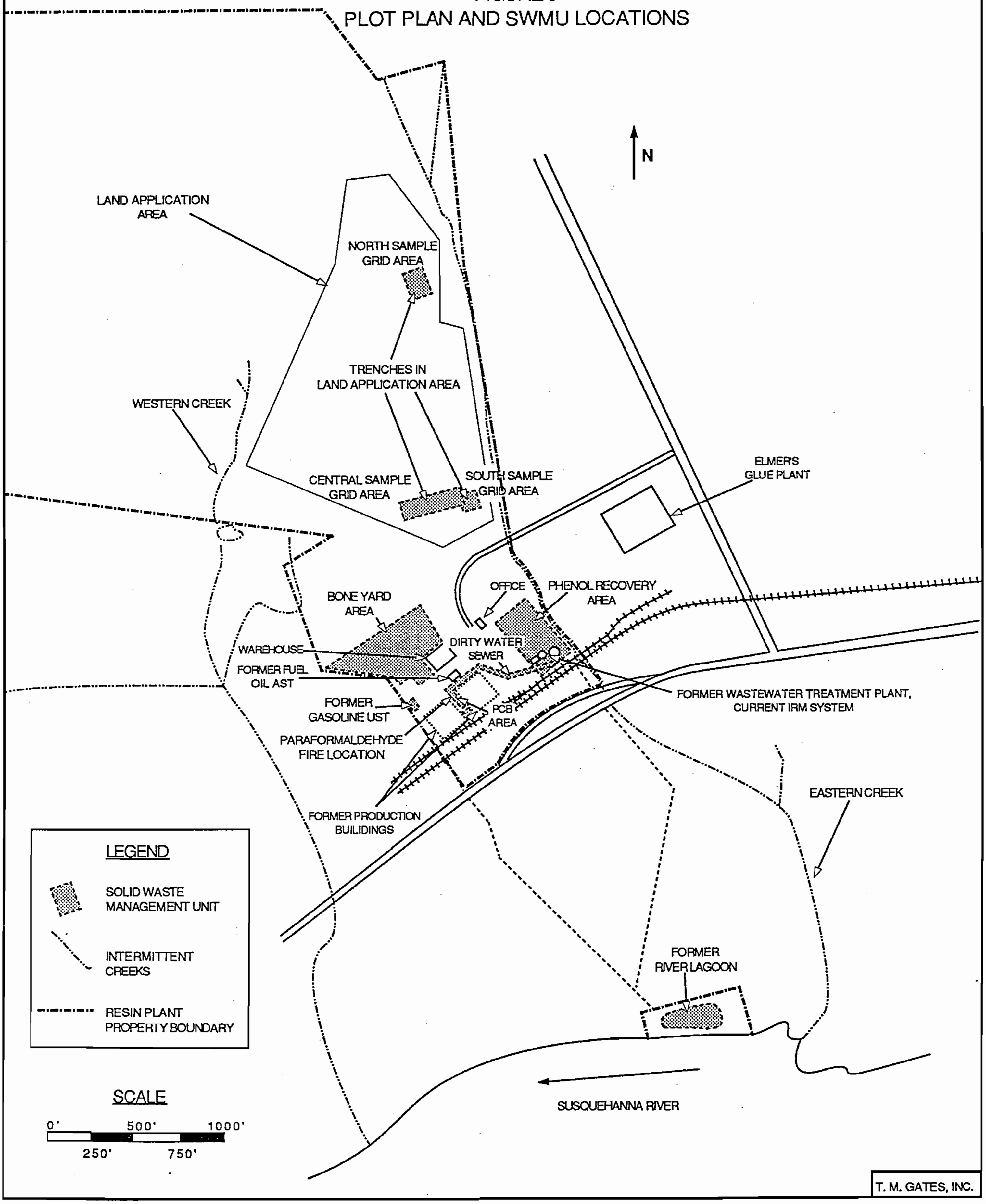
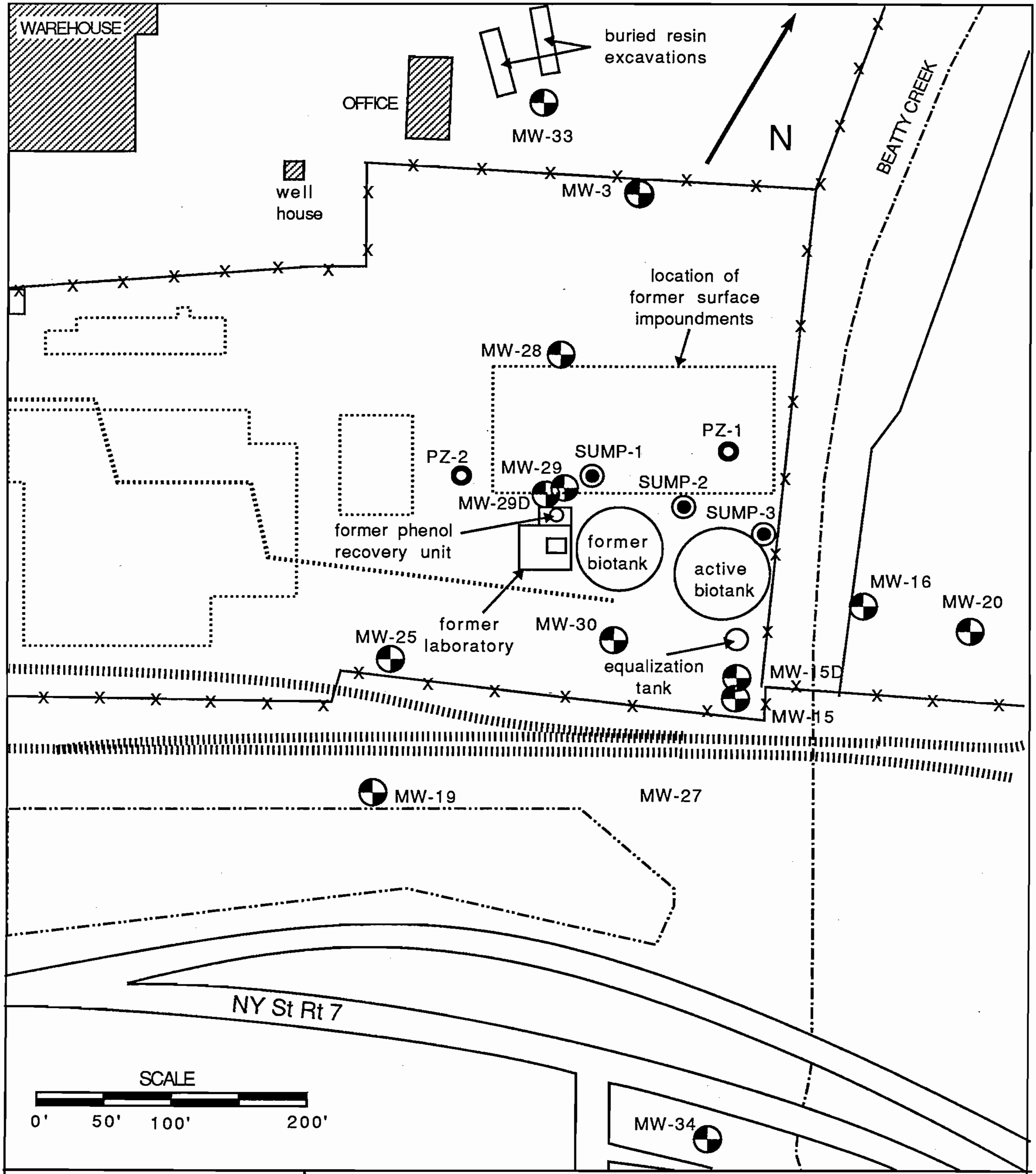
FIGURE 3
PLOT PLAN AND SWMU LOCATIONS



T. M. GATES, INC.



LEGEND

◐ Monitoring well

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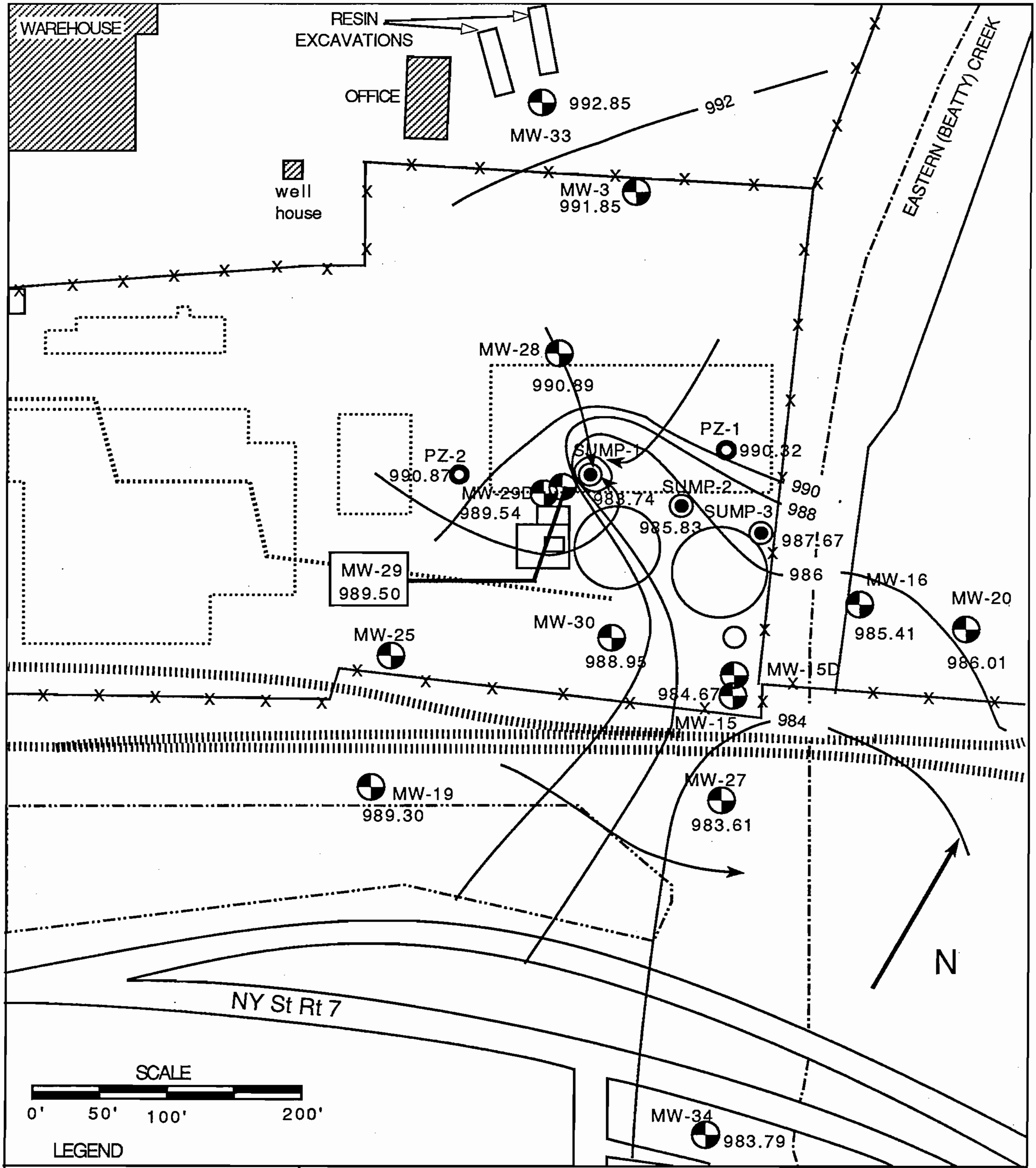
FIGURE 4
PHENOL RECOVERY AREA SAMPLE LOCATIONS
AND WASTE MANAGEMENT UNITS

T. M. Gates, Inc.



Groundwater Contour (1' interval)

Flow Direction

Monitoring well

989.99 Groundwater Elevation (feet MSL)

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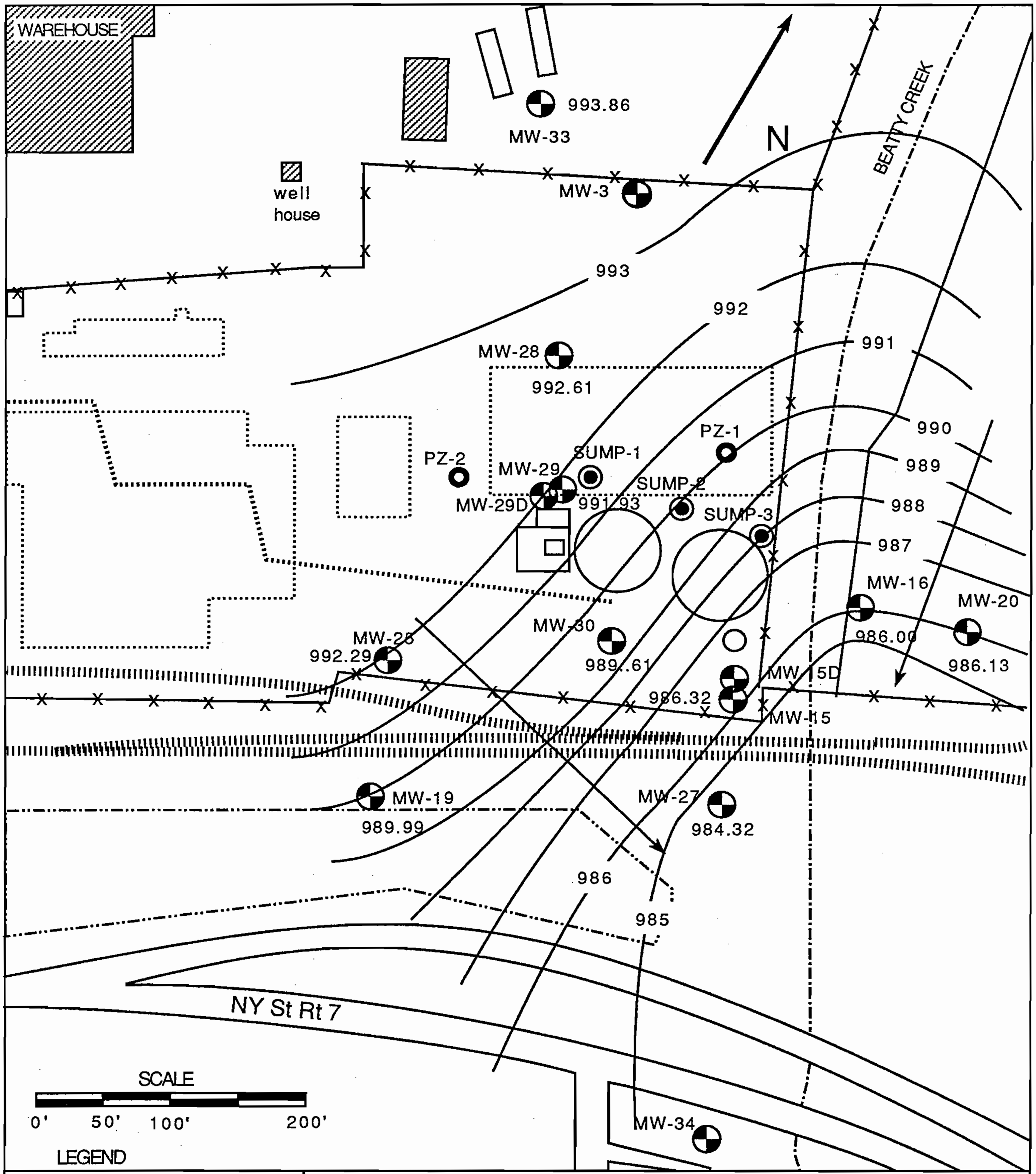
FIGURE 5

