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The leachate collection system will discharge into the on-site sewer system subject to the approval of the Woonsocket Wastewater Treatment Plant, the Town of North Smithfield, and upon meeting all pretreatment and monitoring requirements. Based on the chemical characteristics of the leachate currently being generated in the landfill it appears that the leachate will meet pretreatment standards without requiring any additional treatment. In the event that the physical characteristics of the leachate change as a result of capping or the POTW refuses to accept the leachate, a laboratory-scale treatability study will be performed to determine the cost effectiveness of pretreatment of the leachate and the feasibility of on-site versus off-site disposal.

The landfill cap design will be consistent with the State and Federal closure requirements for a RCRA facility. At a minimum, the cap will consist of a multi-layer system composed of a vegetative topsoil layer and a subsurface drainage layer overlying a low-permeability barrier of clay and synthetic liner material. The details of the materials of construction, the thickness of the layers, and the groundwater monitoring system will be established during the remedial design phase.

Capping of the landfill will also require the protection of landfill side slopes still within the floodplain of the Branch River; the extension of existing manholes up to the new surface of the cap; and may require the installation of a passive gas collection system. The gas collection system, if determined to be necessary during design, will consist of small-diameter PVC pipe placed in a network of shallow trenches backfilled with crushed stone. The trenches will be located within the intermediate cover layer below the final cover. Because of the small size of the landfill, the quantity of gases expected to be generated will be minimal. The potential for emissions and necessary treatment, if any, for any gases collected will be evaluated during the design phase. Sections of the southern side slope of the landfill which would still be subject to the effects of Branch River flooding would be further protected by covering with stone (i.e., rip-rap) once the cap is in place. The existing manholes which provide access to the sewer line travelling roughly diagonally across the landfill would be raised and incorporated into the final design of the cap.

The groundwater extraction system will consist of a number of wells installed on-site into the bedrock. Many of the design details of the extraction system and its associated groundwater monitoring system, including the specific number of wells, depth, pumping rates, and locations, will be defined upon completion of a predesign pump test. Extracted groundwater will be treated on-site using the innovative ultraviolet light and hydrogen peroxide (UV/hydrogen peroxide) technology.

Prior to treatment, the extracted groundwater will undergo pretreatment to remove suspended solids and some inorganic metals. Based on the results of an initial laboratory treatability study conducted with groundwater from the Site, pretreatment will consist of a pressure filtration system. Further laboratory bench-scale or pilot-scale

testing will be conducted during predesign to determine the effectiveness of pressure filtration for removing suspended solids. In the event that testing indicates the need for further pretreatment, either to meet groundwater cleanup ARARS or disposal ARARs for treated groundwater, additional laboratory bench-scale or pilot testing will be completed. It is not anticipated that the need for additional pretreatment will change the selected remedy since this additional pretreatment would be necessary for all of the groundwater treatment alternatives that were considered.

The UV/hydrogen peroxide system consists of a self-enclosed unit having the dimensions of 2x3x5 feet and a 300 gallon high density polyethylene (HDPE) storage tank for hydrogen peroxide. The treatment unit including the storage tank will be constructed within a bermed area. This innovative technology uses ultraviolet light to react with hydrogen peroxide and form hydroxyl radicals which react with and destroy organic contaminants. The technology has been proven to be very effective in destroying chlorinated solvents in a limited number of full-scale operations. A bench-scale laboratory test was performed as well during the FS using groundwater from the Site and it was determined that TCE levels were reduced to below cleanup levels in approximately three minutes. The only residuals produced are carbon dioxide, water, and small amounts of free chlorides which react with minerals in the water to form simple salts.

In order to further test the effectiveness of this innovative technology, a pilot test will be conducted at the Site during predesign activities. Groundwater extracted during the predesign pump test will be treated on-site using full-scale equipment and the results will be used to make a final determination on the effectiveness of this technology to achieve cleanup levels. In the event that this innovative technology is not found to be effective in achieving the groundwater cleanup levels, EPA will select air-stripping with GAC and vapor phase carbon as the treatment technology for removal of TCE and other VOCs from the groundwater.