PHENOL RECOVERY AREA WATER TABLE

CONTOURS AND FLOW LINES - NOVEMBER 1996

(PUMPING CONDITIONS)

T. M. Gates, Inc.

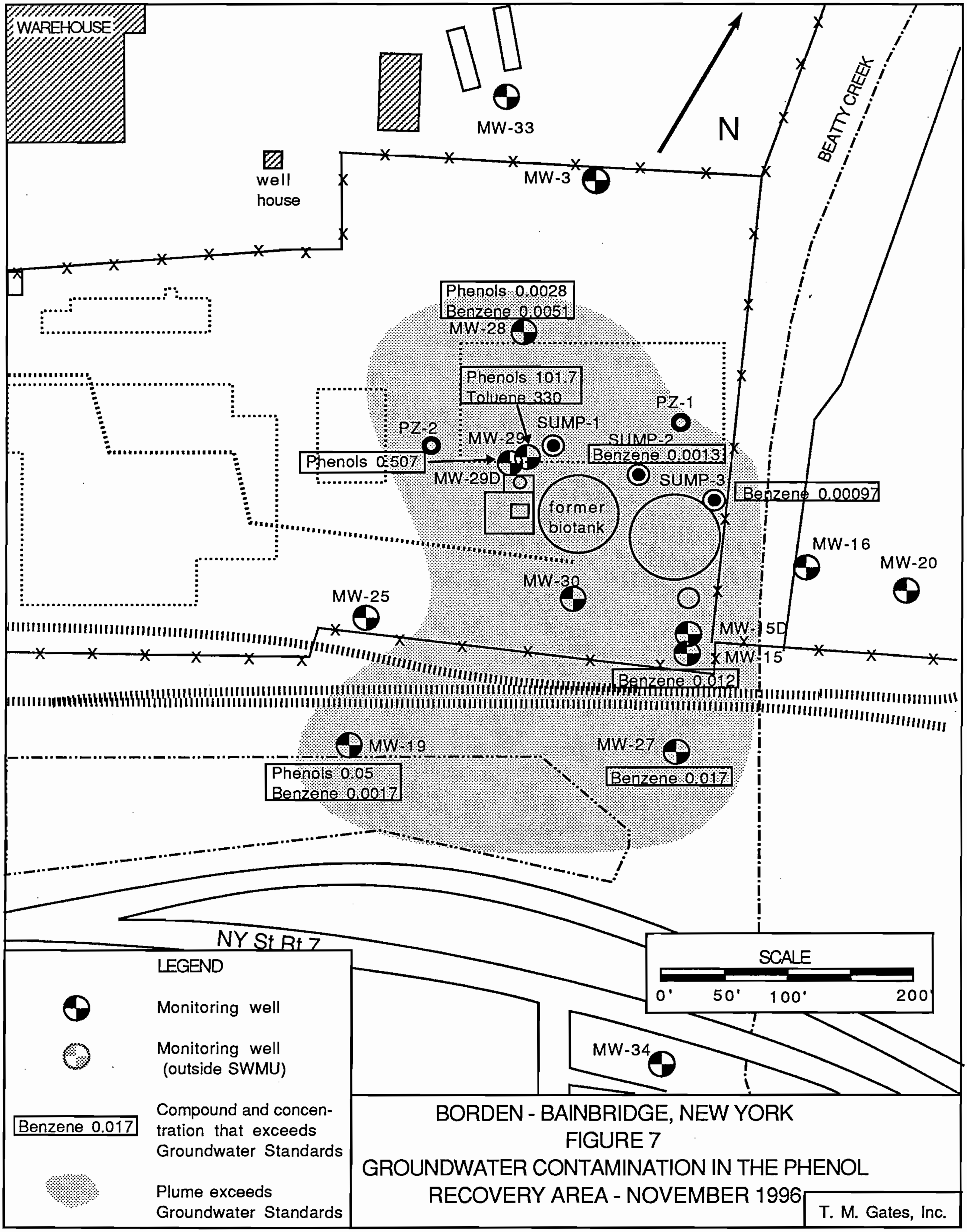


LEGEND

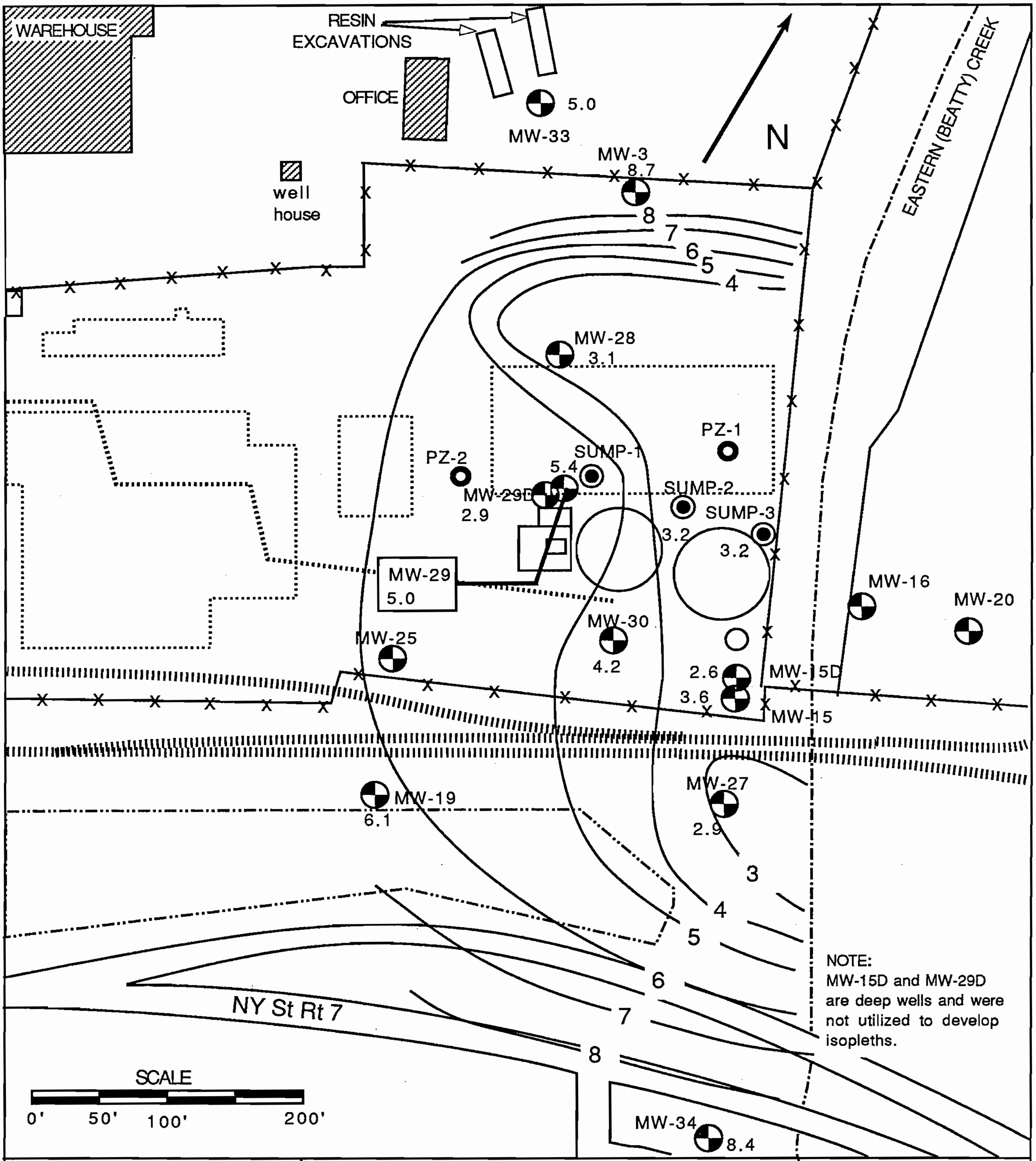
—	Groundwater Contour (1' interval)
→	Flow Direction
◐	Monitoring well
989.99	Groundwater Elevation (feet MSL)

BORDEN - BAINBRIDGE, NEW YORK
FIGURE 6
PHENOL RECOVERY AREA WATER TABLE
CONTOURS AND FLOW LINES - MAY 1996
(NON-PUMPING CONDITIONS)

T. M. Gates, Inc.



BORDEN - BAINBRIDGE, NEW YORK
FIGURE 7
GROUNDWATER CONTAMINATION IN THE PHENOL RECOVERY AREA - NOVEMBER 1996



NOTE:
MW-15D and MW-29D are deep wells and were not utilized to develop isopleths.

LEGEND

Dissolved Oxygen Contour

Monitoring well

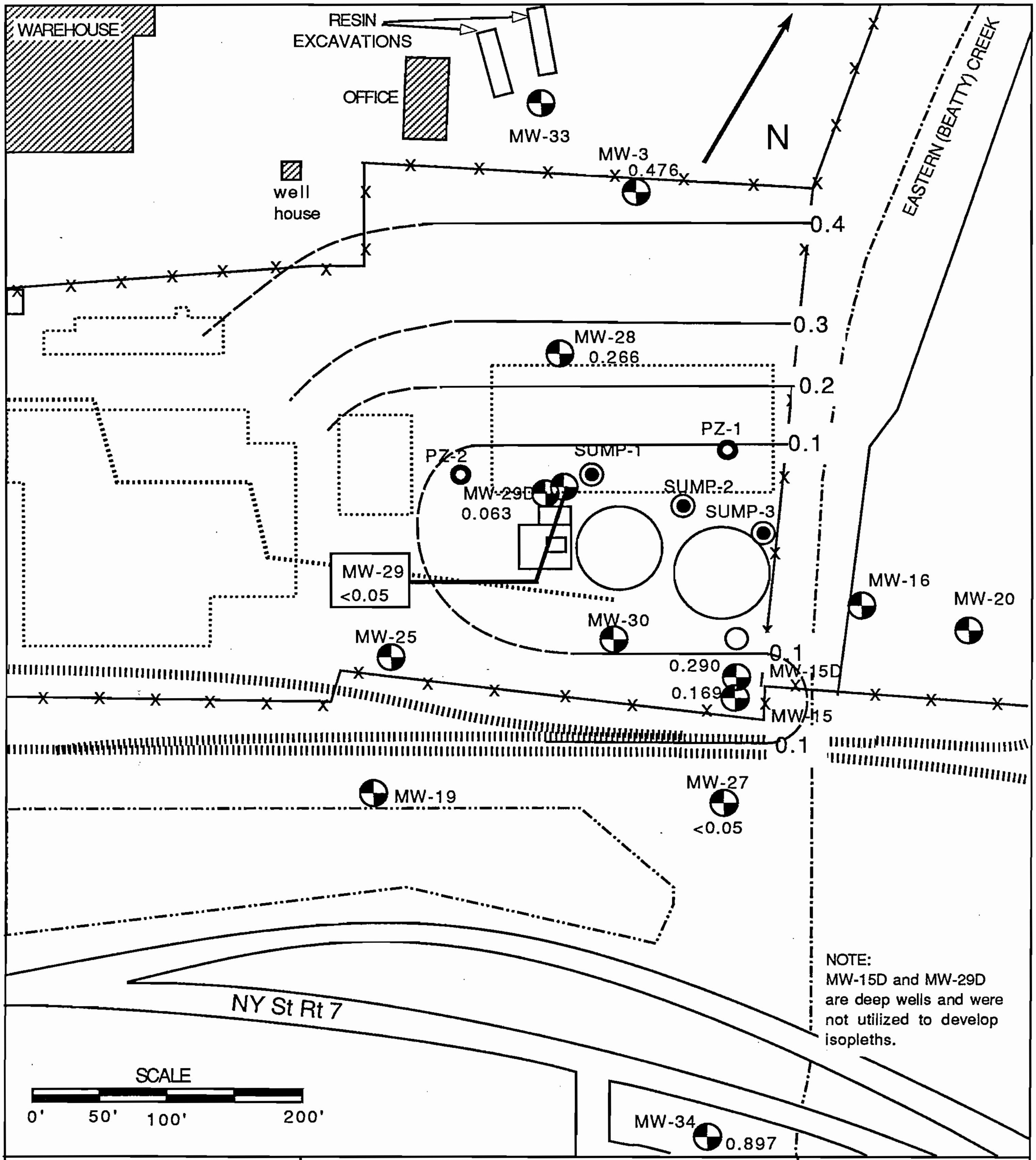
5.0 Measured Dissolved Oxygen level (mg/L)