The results of the predesign groundwater treatment pilot test will also be used to make a final determination on how treated groundwater will be disposed of. Currently the options being considered are on-site surface water discharge, disposal via on-site sewer hookup to an off-site POTW, and on-site subsurface discharge. EPA prefers the first option, on-site surface water discharge, but will review the results of the pilot test and determine if all state discharge requirements which have been identified as ARARs will be met before making a final determination.

Although attaining drinking water quality standards within a reasonable time frame is the desired cleanup goal, groundwater contamination may be especially persistent in the bedrock aquifer beneath the Site. Therefore, periodic review and modification of the design, construction, maintenance, and operation of the groundwater extraction and treatment system as well as the monitoring system may be necessary. A complete

evaluation of the performance of the system will be made within five years of the start up of the groundwater treatment system to determine if the goals and standards of the design criteria are being met. If the evaluation reveals that the remedy cannot achieve the stated cleanup levels, or that the cleanup levels cannot be achieved within a reasonable time frame, consideration will be given to making changes in the remedy.

After the cleanup levels have been met and the remedy is determined to be protective, the groundwater extraction and treatment system will be shut down. The groundwater monitoring system will continue to be utilized to collect information quarterly for three years after the shut down date to ensure that the cleanup levels have been met and the remedy is protective. Once these levels are maintained and the remedy is protective for three years after the shut down date, an additional monitoring program for the Site in accordance with Rhode Island Hazardous and Solid Waste rules will be implemented.

The Site, which has remained vacant since a fire destroyed the mill building in 1977, is covered with rubble, piles of debris, and foundation remains, including a deteriorating smoke stack. These structures will be demolished and removed prior to the implementation of other remedial activities to insure the health and safety of workers on-site. The wood and metal materials found in the demolition debris as well as in the existing debris piles will be removed and disposed of off-site in accordance with Rhode Island Solid Waste Rules. Construction materials of an earthen nature will be disposed of on-site. Engineering controls will be used to limit the generation of dust during demolition.

The inlets and outlets of both raceways will be sealed with concrete barrier walls to stop the flow of water across the Site and into the Branch River. The inlet barriers will be constructed prior to the backfilling of the raceways to reduce the need for dewatering. Temporary coffer dams may be installed to allow for the construction of cast in place concrete walls at the inlets and outlets. The details of the construction of the barrier walls will be established during the remedial design phase. The construction of an additional concrete barriers in the raceways directly upgradient of the landfill will also be considered as a means of reducing the flow of water through the landfill in the event that there is evidence of a continued flow through the old raceway after the raceway entrance has been sealed.

Sections of both raceways will be backfilled using suitable clean fill material. The roof of the raceways will be collapsed or demolished using heavy equipment and this material will be deposited in the open raceway. The material placed in the raceways will be compacted and brought to the original grade. The old raceway will be backfilled from the inlet to a point just before it goes through the landfill. Information derived from the RI indicates that sections of the old raceway in the landfill area are already collapsed. The new raceway will be backfilled along its full length.

Once the Site is cleared of piles of debris and large vegetation, it is anticipated that the septic tank can be located. Any materials remaining in the tank will be tested and the proper disposal will be determined based upon the sampling results. The tank will then be backfilled or demolished depending on the condition of the tank.

At the conclusion of the remedial activities taking place on-site, the entire five acre site would be graded and covered with a vegetated soil covering. A program for increased site security and maintenance would be instituted which would involve the enhancement of the existing perimeter fencing and the mowing and maintenance of the vegetative cover. In addition, to maintain the overall protection of human health and the environment believed to be afforded by this remedy, institutional controls would be implemented. The institutional controls would be in the form of deed restrictions regulating land use at the Site and would be focused on preventing the disturbance of the physical integrity of many of the remedies components. EPA has proposed, in a consent decree lodged in federal court, institutional controls with the current owner -- Hydro-Manufacturing -- to protect the remedy.

To the extent required by law, EPA will review the Site at least once every five years after the initiation of remedial action at the Site if any hazardous substances, pollutants or contaminants remain at the Site to assure that the remedial action continues to protect human health and the environment. EPA will also evaluate risk posed by the Site at the completion of the remedial action (i.e., before the Site is proposed for deletion from the NPL).