BORDEN - BAINBRIDGE, NEW YORK

FIGURE 8

PHENOL RECOVERY AREA DISSOLVED OXYGEN ISOPLETHS IN SHALLOW GROUNDWATER - NOVEMBER 1996

T. M. Gates, Inc.



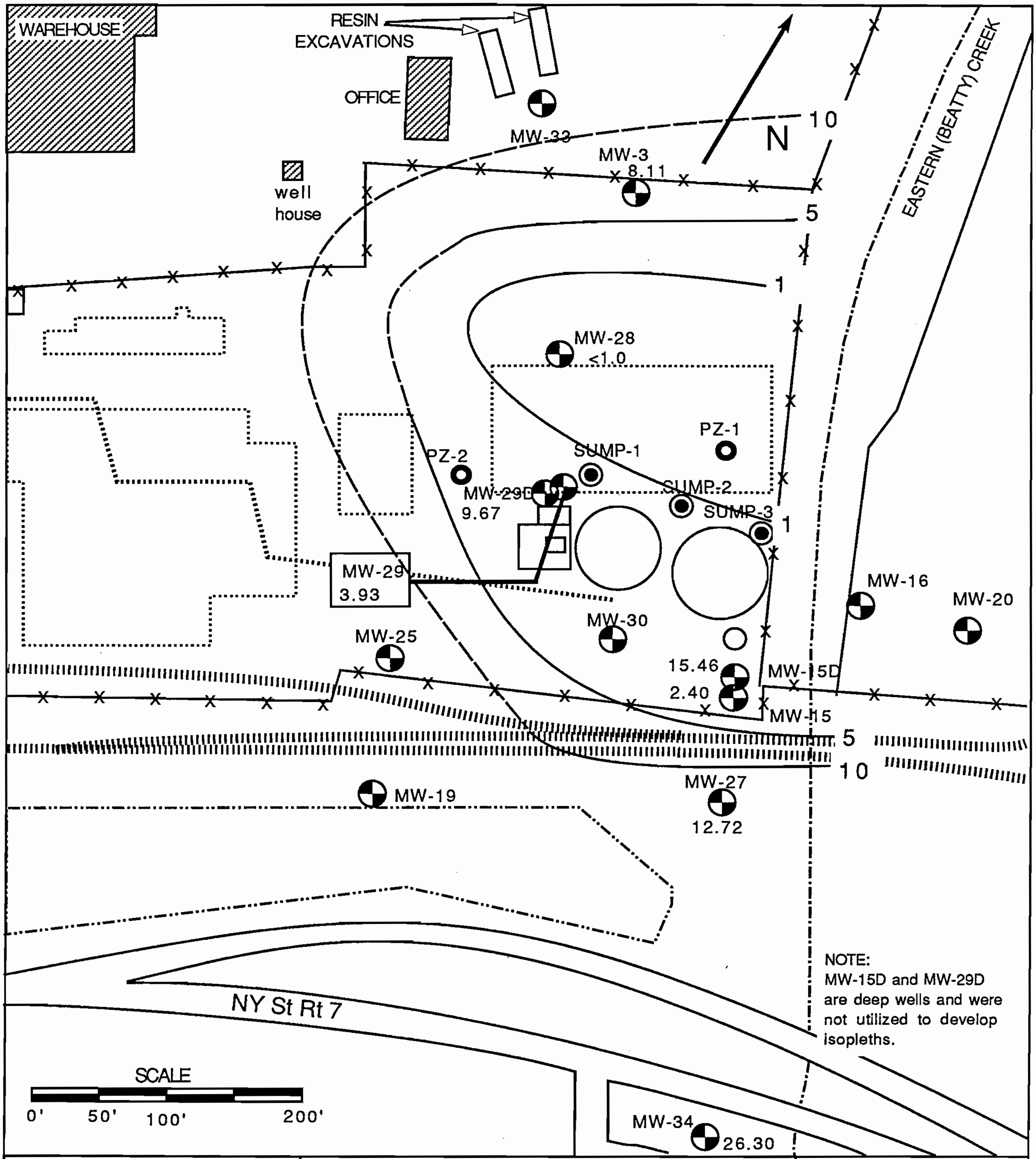
NOTE:
MW-15D and MW-29D are deep wells and were not utilized to develop isopleths.

LEGEND

—	Nitrate Contour
⊕	Monitoring well
0.063	Measured Nitrate level (mg/L)

BORDEN - BAINBRIDGE, NEW YORK
FIGURE 9
PHENOL RECOVERY AREA NITRATE ISOPLETHS IN SHALLOW GROUNDWATER - NOVEMBER 1996

T. M. Gates, Inc.



NOTE:
MW-15D and MW-29D are deep wells and were not utilized to develop isopleths.

LEGEND

Sulfate Contour

Monitoring well

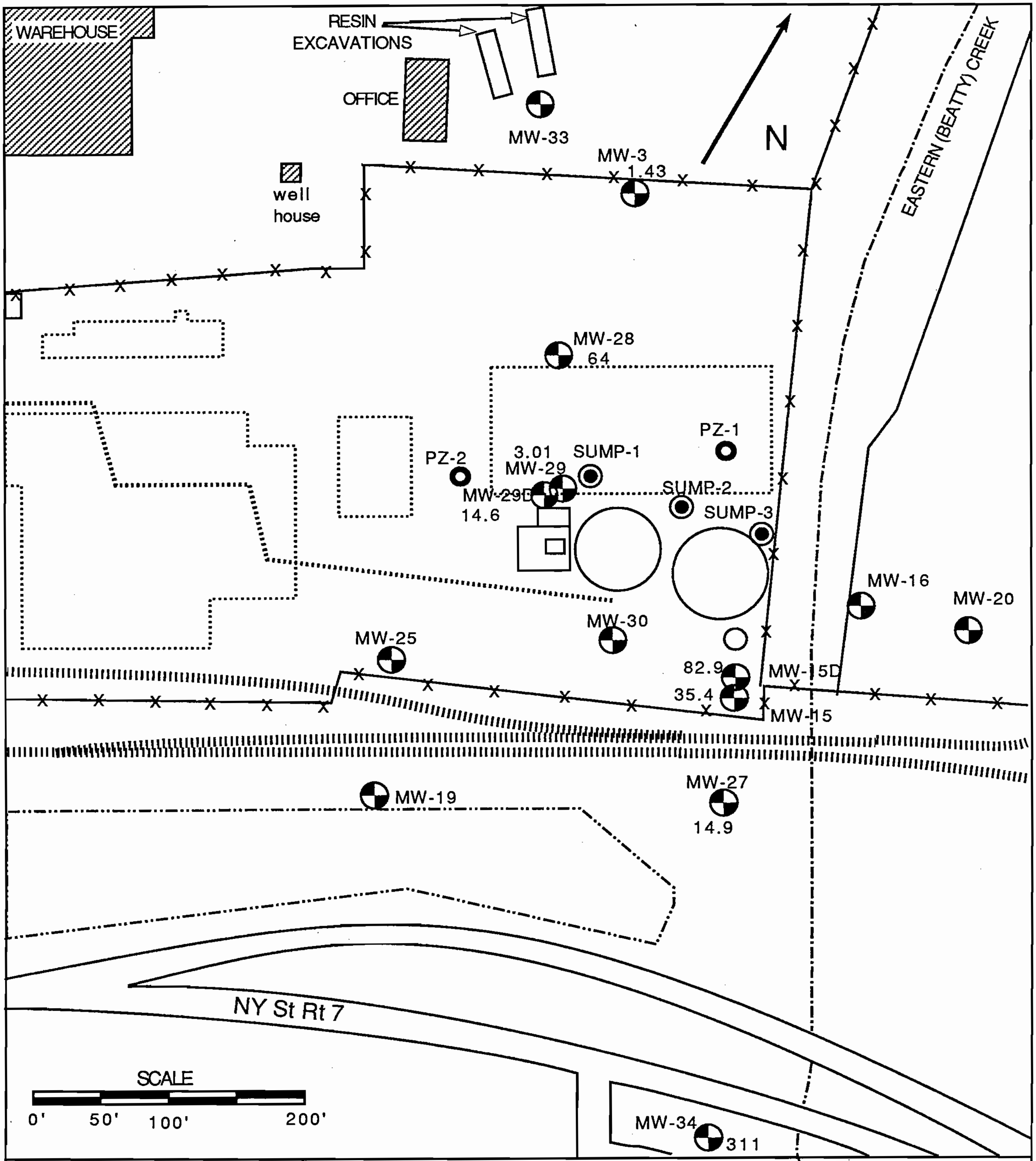
0.063 Measured Sulfate level (mg/L)