XI. STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Stamina Mills Site is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, attains ARARs and is cost effective. The selected remedy also satisfies the statutory preference for treatment which permanently and significantly reduces the mobility, toxicity or volume of hazardous substances as a principal element. Additionally, the selected remedy utilizes alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

A. The Selected Remedy is Protective of Human Health and the Environment

The remedy at this Site will permanently reduce the risks posed to human health and the environment by eliminating, reducing or controlling exposures to human and environmental receptors through treatment, engineering controls, and institutional controls.

In-situ soil vacuum extraction will be used to treat one of the principal threats identified at the Site, the TCE spill area soils. The TCE spill area soils will be treated to levels which will not impact the groundwater above drinking water standards. Soil vacuum extraction will remove the contaminants from the spill area which continue to act as a

source of groundwater contamination by trapping them on activated carbon filters and then treating and disposing of the spent filters off-site.

Capping of the landfill will eliminate exposure to contaminants by direct contact and will control exposure from wind blown particles and surface runoff. Capping will also limit infiltration of precipitation and control leaching of contaminants into the groundwater and surface water. A leachate collection system will insure that contaminants from the landfill do not impact the groundwater or surface water. Capping is appropriate for the landfill wastes as they have been shown to pose a relatively low long-term threat.

The ultraviolet light and hydrogen peroxide (UV/hydrogen peroxide) system will be used to treat one of the principal threats identified at the Site, the contaminated groundwater plume. Contaminated groundwater extracted from the bedrock aquifer will be treated using this innovative technology thereby eliminating future exposure through ingestion by destroying the contaminants. The extraction system will be designed to draw the groundwater contaminant plume back within the Site boundaries and to prevent the further migration of contaminants beyond its current boundaries. The ultimate goal of the groundwater extraction and treatment remedy will be to prevent further contamination of the areas of the bedrock aquifer currently being used as a drinking water source and to return the areas which have been impacted by the contamination from the Site to their previous use as a drinking water source.

The overall Site alternative will remove the safety risks posed to the public and workers on-site implementing the remedy by eliminating the physical hazards at the Site. This alternative includes the demolition of the partially standing building, the smokestack, the collapsing substructures, and the removal of piles of debris. The overall Site alternative also will reduce the risks to the public and the environment posed by contaminants migrating through on-site raceways to the Branch River. Sealing the raceways will prevent exposure to contaminants through direct contact and also indirect exposure through the ingestion of fish tissue that may have ingested contaminants. The confirming of the septic tank location and the testing and removal of its contents will eliminate the future risks of the tank contaminating the groundwater. The use of engineering controls to address these activities is appropriate as the conditions described pose a relatively low long-term threat.

A long-term monitoring program will insure that the selected remedy for the Site remains protective of human health and the environment. This program will include groundwater monitoring and surface water and sediment monitoring in the Branch River. Institutional controls in the form of deed restrictions, will be used to control the future uses of the Site and will be focused on preventing the disturbance of the physical integrity of components of the remedy.

Finally, implementation of the selected remedy will not pose unacceptable short-term risks or cross-media impacts. The vacuum

extraction technology will be done in-situ and will not require any soil excavation. The landfill will only be minimally disturbed during cap construction and relocation of landfill wastes from the floodplain. The innovative technology being used to treat the groundwater destroys the contaminants and produces no additional waste streams. During implementation of the overall Site alternative, strict engineering controls will be used to minimize any harmful releases from on-site activities.

B. The Selected Remedy Attains ARARs

This remedy will attain all applicable or relevant and appropriate federal and state requirements that apply to the Site. The key environmental laws from which ARARs for the selected remedial action are derived, and the specific ARARs include:

Chemical-Specific

Rhode Island Rules and Regulations Pertaining to Public Drinking Water (R46-13-DWS)
Safe Drinking Water Act (SDWA)- Maximum Contaminant Levels (MCLs)
Safe Drinking Water Act (SDWA)- Maximum Contaminant Level Goals (MCLGs)
Rhode Island Water Quality Regulations for Water Pollution Control (R.I.G.L. 46-12, 42-17.1, 42-35)
Rhode Island Pollutant Discharge Elimination System (R.I.G.L. 46-12, 42-17, 42-35)
Clean Water Act (CWA)- Ambient Water Quality Criteria

Location-Specific

Rhode Island Freshwater Wetlands Act (R.I.G.L. 2-1-18-27)
Resource Conservation and Recovery Act (RCRA)[1]
Clean Water Act, Section 404
Fish and Wildlife Coordination Act
Clean Water Act (CWA)- Section 404 (Wetlands Protection)

Action-Specific

Rhode Island Hazardous Waste Generation, Transportation, Storage and Disposal Regulations (R.I.G.L. 23-19-1-10)
Rhode Island Solid Waste Management Regulations (R.I.G.L. 23-18.9, 23-19, 42-17.1)
Rhode Island Underground Injection Control Program (R.I.G.L. 42-17.1, 46-12)
Rhode Island Pretreatment Regulations (R.I.G.L. 46-12, 42-17.1, 42-45)
Rhode Island Air Pollution Control Regulations
Resource Conservation and Recovery Act (RCRA)[1]
DOT Rules for Transportation of Hazardous Materials
OSHA Health and Safety Standards
OSHA Record Keeping, Reporting and Related Regulations
Clean Air Act- National Emission Standards for Hazardous Air Pollutants (NESHAPs)

To-be-Considered

Rhode Island Draft Groundwater Classification Regulations (R.I.G.L. 46-13.1)
EPA Risk Reference Doses
EPA Carcinogen Assessment Group Potency Factors
Threshold Limit Values
OSWER Directive 9355.0-28
Executive Order 11988 (Floodplain Management Policy)
Executive Order 11990 (Wetlands Protection Policy)

[1] Rhode Island is a RCRA authorized State Program.

A more inclusive listing of ARARs can be found in tables 2-1, 2-3, and 2-4 of Section 2 of the FS. These tables, which are identified in Appendix B of this Record of Decision, as Tables 9, 10, and 11 respectively, list all potential ARARS identified for the Site and give brief synopses of the ARARs and explanations of the actions necessary to meet the ARARs. The tables also indicate whether the ARARs are applicable or relevant and appropriate to actions at the Site. In addition to ARARs, the tables describe standards that are To-Be-Considered (TBC) with respect to remedial actions.

Tables 5-1, 5-2, and 5-3 of Section 5 of the FS, which are included in Appendix B of this Record of Decision, as Tables 12, 13, and 14 respectively, list the identified ARARs for each alternative and note whether the ARARs will be attained by the alternative. The July 10, 1990 Addendum to the FS adds ARARs for a number of alternatives and deletes laws incorrectly described as ARARs for three alternatives. It is identified as Table 15 in Appendix B of this Record of Decision.

Applicable requirements are federal or state cleanup standards or standards of control that specifically address a hazardous substance, remedial action, location or other circumstance at a Superfund site. NCP at 40 CFR 300.5, Federal Register, Vol. 55, No. 46, March 8, 1990. Relevant and appropriate requirements are federal or state cleanup standards or standards of control that, although not "applicable" to the Superfund site, address situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. Id. TBCs are advisories, criteria or guidance that were developed by EPA, other federal agencies or states that may be useful in developing CERCLA remedies. Id. at 300.400.

Requirements that EPA found to be not legally applicable to remedial activities at the Stamina Mills Site, but either to be relevant and appropriate or TBC for these activities are discussed below. All other ARARs listed in the above-referenced tables are applicable to Site remedial action.

1. Chemical-Specific Relevant and Appropriate Requirements

SDWA MCLs and MCLGs are standards that apply to public water systems. Because the groundwater in the vicinity of Stamina Mills is used as a source of private residential drinking water, but is not a public water system as defined by the SDWA, MCLs and MCLGs are relevant and appropriate rather than applicable.

The Clean Water Act Federal Water Quality Criteria are non-enforceable federal guidelines developed under the Clean Water Act which are used by states to set water quality standards for surface water. Because contaminants are migrating from the Site to the Branch River, the criteria are relevant and appropriate to remedial action at the Site. In addition, the criteria would be relevant and appropriate to any discharge of treated effluent from the Site to the River.