BORDEN - BAINBRIDGE, NEW YORK

FIGURE 10

PHENOL RECOVERY AREA SULFATE ISOPLETHS IN SHALLOW GROUNDWATER - NOVEMBER 1996

T. M. Gates, Inc.



LEGEND

Iron Contour

Monitoring well

0.063 Measured Iron level (mg/L)

BORDEN - BAINBRIDGE, NEW YORK

FIGURE 11

PHENOL RECOVERY AREA IRON CONCENTRATIONS IN SHALLOW GROUNDWATER - NOVEMBER 1996

T. M. Gates, Inc.

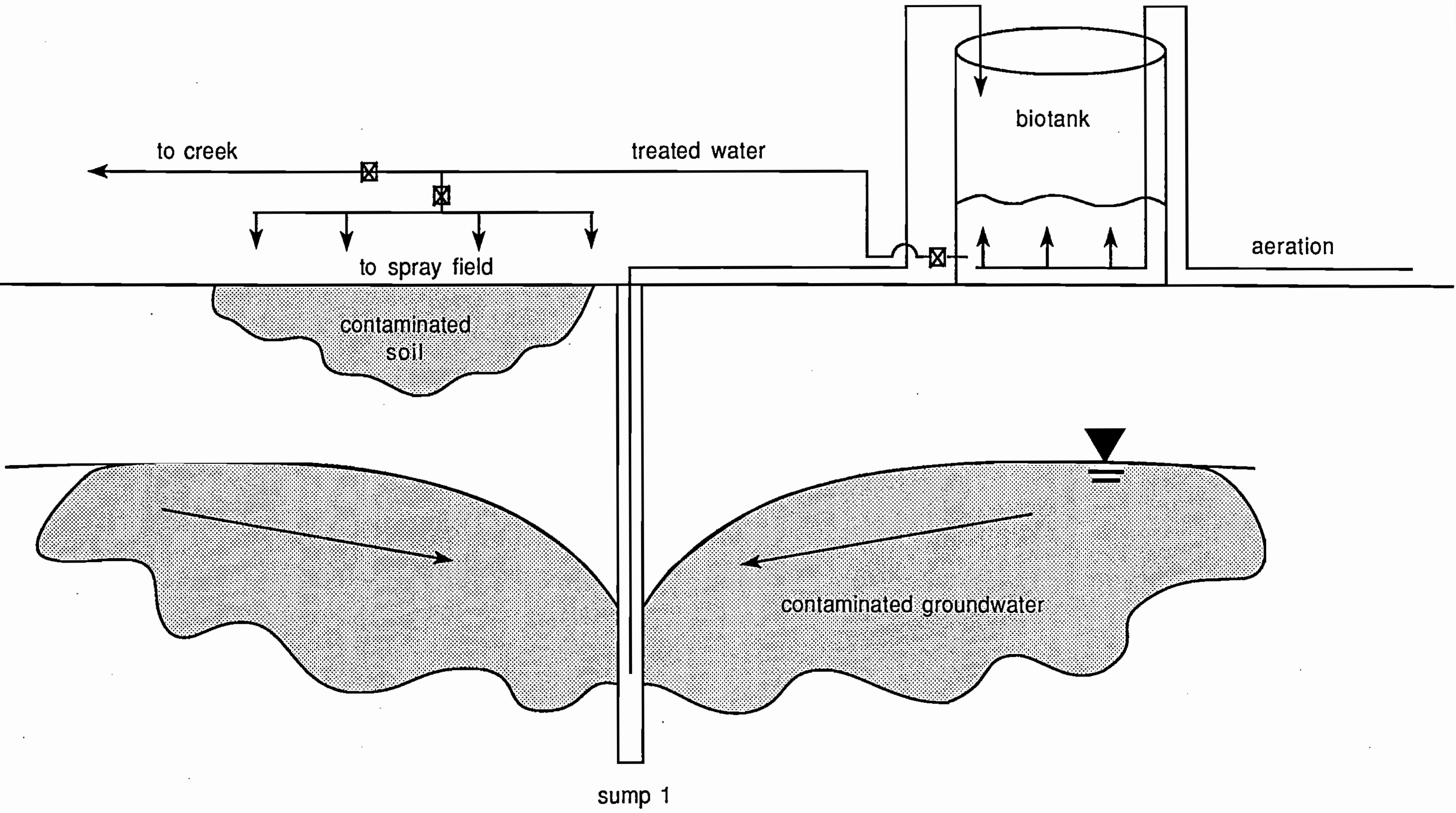


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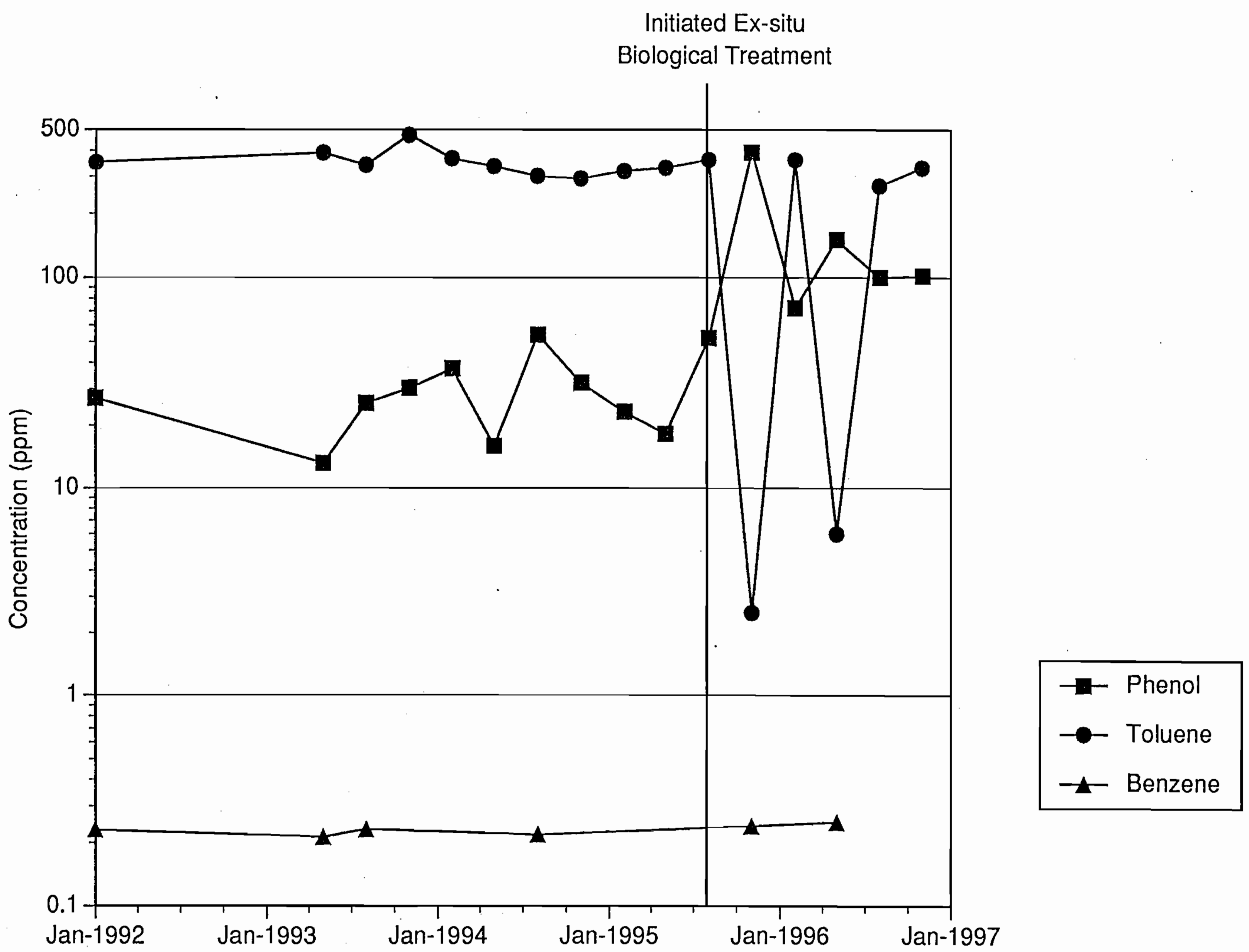
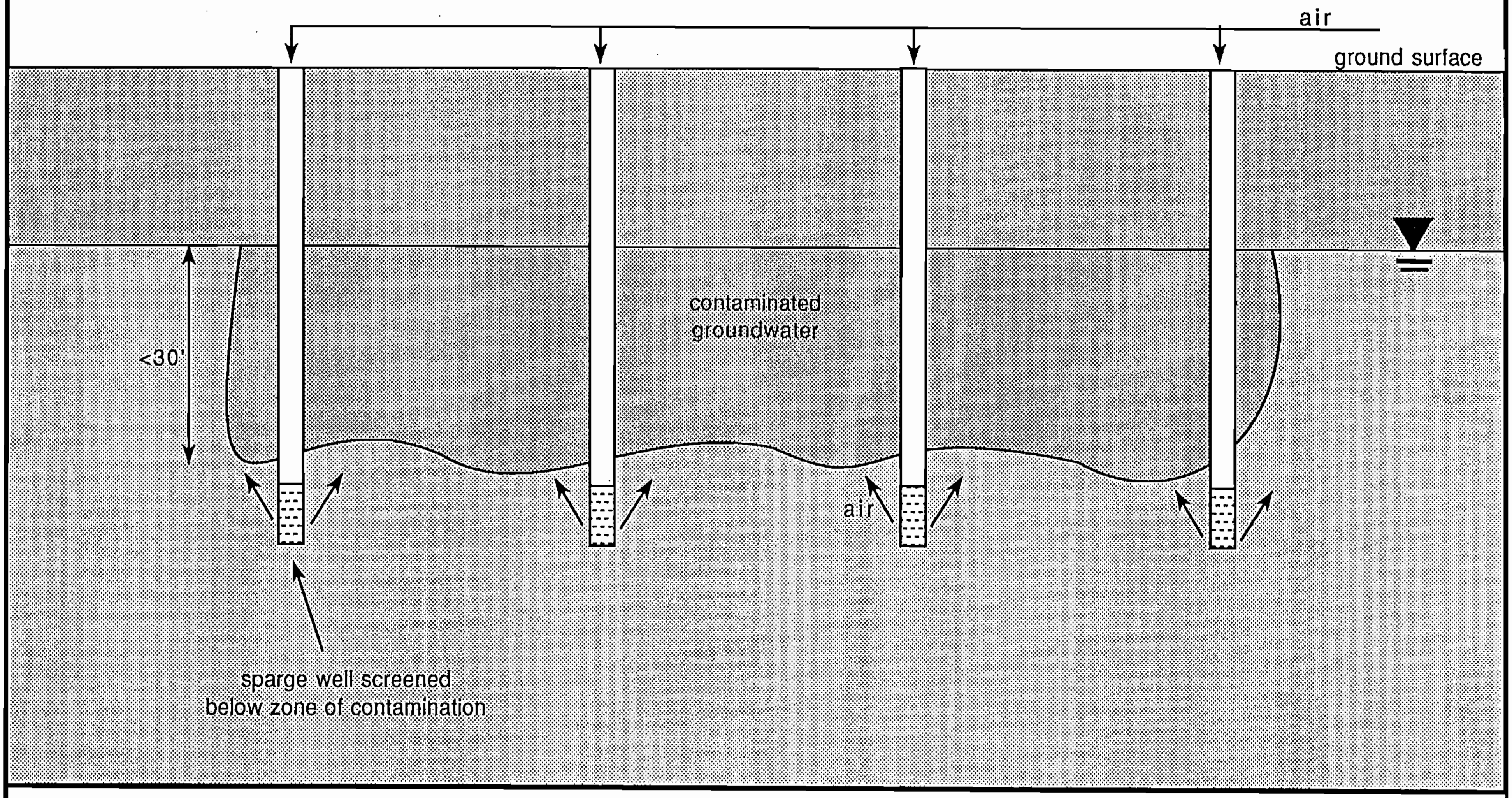
FIGURE 12
SCHEMATIC DIAGRAM OF EX-SITU BIOLOGICAL TREATMENT SYSTEM

T. M. GATES, INC.



Borden - Bainbridge, New York
Figure 13
Contaminant Concentration Trend at MW-29



BORDEN - BAINBRIDGE, NEW YORK
FIGURE 14
SCHEMATIC DIAGRAM OF IN-SITU BIOREMEDIATION SYSTEM

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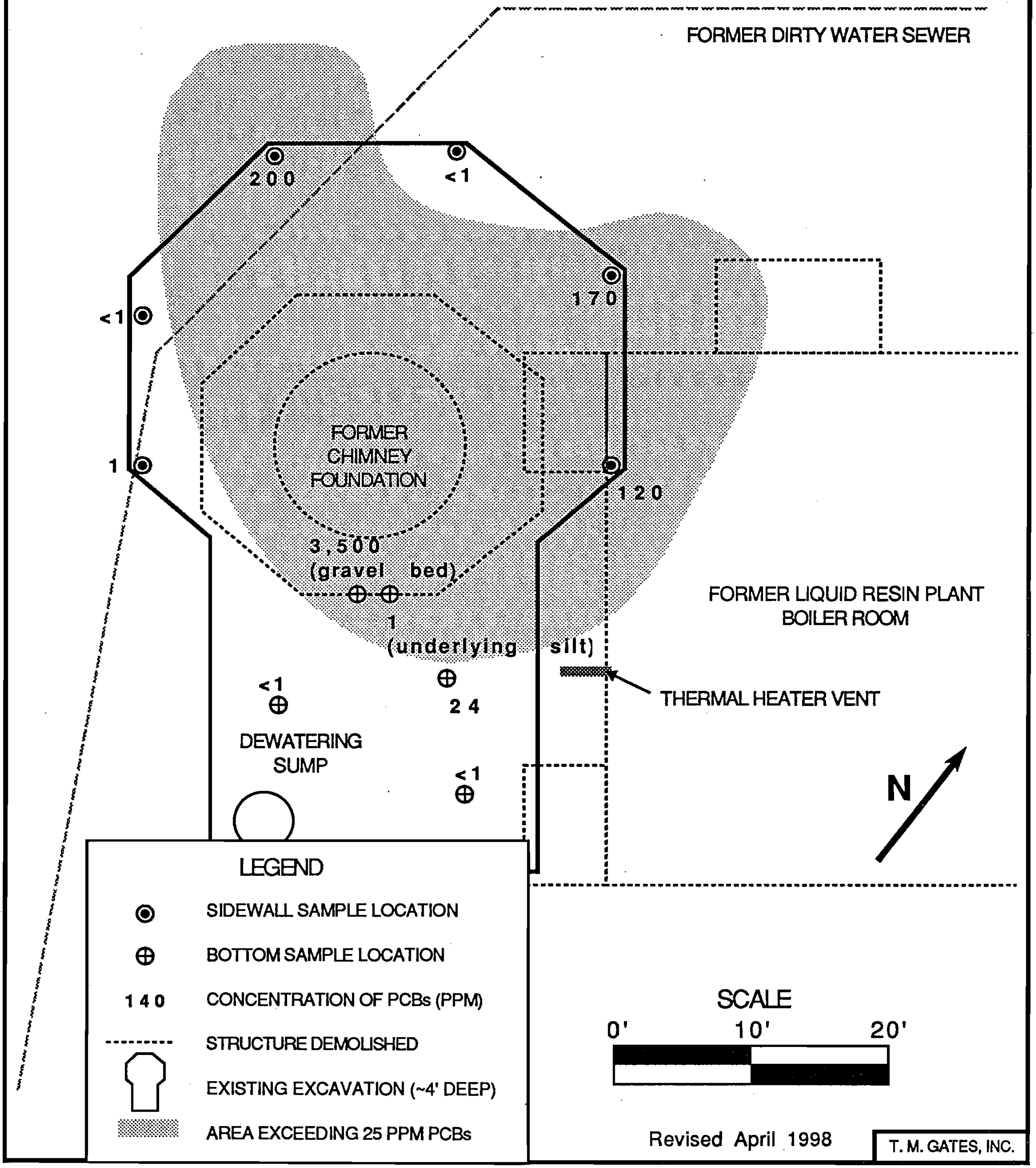
BORDEN, INC. - BAINBRIDGE, NEW YORK
FIGURE 15
EXISTING PCB CONCENTRATIONS AT THE PCB AREA



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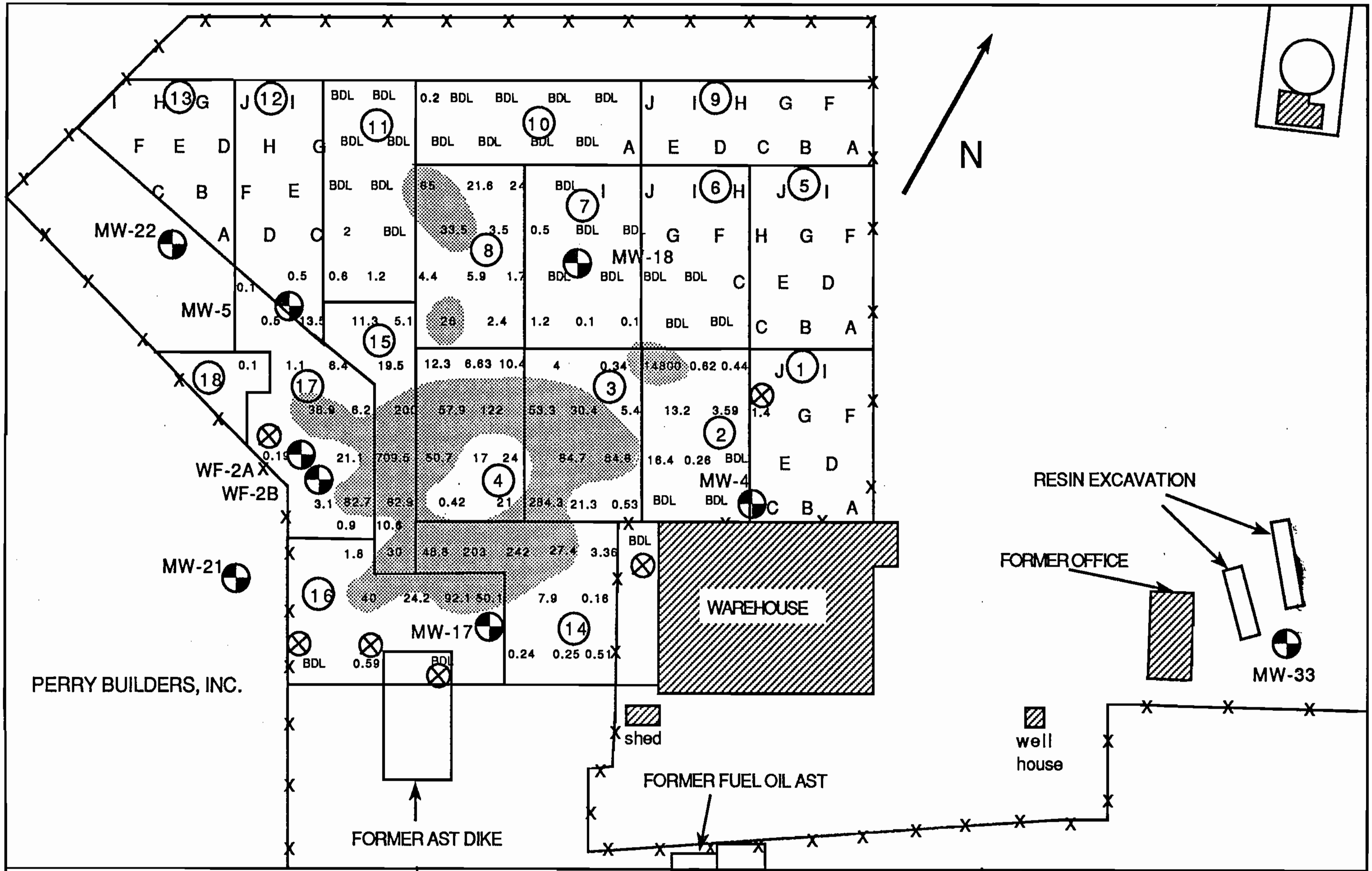

LEGEND

- (11) Grid Section Number
- K Soil Sample Location
- ⊗ RFI Phase II Soil Boring
- 21.1 Highest PCB Concentration within Boring
- ▒ Area Exceeding 25 PPM PCBs

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FIGURE 16
HIGHEST PCB CONCENTRATIONS AND AREA EXCEEDING 25 PPM PCBs BONEYARD

SCALE

0' 50' 100' 200'