The Rhode Island Rules and Regulations Pertaining to Public Drinking Water are intended to protect public drinking water sources. Although the groundwater below the Site is not a source of public drinking water as defined by these regulations, it is a source of private residential drinking water. The regulations are therefore relevant and appropriate to groundwater remediation at the Site.

2. Location-Specific Relevant and Appropriate Requirements

RCRA Location Requirements impose limitations on the storage, treatment, and disposal of RCRA hazardous wastes in 100-year floodplains. There are not, to EPA's knowledge, any RCRA hazardous wastes disposed of in the landfill on-site, including those areas of the landfill within the 100-year floodplain of the Branch River. Nonetheless, RCRA location requirements are relevant and appropriate because the landfill contains other hazardous substances. Remedial actions in the landfill should therefore be consistent with the requirements that RCRA establishes for activities affecting the 100-year floodplains and which are designed to be protective of human health and the environment.

Section 404 of the Clean Water Act (Pertaining to Wetlands) is not applicable because the Site in not a federal wetlands. Section 404 is relevant and appropriate, however, because remedial activities will take place in areas that are wetlands under state law. These activities, e.g., backfilling the raceways, should conform to the specific requirements that Section 404 imposes, to protect public health and the environment, on activities in federally designated wetlands.

3. Action-Specific Relevant and Appropriate Requirements

RCRA groundwater monitoring requirements are applicable for all of the groundwater treatment alternatives with the exception of GW-5, the no-action alternative, for which they are relevant and appropriate. The no-action alternative would not involve the treatment, storage, or disposal of the groundwater and therefore would not trigger RCRA applicability.

RCRA landfill requirements are relevant and appropriate based upon EPA's current information. This information indicates that although the landfill area contains no RCRA wastes, it does contain hazardous substances. One of the purposes of RCRA is to protect human health and the environment by providing for the safe storage, treatment, and disposal of hazardous materials. Because hazardous substances were disposed of in the on-site landfill, the circumstances at the Site are similar to those intended to be regulated by RCRA making RCRA landfill requirements relevant and appropriate. If EPA learns that the landfill does contain RCRA wastes, then EPA would consider RCRA landfill requirements to be applicable.

4. Chemical-Specific TBCs

The Draft Groundwater Classification System under the Rhode Island Groundwater Protection Act is a TBC because it has not been officially promulgated. If this classification is promulgated, it will be applicable to the Site. Under the Draft, the projected classification of the groundwater beneath the Site, with the exception of the landfill area, is GAA, non-attainment -- which would require restoration to drinking water standards. Promulgation of the Draft Classification would therefore not affect remediation because federal ARARs for the Site, i.e., SDWA MCLs and MCLGs, already require the groundwater to be remediated to drinking water standards.

5. Action-Specific TBCs

Executive Order 11988 (Floodplain Management) is a TBC because, it has no specific requirements that pertain to this Site. The Executive Order, however, is a TBC to the extent that is provides general guidance for remedial activities in a floodplain.

Executive Order 11990 (Wetlands Protection Policy) is not an ARAR because no parts of the Site meet the criteria of a federally designated wetlands. Parts of the Site, including areas where remedial activity will take place are, however, wetlands under the Rhode Island law. The Executive Order, therefore, will be considered to the extent that it provides guidance on wetlands not provided by the Rhode Island wetlands ARARs.

The Rhode Island Division of Air and Hazardous Materials Policy on permitting air strippers is a TBC because it is not a promulgated statute or regulation. It is a policy which is potentially useful to this CERCLA remedy.

It should be noted that although the Site lies within the Forestdale Historic District, which is listed on the National Register of Historic Places, The National Historic Preservation Act is not an ARAR or a TBC. In the judgement of EPA and the Rhode Island Historic Preservation Commission, the selected remedy will have no adverse effect on the Historic District.

6. Land Disposal Restrictions

RCRA includes specific provisions restricting the land disposal of certain RCRA wastes. The land disposal restrictions (LDRs) establish treatment standards which must be achieved (by specific dates) for RCRA hazardous wastes prior to their disposal or placement on land. It is important to note that LDRs apply prospectively to wastes land disposed after the effective date of the restrictions but do not require removal and treatment of wastes land disposed prior to this.

LDRs are not an ARAR for the TCE spill area soils because the treatment of soils in the spill area will solely be an in-situ activity and therefore will not involve the placement of a RCRA hazardous waste.

The LDRs are not an ARAR for the excavation of sediments in the floodplain of the Branch River and the consolidation of the sediments under the cap, because this action does not involve placing of hazardous waste in a land-based unit. The area where the sediment is to be excavated from is located in the floodplain of the Branch River at the base of the retaining wall which acts as the southern boundary of the landfill. Sediments found adjacent to the landfill retaining wall result primarily from the erosion of materials from the slopes of the landfill. The sediments to be consolidated are contiguous to the landfill, uninterrupted by roads, paths, or other easements or right of ways. The landfill and sediments adjacent to it constitute one area of contamination for CERCLA purposes and thus one unit for land disposal purposes. Therefore, movement of the sediment adjacent to the landfill does not qualify as placement but is merely movement within the unit.

The only site activity for which LDRs may be an ARAR is for the removal of the contents of the septic tank. The septic tank is believed to be located underneath one of the existing debris piles at the Site. As a result, EPA has been unable to sample its contents but did find during the RI elevated levels of TCE in a leaching field pipe associated with the septic tank. Therefore, a determination cannot be made until the contents of the tank are sampled as to whether LDRs are an ARAR.

C. The Selected Remedial Action is Cost-Effective

In the Agency's judgment, the selected remedy is cost effective, i.e., the remedy affords overall effectiveness proportional to its costs. In selecting this remedy, once EPA identified alternatives that are protective of human health and the environment and that attain, or, as appropriate, waive ARARs, EPA evaluated the overall effectiveness of each alternative by assessing the relevant three criteria-- long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs. The costs of this remedial alternative are:

COST OF OVERALL REMEDY

		Capital Costs	O&M Costs ($/yr)	Present Worth
TSA-3	Soil Vacuum Extraction	$266,465	1,500	280,605
LA-3	Consolidation and Capping	$587,750	62,000	1,172,000
GW-4	UV/hydrogen Peroxide	$705,890	73,500	1,889,760
OS-3	Demolition, Sealing Raceways, Septic Tank, and Site Grading	$715,825	27,400	974,120

A discussion of the relative cost effectiveness of each component of the selected remedy follows. The present worth costs shown are based on a discount rate of ten percent as recommended in the NCP.

1. **TCE Spill Area**

COST COMPARISON OF TCE SPILL AREA ALTERNATIVES

		Capital Costs	O&M Costs ($/yr)	Present Worth
TSA-1	Excavation and Incineration	$9,994,150	100,000	10,690,620
TSA-3	Soil Vacuum Extraction	$266,465	1,500	280,605
TSA-4	No-action	$40,140	1,500	54,280

Of the two alternatives that are protective and attain ARARs, TSA-1 and TSA-3, alternative TSA-3 has the more cost-effective components. TSA-3 provides a degree of protectiveness proportionate to its costs. Soil vacuum extraction was estimated to be significantly less costly than excavation and incineration. Excavation and incineration would cost approximately 4000 percent more than soil vacuum extraction. The least expensive alternative, TSA-4, the no-action alternative, did not meet ARARs since it would not remove the contaminants from the spill area soils which are migrating into the groundwater.

2. **Landfill Area**

COST COMPARISON OF LANDFILL AREA ALTERNATIVES

		Capital Costs	O&M Costs ($/yr)	Present Worth
LA-1	Excavation and Incineration	$17,960,700	100,000	18,815,840
LA-3	Consolidation and Capping	$587,750	62,000	1,172,000
LA-5	No-action	$30,140	18,500	204,540

Of the two alternatives that are protective and attain ARARs, LA-1 and LA-3, alternative LA-3 has the more cost-effective components. LA-3 provides a degree of protectiveness proportionate to its costs. Consolidation of landfill wastes in the floodplain of the Branch River, construction of a leachate collection system, and capping of the landfill was estimated to be far less costly than excavation and incineration of all landfill wastes. Excavation and incineration would cost approximately 1600 percent more than consolidation and capping. The least expensive alternative, LA-5, the no-action alternative, did not meet ARARs since it would not reduce the leaching of contaminants from the landfill into the groundwater and river, nor would it prevent the erosion into the river of landfill wastes containing contaminants.