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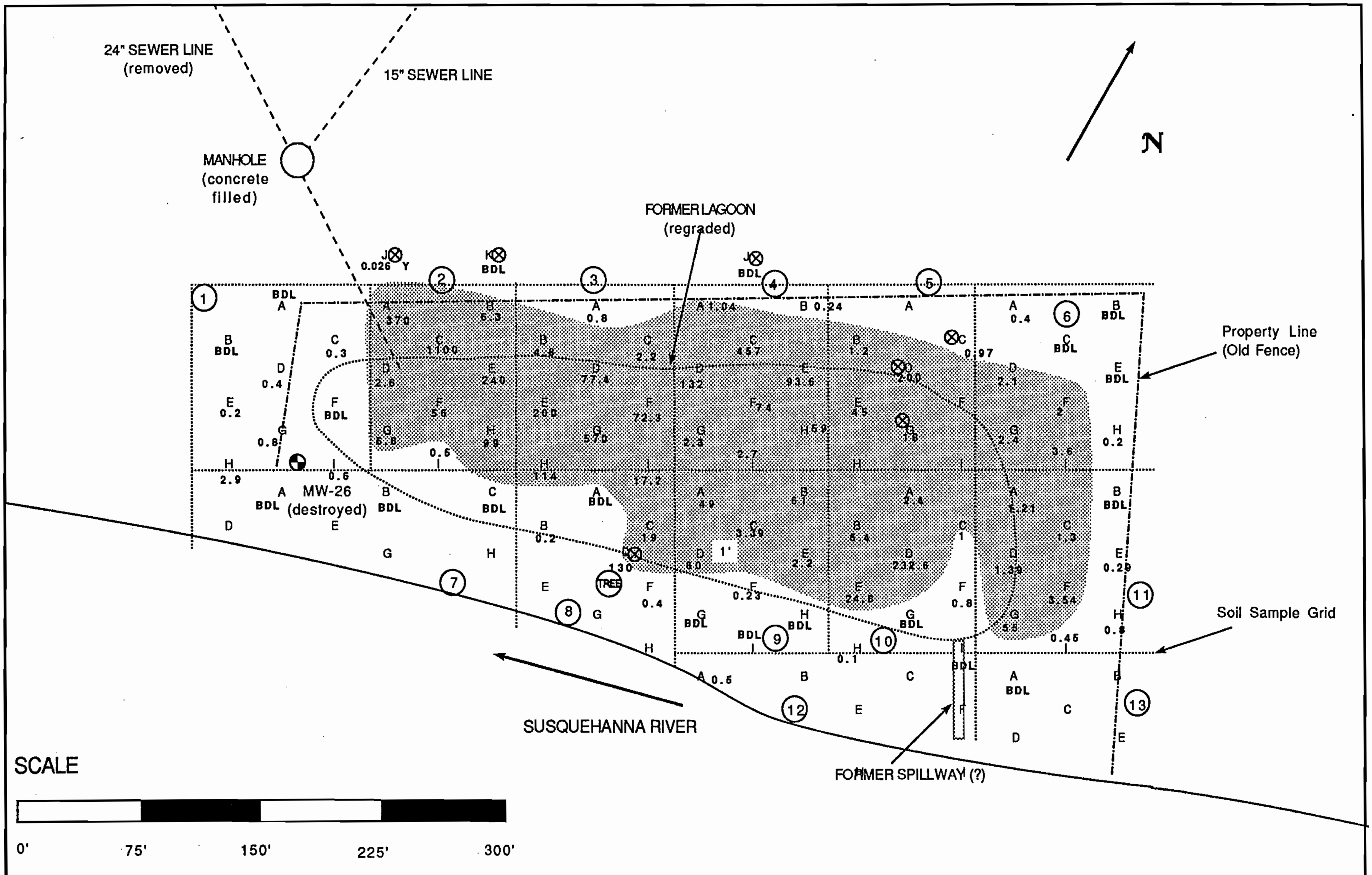
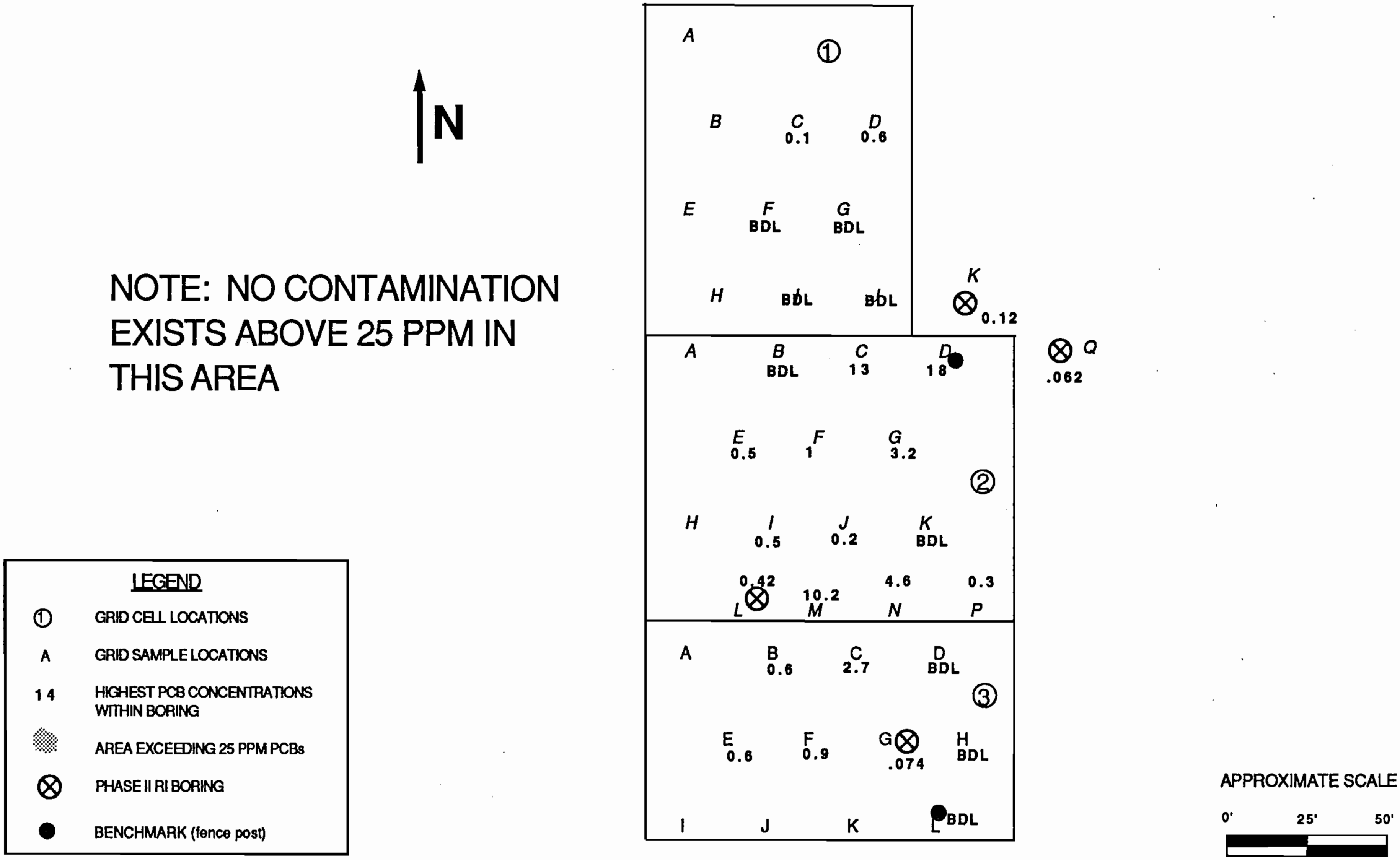


LEGEND

- ④ GRID SECTION NUMBER
- ⊗ PHASE II RFI SAMPLING LOCATION
- F GRID SAMPLE LOCATION
- 9 9 HIGHEST PCB CONCENTRATION WITHIN BORING
- ▨ AREA EXCEDING 1 PPM PCBs

BORDEN - BAINBRIDGE, NEW YORK
FIGURE 17
HIGHEST PCB CONCENTRATIONS AND THE AREA EXCEEDING ONE PPM PCBs RIVER LAGOON

T. M. GATES, INC.



NOTE: NO CONTAMINATION EXISTS ABOVE 25 PPM IN THIS AREA

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FIGURE 18
HIGHEST PCB CONCENTRATIONS AND
AREAS EXCEEDING 25 PPM PCBs
NORTH LAND APPLICATION AREA

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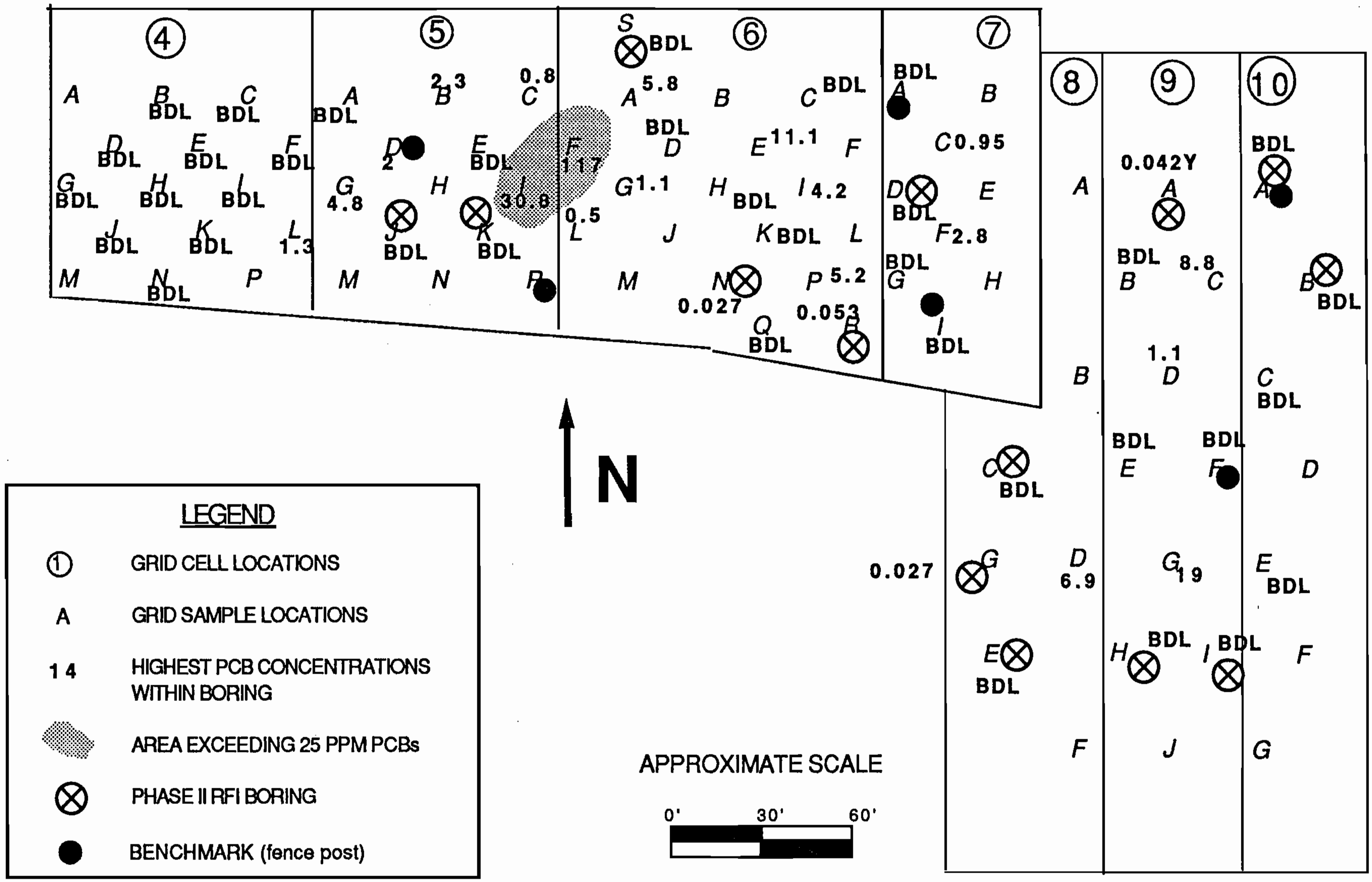

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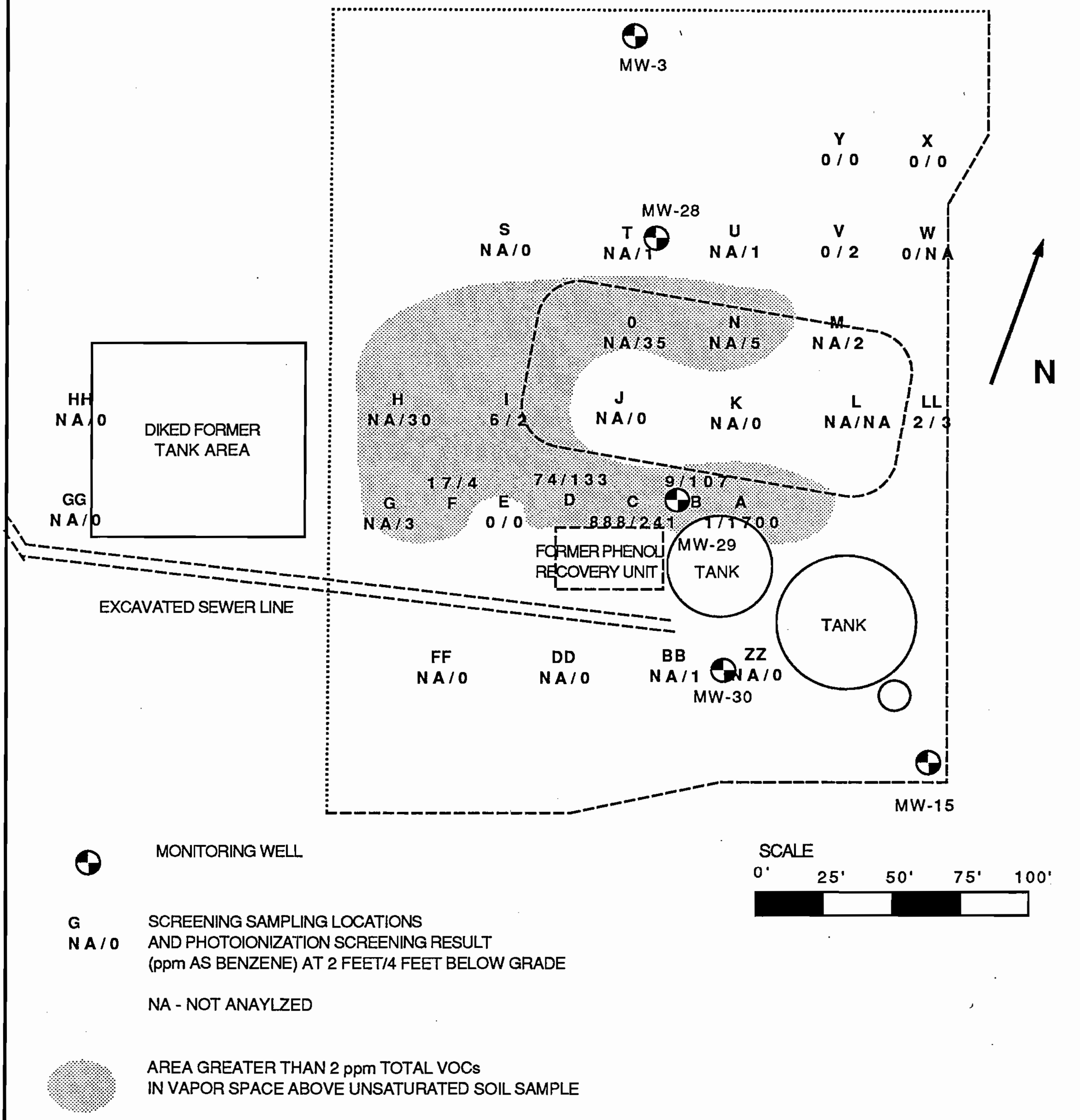
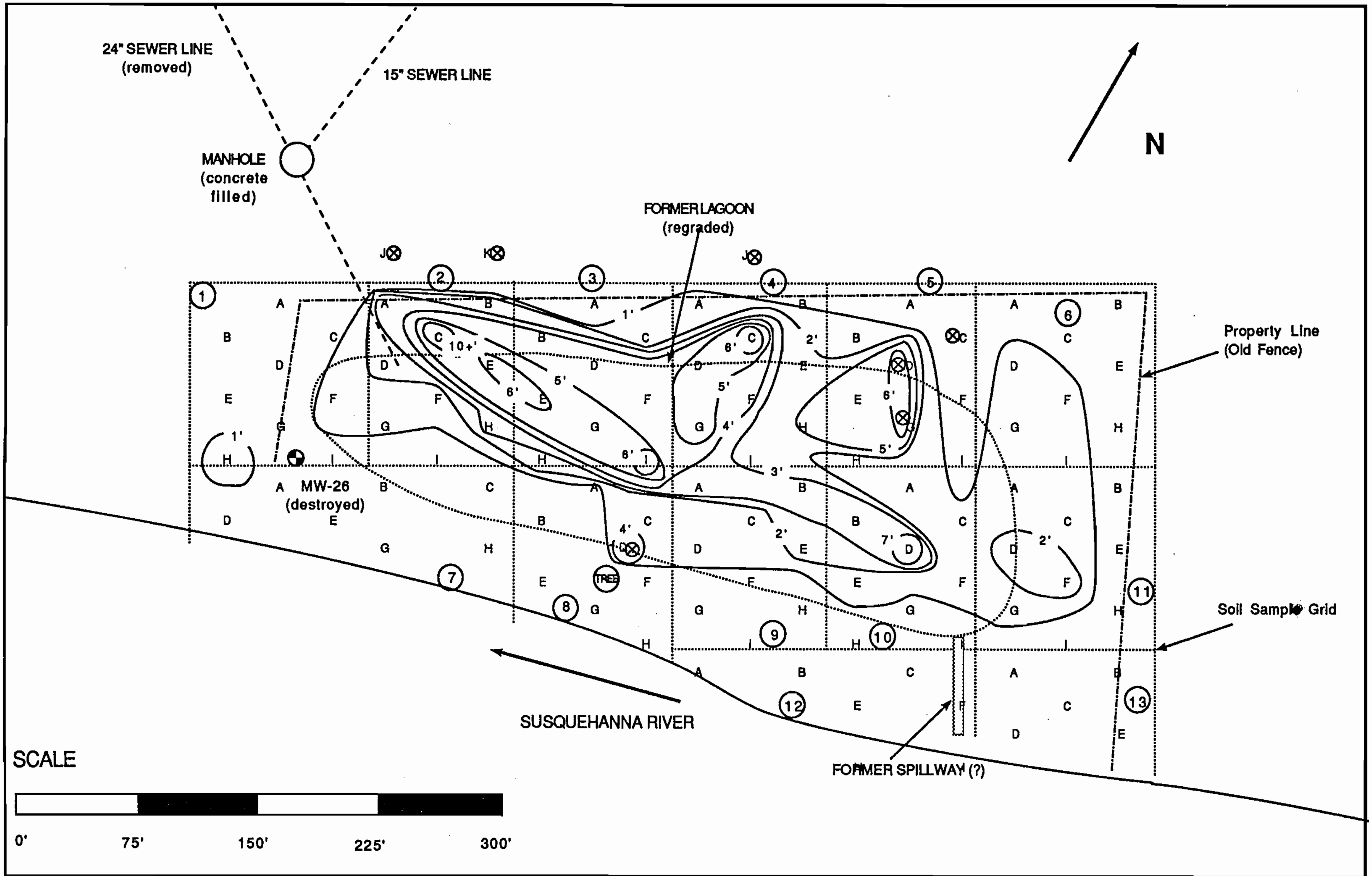
BORDEN, INC. - BAINBRIDGE, NY
FIGURE 19
HIGHEST PCB CONCENTRATIONS AND
AREA EXCEEDING 25 PPM PCBs
CENTRAL AND SOUTH TRENCHES OF THE LAND APPLICATION AREA

T.M .Gates, Inc.

BORDEN, INC. - BAINBRIDGE, NEW YORK
FIGURE 20
UNSATURATED SOIL SAMPLING LOCATIONS AND SCREENING RESULTS
PHENOL RECOVERY AREA



T. M. GATES, INC.



LEGEND

- ④ GRID SECTION NUMBER
- ⊗ PHASE II RFI SAMPLING LOCATION
- F GRID SAMPLE LOCATION
- 3' ONE PPM ISOPLETH AT GIVEN DEPTH

BORDEN - BAINBRIDGE, NEW YORK
FIGURE 21
DEPTH TO WHICH CONTAMINATION EXCEEDS ONE PPM RIVER LAGOON

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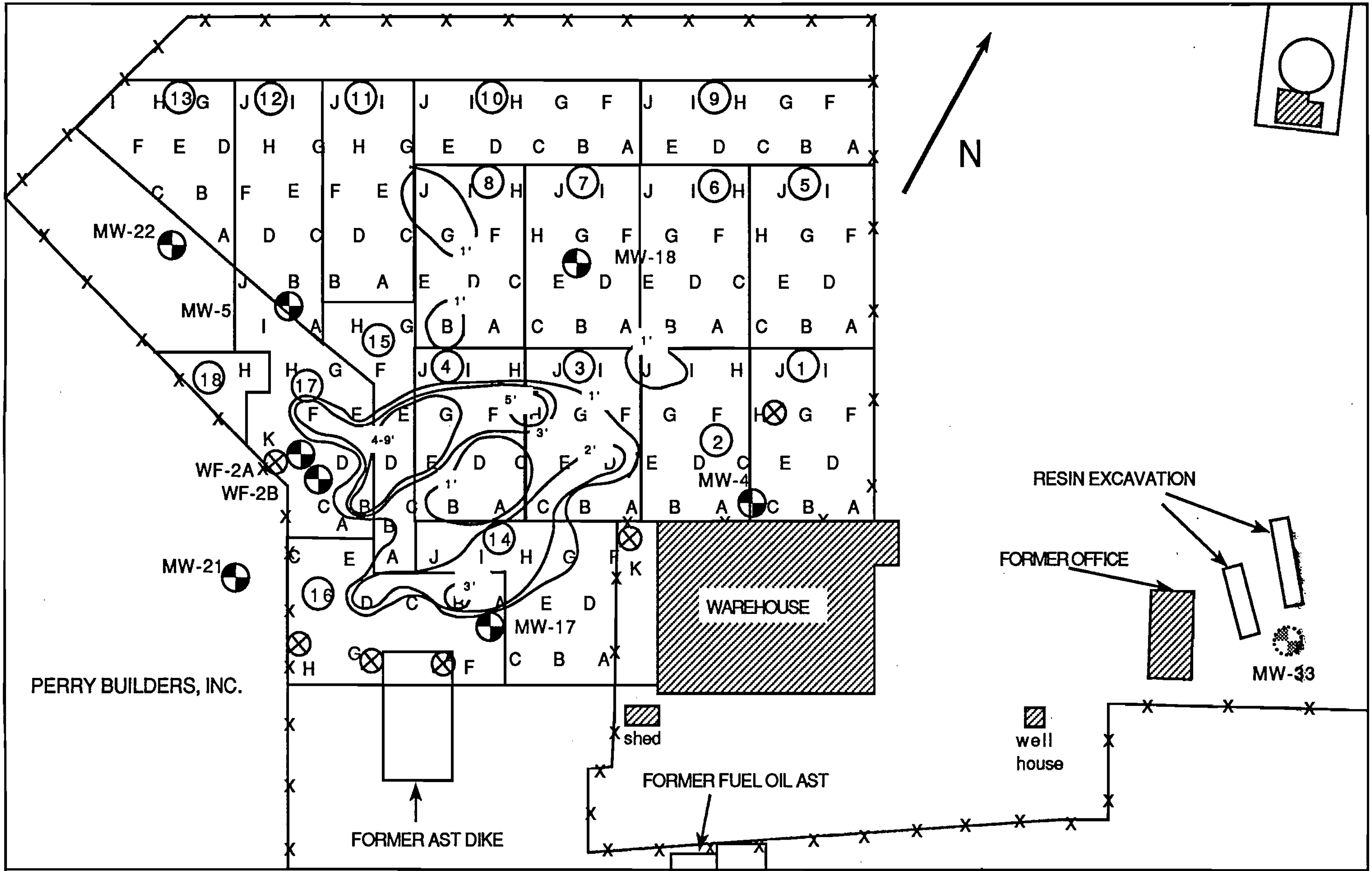

LEGEND

- ⑪ Grid Section Number
- K Soil Sample Location
- ⊗ RFI Phase II Soil Boring
- 3' 25 PPM Isopleth at Given Depth (in feet)

BORDEN - BAINBRIDGE, NEW YORK
FIGURE 22
DEPTH TO WHICH CONTAMINATION EXCEEDS 25 PPM
BONEYARD

SCALE

0' 50' 100' 200'

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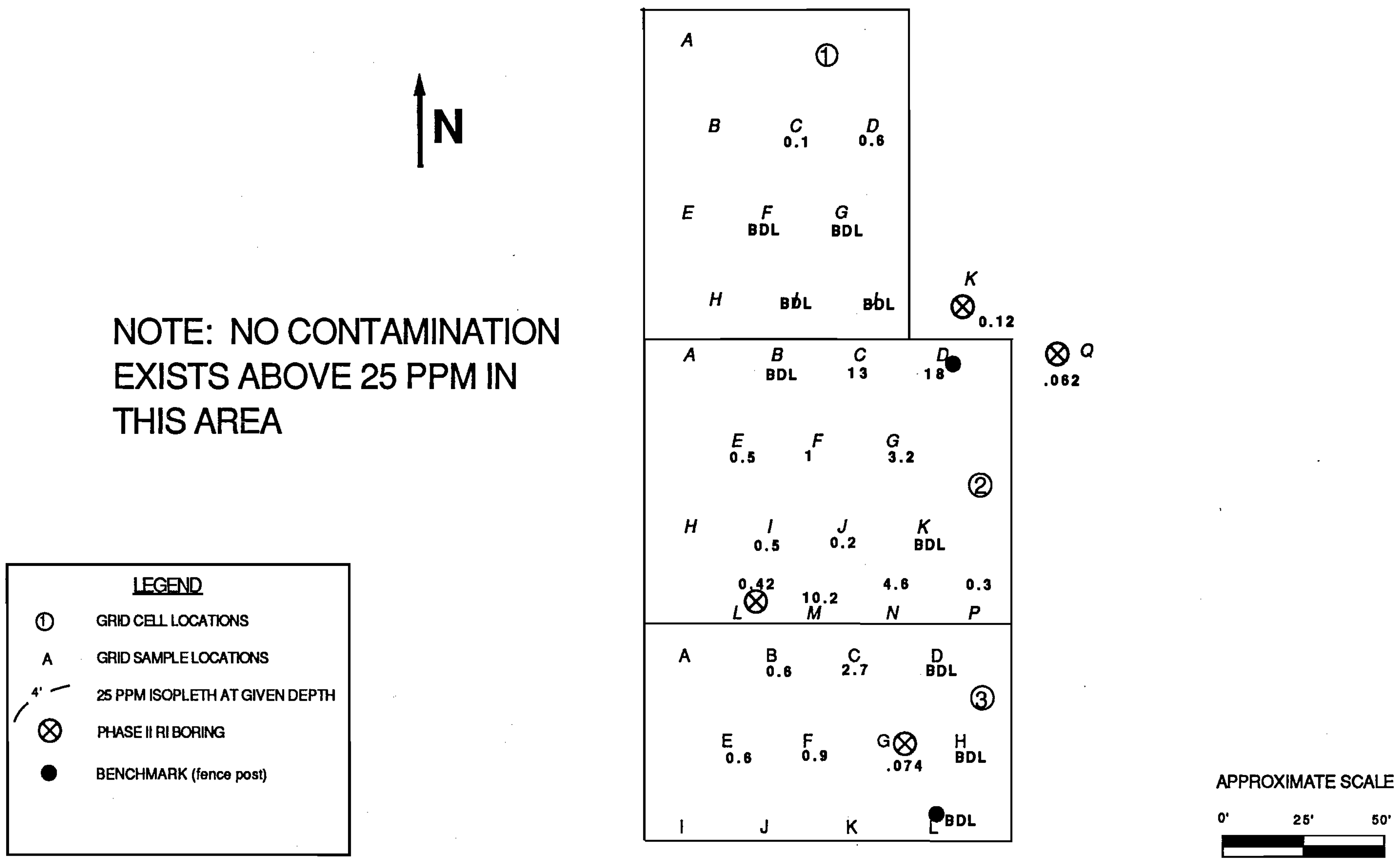

BORDEN, INC. - BAINBRIDGE, NEW YORK
FIGURE 23
DEPTH TO WHICH CONTAMINATION
EXCEEDS 25 PPM
NORTH LAND APPLICATION AREA

Revised April 1998

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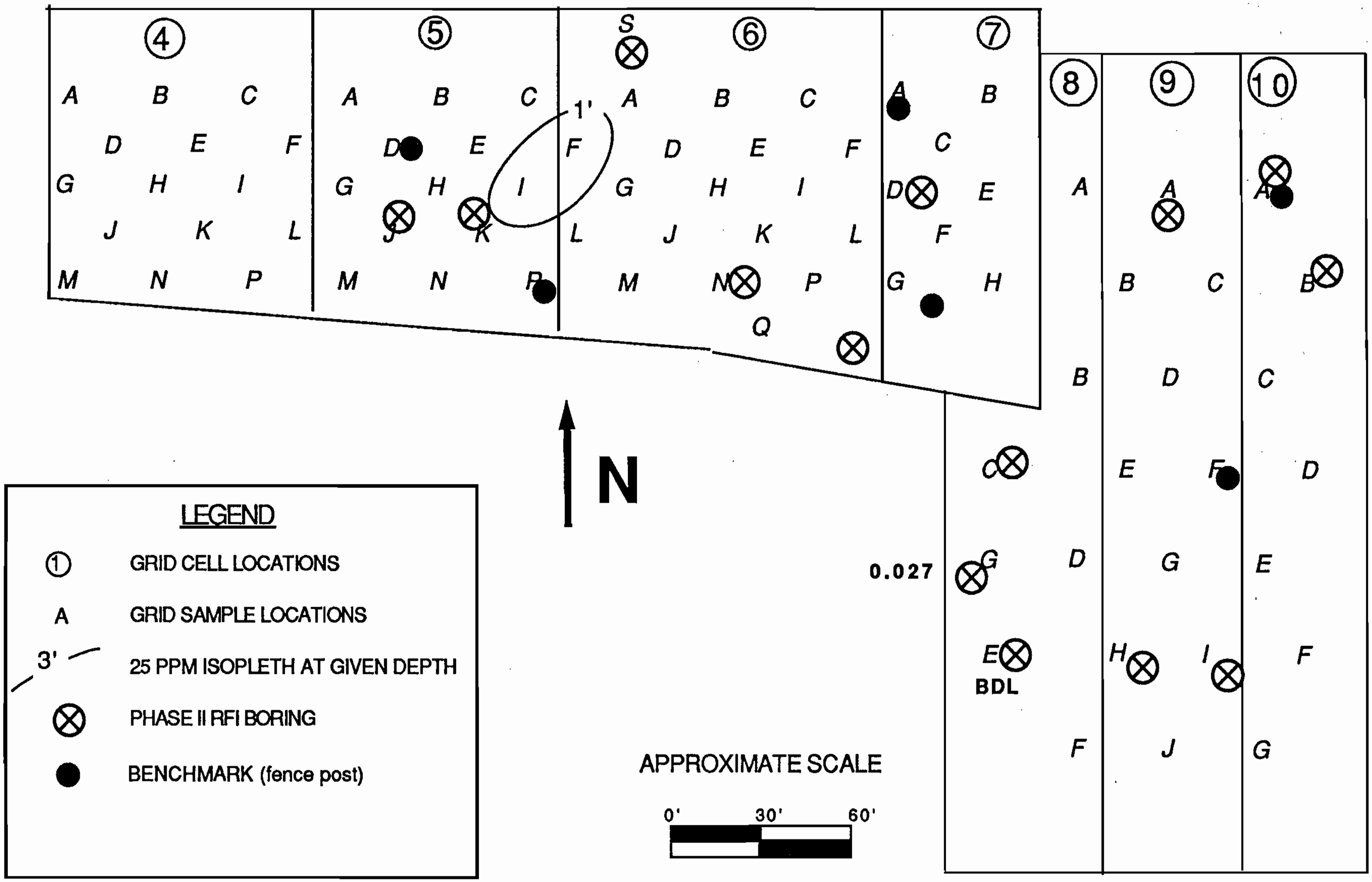

BORDEN, INC. - BAINBRIDGE, NY
FIGURE 24
DEPTH TO WHICH
CONTAMINATION EXCEEDS 25 PPM
CENTRAL AND SOUTH TRENCHES OF THE LAND APPLICATION AREA

Revised April 1998

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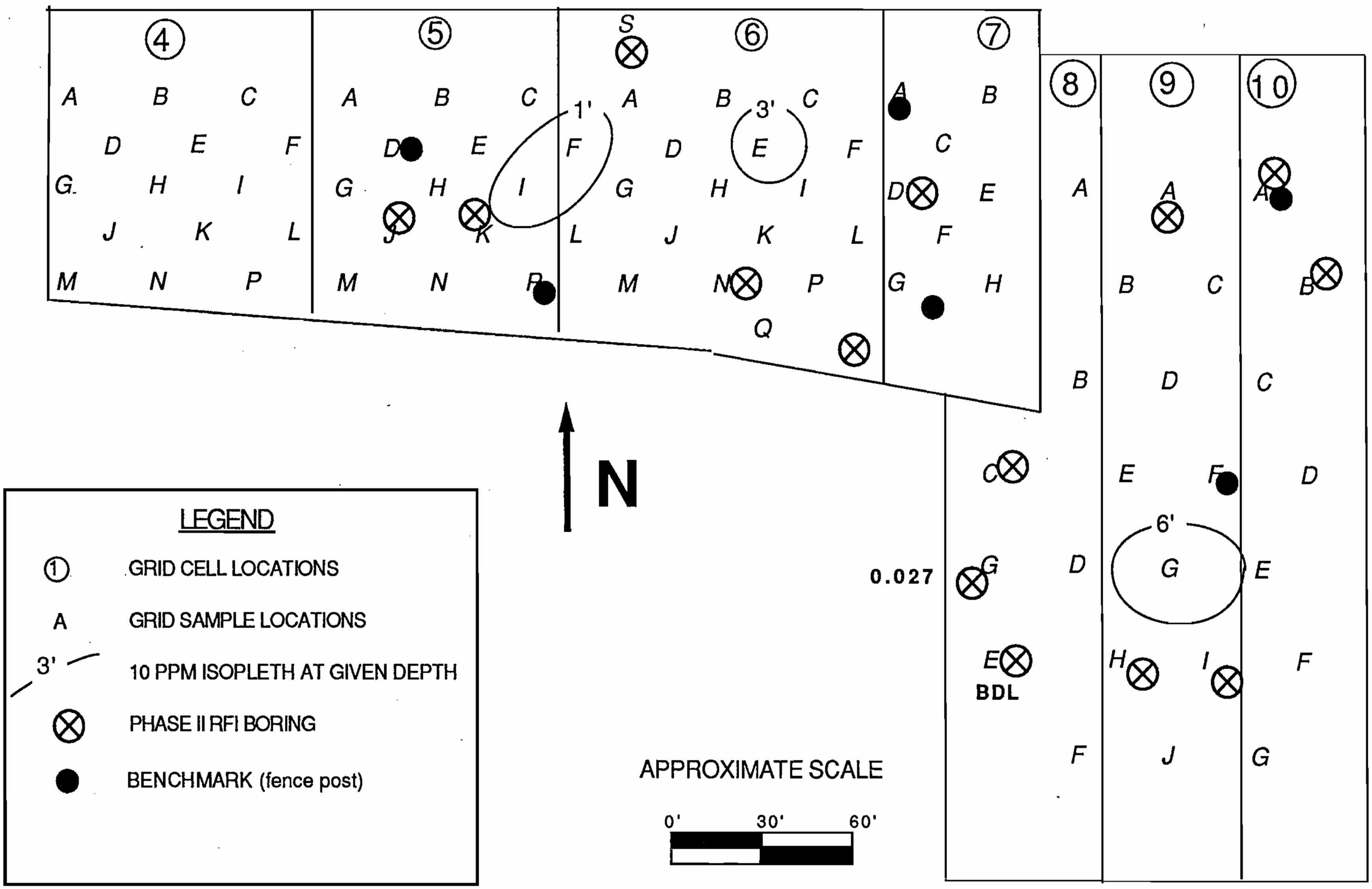
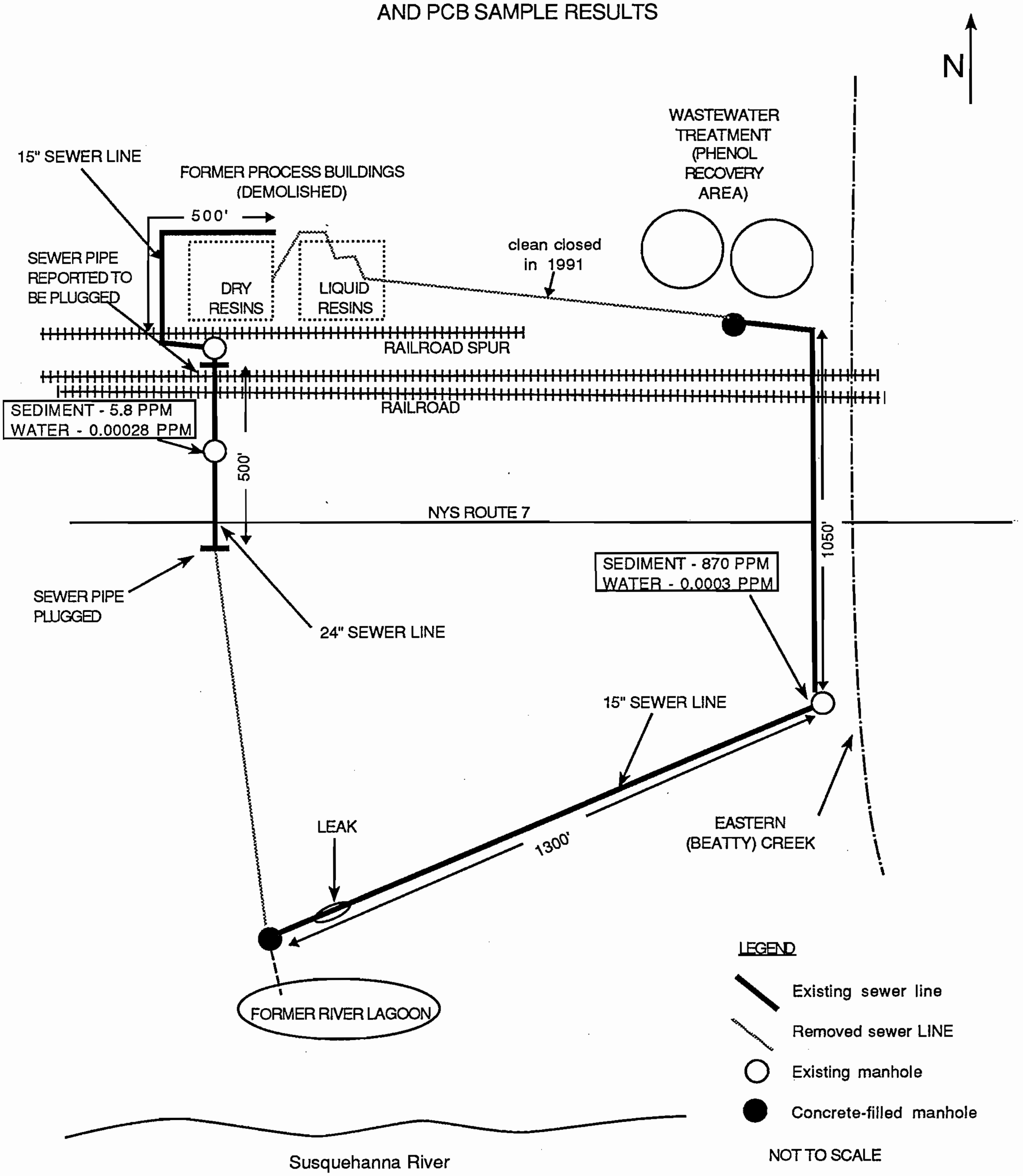


BORDEN, INC. - BAINBRIDGE, NY
FIGURE 24
DEPTH TO WHICH
CONTAMINATION EXCEEDS 10 PPM
CENTRAL AND SOUTH TRENCHES OF THE LAND APPLICATION AREA

T.M .Gates, Inc.

BORDEN, INC. - BAINBRIDGE, NEW YORK
FIGURE 25
FORMER RESIN PLANT WASTEWATER SEWERS AND PCB SAMPLE RESULTS



T. M. Gates, Inc.

BORDEN, INC. - BAINBRIDGE, NEW YORK
TABLE 1
CHRONOLOGIES OF CORRECTIVE ACTIONS COMPLETED THROUGH DECEMBER 1996

SWMU	YEAR(S)	ACTIVITY	DISPOSITION OF WASTES
River Lagoon	1983	Re-graded (filled) lagoon with berm material	Not applicable
Bone Yard	1981	Disposed of 630 tons of stockpiled waste resin	Haz, Non-haz landfills, or Reclamation
	1981	Excavated 275 tons of buried resin and contaminated soil	Hazardous waste landfill
	1981	Biologically treated 500,000 gallons (est'd) of contaminated groundwater	Re-applied to land surface
Phenol Recovery Area	1982-83	Excavated 100 tons of contaminated soil from former lined surface impoundment	Hazardous waste landfill
	1981-90	Biologically treated 4,000,000 gallons (est'd) of contaminated groundwater	Re-applied to land surface
	1991	Excavated 35 tons of contaminated soil from former lined surface impoundment	Non-hazardous waste landfill (1995)
	1995-96	Biologically treated 2,000,000 gallons of contaminated groundwater	Re-applied to land surface and/or discharged to creek
	1996	Removed 10 tons of sludge, debris from IRM tank	Non-hazardous waste landfill
	1996	Carbon treated 250,000 gallons of PCB-water in former bio-tank	Re-applied to land surface
	1996	Removed 42 tons of PCB sludge from former bio-tank	Off-site incineration
PCB Area	1983	Cleaned and removed all PCB Equipment	Incinerated PCB oils
	1987	Excavated 225 tons of contaminated soil	Hazardous waste landfill
	1995	Excavated 270 tons of contaminated soil and stack foundation	Hazardous waste landfill (1996)
PCB Sewers	1991	Excavated 250 tons of contaminated soil and sewer tile	Haz, Non-haz landfills (1995-96)
Resin Excavations	1993	Excavated 530 tons of buried resin and contaminated soil	Non-hazardous waste landfill (1995)
Gasoline UST	1991	Removed UST and aerated excavation spoils	Returned to excavation after testing
Paraformaldehyde Fire	1987	Disposed of 65 tons of waste resin and contaminated soil	Hazardous waste landfill

BORDEN, INC. - BAINBRIDGE, NEW YORK
TABLE 2
SUMMARY OF GROUNDWATER QUALITY ANALYSIS - NOVEMBER 1996

	New York Groundwater Standards	U.S.EPA Drinking Water Standards	Phenol Recovery Area														
			MW-3	MW-15	MW-15D	MW-19	MW-27	MW-28	MW-29	MW-29D	MW-30	MW-33	MW-34	SUMP 2	SUMP 3	INFLUENT	TRIP BLANK
Formaldehyde			< 0.0083	0.016	<0.0083	<0.0083	< 0.0083	0.027	2.100	<0.0083	< 0.0083	< 0.0083	<0.0083	0.013	0.010	<0.0083	
PCBs	0.0001		< 0.0001	< 0.0001	<0.0001	< 0.0001	< 0.0001	<0.0001	< 0.0001	<0.0001	< 0.0001	< 0.0001	< 0.0001	<0.00011	<0.0001	0.00024	
Phenolics																	
2,4-Dimethylphenol			<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD D	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD D	
2-Methylphenol			<LOD	<LOD	<LOD	<LOD	<LOD	0.0007 Y	1.8 D	0.016	<LOD	<LOD	<LOD	<LOD	<LOD	0.049 D	
3- and 4-Methylphenol			<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.9 D	0.031	<LOD	<LOD	<LOD	<LOD	<LOD	0.0370 YD	
2-Nitrophenol			<LOD	<LOD	<LOD	0.039	<LOD	<LOD	<LOD D	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD D	
4-Nitrophenol			<LOD	<LOD	<LOD	0.011	<LOD	<LOD	<LOD D	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD D	
Phenol			<LOD	<LOD	<LOD	<LOD	<LOD	0.0021 Y	98 D	0.460 D	<LOD	<LOD	<LOD	<LOD	<LOD	0.910 D	
Total phenols	0.001		<LOD	<LOD	<LOD	0.05	<LOD	0.0028	101.7	0.507	<LOD	<LOD	<LOD	<LOD	<LOD	0.996	
SVTICs																	
Benzene, (1-methylethyl)-				0.007 JN				0.028 JN									
Benzene, 1-methyl-2-propyl								0.011 JN									
Benzene, (2-methyl-1-propeny								0.006 JN									
2,3-Benzofurandione				0.005 JN													
Caprolactam				0.016 JN	0.044 JN	0.022 JN				0.018 JN			0.005 JN				
2,4,6-Cycloheptatrien-1-one				0.006 JN						0.120 JN							
2-Heptanone									0.460 JN								
3-Heptanone, 5-ethyl-4-methy								0.011 JN									
Methyl Isobutyl Ketone									0.770 JN								
3-Methyl-4-octanone									0.300 JN								
3-Pentanone				0.010 JN													
3-Penten-2-one, 4-methyl									0.390 JN								
Phenol, 2-[(4-hydroxyphenyl)															0.005 JN	0.081 JN	
Phenol, 2,3-dimethyl															0.006 JN		
Phenol, 2,6-dimethyl-								0.017 JN									
Phenol, 2,2'-methylenebis-				0.008 JN				0.020 JN	4.900 JN	0.008 JN							
Phenol, 4,4'-methylenebis-								0.035 JN	8.800 JN	0.015 JN					0.015 JN	0.160 JN	
Phenol, 4,4'-methylenebis[2,				0.007 JN											0.004 JN		
Phenol, 4-(1-methyl-1-phenyl								0.023 JN									
Phenol, 4-phenoxy								0.007 JN									
Phenol, 4-(1,1,3,3-tetrameth				0.0018 JN													
2-Propanol, 1-chloro-3-pheno								0.008 JN									
Salicylic Acid									0.670 JN								
Salicyl Alcohol									0.450 JN								
Unknown Aromatic Compound								0.009 J									
Unknowns				2.110 J		0.030 J	0.032 J	1.068 J	79.300 J	0.014 J				0.322 J	0.397 J	1.160 J	
Total				2.1708	0.044	0.052	0.032	1.243	96.04	0.175			0.005	0.322	0.427	1.401	
Volatile Organics (8021)																	
Benzene	0.0007		<LOD	0.012	<LOQ	0.0017	0.0017	0.0051	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0013	0.00097	<LOQD	<LOQ
sec-Butylbenzene			<LOD	0.005	<LOQ	<LOQ	<LOQ	0.028	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0024	0.0012	<LOQD	<LOQ
Carbon Tetrachloride	0.005	0.005	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQ
Chlorobenzene		0.1 (proposed)	<LOD	0.009	<LOQ	<LOQ	0.0011	0.030	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0047	0.0039	<LOQD	<LOQ
Chloroform	0.007		<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQD	0.00074	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	0.00095
1,2-Dichlorobenzene	0.0047 (total 1,2- and 1,4-)		<LOD	0.002 J	<LOQ	<LOQ	<LOQ	0.0029	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0014	0.0011	<LOQD	<LOQ
1,3-Dichlorobenzene			<LOD	0.0008 J	<LOQ	<LOQ	<LOQ	0.0013	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQ
1,4-Dichlorobenzene	0.0047 (total 1,2- and 1,4-)		<LOD	0.003 J	<LOQ	<LOQ	<LOQ	0.0047	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0030	0.0028	<LOQD	<LOQ
1,2-Dichloroethane		0.005	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQ
cis-1,2-Dichloroethene			<LOD	<LOD	<LOQ	<LOQ	<LOQ	0.00067	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	<LOQ	0.00068	<LOQD	<LOQ
Dichloromethane (Methylene Chloride)			<LOD	<LOD	0.0019	0.0021	<LOQ	0.0019	<LOQD	<LOQD	0.001	0.0019	<LOQ	<LOQ	<LOQ	<LOQD	0.0011
Ethylbenzene		0.7	<LOD	0.005	<LOQ	<LOQ	<LOQ	0.0026	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.012	0.0020	<LOQD	<LOQ
Isopropylbenzene			<LOD	0.008	<LOQ	<LOQ	<LOQ	0.037	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0032	0.0018	<LOQD	<LOQ
Methyl-Tert-Butyl-Ether			<LOD	NA	<LOQ	0.0012	<LOQ	0.0025	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0012	<LOQ	<LOQD	<LOQ
Napthalene			<LOD	0.001 J	<LOQ	<LOQ	<LOQ	0.018	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.0031	0.0025	<LOQD	<LOQ
Toluene		1	<LOD	0.031	<LOQ	<LOQ	<LOQ	0.0021	330 D	0.110 D	<LOQ	<LOQ	<LOQ	0.014	0.0011	1.700	<LOQ
1,2,4-Trimethylbenzene			<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQD	0.00043	<LOQ	<LOQ	0.00052	0.00050	<LOQD	<LOQ
1,3,5-Trimethylbenzene			<LOD	<LOD	<LOQ	<LOQ	<LOQ	0.0016	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQD	<LOQ
Xylene (total)		10	<LOD	0.003 JX	<LOQ	<LOQ	<LOQ	5.0	<LOQD	<LOQD	<LOQ	<LOQ	<LOQ	0.00046	<LOQ	<LOQD	<LOQ
Total			<LOD	0.0798	0.0019	0.005	0.0028	5.13837	330	0.11	0.00217	0.0019	<LOQ	0.04728	0.01855	1.7	0.00205
VOA TICs																	
Benzofuran, 2-methyl-								0.006 JN									
Cyclotetrasiloxane, octamethyl							0.005 JN										
Nonanal				0.005 JN													
Unknown				0.069 JN				0.037 JN			0.025 JN			0.015 JN	0.005 JN	0.008 JN	
Total				0.074			0.005	0.043			0.025			0.015	0.005	0.008	

NOTES: All Concentrations in Parts Per Million (mg/l)
Summary includes only compounds detected in one or more samples.
NA - Not Analyzed
▢ - Exceeds Standard

<LOD = Less than Limit of Detection
<LOQ = Less than Limit of Quantation
D = Concentration determined from a diluted analysis
Y = Compound Concentration Value between LOD and LOQ

J - Concentration below detection limit, but tentatively identified.
N - Compound compared to a mass spectrometer library.
X - Concentration estimated.

BORDEN, INC. - BAINBRIDGE, NEW YORK
TABLE 3
SUMMARY OF GROUNDWATER QUALITY ANALYSIS - NOVEMBER 1996
INORGANICS AND DISSOLVED OXYGEN

		New York Groundwater Standards	U.S.EPA Drinking Water Standards						Phenol Recovery Area								
				MW-3	MW-15	MW-15D	MW-19	MW-27	MW-28	MW-29	MW-29D	MW-30	MW-33	MW-34	SUMP 2	SUMP 3	INFLUENT
	Nitrate			0.476	0.169	0.290	NA	<0.05	0.266	<0.05	0.063 Y	NA	NA	0.897	NA	NA	NA
	Sulfate			8.11	2.40 Y	15.46	NA	12.72	<1.0	3.93	9.67	NA	NA	26.30	NA	NA	NA
Metals	Fe			1.43	35.4	82.9	NA	14.9	64.0	3.01	14.6	NA	NA	311	NA	NA	NA
	As		0.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Pb		0.015	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dissolved Oxygen			8.7	3.6	2.6	6.1	2.9	3.1	5.0	2.9	4.2	5.0	8.4	3.2	3.2	5.4

NOTES: All Concentrations In Parts Per Million (mg/l)
NA = Not Analyzed
Y = Compound concentration between Limit of Detection and Limit of Quantitation

BORDEN, INC. - BAINBRIDGE, NEW YORK
TABLE 4
SUMMARY OF IRM BATCH GROUNDWATER TREATMENT

BATCH	START DATE/DTW (FT)	END DATE/DTW (FT)	VOLUME TREATED (GAL)	TIME TO FILL (DAYS)	COLLECTION RATE (GPM)	EFFLUENT DISCHARGED TO	COMMENT	INFLUENT * CONCENTRATION (ppm)
1	6/27/95 13.4	8/14/95 2.3	319,680	48	5	SF		Phenol - 18 Toluene - 8.2 Total - 26.2
2	6/28/96 14.4	7/5/96 2.3	348,480	7	35	SW/SF	High collection rate due to rain and re-application of tank vol	
3	7/25/96 11.4	8/5/96 2.3	262,080	11	17	SW/SF		
4	8/14/96 13.3	9/24/96 2.3	316,800	41	5	SW/SF		
5	10/4/96 11.4	11/4/96 2.2	264,960	31	6	SW		
6	11/19/96 10.1	12/2/96 2.1	230,400	13	12	SW	Acid-treated sump prior to collection	Phenol - 0.996 Toluene - 1.7 Total - 2.7
7	12/12/96 11.4	12/30/96 2.1	267,840	18	10	SW		
		TOTAL:	2,010,240					
		AVERAGE:		24	13			14.5

NOTES: DTW - Depth to water surface from top of tank. Total tank depth is 14.4'. Tank capacity is 28,800 gal/ft.
SF - Discharged to Spray Field at 5 to 10 gpm.
SW - Discharged to Surface Water at approximately 200 gpm.
* - Primary constituents only.

BORDEN - BAINBRIDGE, NEW YORK
TABLE 5
SELECTION CRITERIA VALUES FOR CORRECTIVE MEASURES ADDRESSING GROUNDWATER CONTAMINATION

Alternative	Estimated Time Required (yrs)	O & M Requirements	Monitoring Requirements	Estimated Relative Life-Cycle Cost	Other
Ex-situ Bio-treatment	12	Relatively High	Effluent - monthly for 12 years Groundwater - semi-annually for 14 years	1.9	Creates capture zone; re-application addresses soil contamination
In-situ Bio-treatment	7	Relatively Low	Groundwater - semi-annually for 9 years	1.0	--
Intrinsic Biodegradation	30	None	Groundwater - semi-annually for 30 years	2.3	--
Combination Ex-situ/in-situ	6	Relatively High	Effluent - monthly for 10 years Groundwater - semi-annually for 8 years	1.3	Creates capture zone; re-application addresses soil contamination

BORDEN, INC. - BAINBRIDGE, NEW YORK
TABLE 6
PCB-SOIL REMEDIAL TECHNOLOGY SCREENING RESULTS

TECHNOLOGY	U.S.EPA "DEVELOPMENT STATUS"	REGULATORY STATUS	SCREENING RESULT
CHEMICAL WASTE LANDFILL (HAZ OR NON-HAZ AS NECESSARY)	ESTABLISHED	40 CFR 761.61	FAVORED
INCINERATION	ESTABLISHED	40 CFR 761.61	FAVORED
THERMAL DESORPTION	DEMONSTRATED	N/A	CONTINUED
CHEMICAL DEHALOGENATION	DEMONSTRATED	N/A	CONTINUED
SOLVENT EXTRACTION	DEMONSTRATED	PROPOSED 40 CFR 761.61 (non-chlorinated, non-thermal)	FAVORED
SOIL WASHING	DEMONSTRATED	N/A	ELIMINATED
SOLIDIFICATION/STABILIZATION (MICROENCAPSULATION)	EMERGING	PROPOSED 40 CFR 761.61 (Ex-situ, off-site disposal only)	ELIMINATED
BIOREMEDIATION	EMERGING	N/A	ELIMINATED
VITRIFICATION	EMERGING	PROPOSED 40 CFR 761.61	ELIMINATED
ON-SITE CAPPING	NOT CLASSIFIED	PROPOSED 40 CFR 761.61	ELIMINATED

BORDEN, INC. - BAINBRIDGE, NEW YORK
TABLE 7
SUMMARY OF SUITABILITY AND COSTS OF SELECTED TECHNOLOGIES

TECHNOLOGY	VENDOR	SUITABLE FOR BAINBRIDGE SITE?	REPORTED COST (VISITT) ($/TON) (1)	QUOTED COST ($/TON) (1)
HAZ WASTE LANDFILL	CHEM WASTE MGMT	YES - USED FOR IRM	N/A	169 (3) (4)
NON-HAZ WASTE LANDFILL	BFI	YES - USED FOR IRM	N/A	60 (3)
INCINERATION	LAIDLAW	NO - TOO EXPENSIVE	N/A	1440
	CHEM WASTE MGMT	NO - TOO EXPENSIVE	N/A	820 (3)
	ROLLINS	NO - TOO EXPENSIVE	N/A	2000
CHEMICAL DEHALOGENATION	SDTX TECHNOLOGY	YES - FULL SCALE IN NY	100-300	NO RESPONSE
	COMMODORE APPLIED TECH.	? - NOT FULLY COMMERICIAL BUT NAT'L TSCA PERMIT	NOT REPORTED	> OR = 170
	DELPHI RESEARCH	NO - TOO EXPENSIVE	2270-9080	NOT PURSUED
	HIGH VOLTAGE ENVIRON. APPLI	NO - LIQUID ONLY	NOT REPORTED	NOT PURSUED
SOLVENT EXTRACTION	RESOURCES CONSERV. CO.	YES - PILOT SCALE IN NY	100-400	>300
	TERRA-KLEEN RESP. GROUP	YES - NAT'L TSCA PERMIT	130-900	150
	SRE, INC.	NO - NOT FOR >50 PPM PCBS	30-50	NOT PURSUED
THERMAL DESORPTION	RECYCLING SCIENCE INT'L	YES - FULL SCALE FOR PCBS	61-89	NO RESPONSE
	THEROTECH SYSTEMS	YES - FULL SCALE FOR PCBS	15-30	NOT PURSUED
	WESTINGHOUSE REMED. SERV.	NO - TOO EXPENSIVE	150-300	EX: $225 FOR 7,500 TONS
	RUST INTERNATIONAL	NO - TOO EXPENSIVE	125-225	EX: $175 FOR 50,000 TONS
	MAXYMILLIAN TECHNOLOGIES	YES - FULL SCALE IN NY	70-150	135 (2)
	COVENANT ENVIRON. TECH.	NO - REQUIRES PREPROCESS	100-800	NOT PURSUED
	REMEDIATION TECHNOLOGIES	NO - REQUIRES PREPROCESS	100-600	NOT PURSUED
	SOILTECH ATP SYSTEMS	YES - FULL SCALE IN NY	120-400	> $200 PLUS $1MM MOB

NOTES:
(1) - EXCLUDES SOIL EXCAVATION, HANDLING, AND BACKFILL
(2) - COST APPLICABLE ONLY FOR ALL (HAZ AND NON-HAZ) SOIL
(3) - INCLUDES TRANSPORTATION
(4) - QUOTE FOR 3,300 TONS. SMALL QUANTITIES $250/TON
BOLD - "FAVORED" TECHNOLOGIES FROM TABLE 6

BORDEN - BAINBRIDGE, NEW YORK
TABLE 8
SELECTION CRITERIA VALUES FOR CORRECTIVE MEASURES ADDRESSING PCB-SOIL CONTAMINATION

Alternative	Estimated Relative Life-Cycle Cost	Advantages	Disadvantages
Hazardous and Non-hazardous Landfilling	1.00	No permitting Site experience Quickest	Long-term liability
Hazardous Solvent Extraction and Non-hazardous Off-site Landfilling	0.97	National TSCA permit Reduced long-term liability	Lack of site experience Higher logistical requirements
Hazardous and Non-hazardous Thermal Desorption	1.58	Reduced long-term liability	May be permitting difficulty Lack of site experience Higher logistical requirements