3. **Groundwater Extraction and Treatment**

COST COMPARISON OF GROUNDWATER TREATMENT ALTERNATIVES

		Capital Costs	O&M Costs ($/yr)	Present Worth
GW-1	Air Stripping	$1,537,140	139,525	3,190,010
GW-2	Granular Activated Carbon	$1,789,425	114,225	3,262,792
GW-4	UV/hydrogen Peroxide	$705,890	73,500	1,889,760
GW-5	No-action	$6,850	46,200	442,372

Of the three alternatives that are protective and attain ARARs, GW-1, GW-2 and GW-4, alternative GW-4 has the most cost-effective components. GW-4 provides a degree of protectiveness proportionate to its costs.

All three alternatives include the estimated costs of an extraction system and a pretreatment process to remove suspended solids (e.g., pressure filtration). The final details of the extraction system will be decided upon completion of the pump test during predesign activities. Although extraction costs may therefore change, the cost of extraction would be the same for each groundwater treatment alternative.

As part of predesign activities, a pilot test of the UV/hydrogen peroxide system will be performed with groundwater obtained from the pump test. One of the goals of the pilot test will be to determine the effectiveness of pressure filtration for removing suspended metals. In the event that additional pretreatment is needed, EPA will re-evaluate the costs of this alternative and make a determination of whether the degree of protectiveness is still proportional to its cost.

Treatment of the extracted groundwater with the UV/hydrogen peroxide system was estimated to be significantly less costly than the air stripping and the granular activated carbon alternatives. Air stripping and granular activated carbon would both cost approximately 170 percent more than the UV/hydrogen peroxide system. The least expensive alternative, GW-5, the no-action alternative, does not meet ARARs since it would not reduce the concentration of contaminants found in the groundwater to drinking water standards.

4. Overall Site

COST COMPARISON OF OVERALL SITE ALTERNATIVES

		Capital Costs	O&M Costs ($/yr)	Present Worth
OS-3	Demolition, Sealing Raceways, Septic Tank, and Site Grading	$715,825	27,400	974,120
OS-4	Demolition, Sealing Raceways, Septic Tank, "Hot Spot" Excavation, and Site Grading	$914,475	31,400	1,210,480
OS-5	No-action	$42,510	8,000	116,930

Of the two alternatives that are protective and attain ARARs, OS-3 and OS-4, alternative OS-3 has the more cost-effective components. OS-3 provides a degree of protectiveness proportionate to its costs. Demolition of the on-site structures, sealing and backfilling of the raceways, confirming the location of the septic tank and removing its contents, and site grading were estimated to be slightly less costly than alternative OS-4 which requires, in addition, the excavation of "hot spot" soils and the removal of sediment from the raceways. It

should be noted that EPA has evaluated the risk levels associated with the "hot spot" soils and has determined that these soils do not pose a risk to public health and the environment. In addition, the costs for alternative OS-4 are very preliminary in that the areal extent of "hot spot" contamination and the quantity of raceway sediment has never been delineated. Moreover, the cost estimates for OS-4 shown above assume that the excavated materials could be disposed of in the on-site landfill. Based upon state comments on the FS, excavated materials would have to be tested and, if they contain hazardous substances, would have to be treated and/or disposed of off-site. The off-site disposal or treatment of excavated hazardous wastes would significantly increase the cost estimates for OS-4 shown above. Therefore, EPA does not believe that the additional activities proposed under alternative OS-4 provide a degree of protectiveness proportional to their costs. The least expensive alternative, OS-5, the no-action alternative, does not meet ARARs because it would not reduce the migration of contaminants through the raceways into the Branch River and it would not eliminate the potential groundwater contamination source presented by the septic tank and its contents.

D. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Once the Agency identified those alternatives that attain or, as appropriate, waive ARARs and that are protective of human health and the environment, EPA identified which alternative utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of trade-offs among alternatives in terms of: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility and volume through treatment; and considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The selected remedy provides the best balance of trade-offs among the alternatives.

1. TCE Spill Area

Alternative TSA-3, in-situ soil vacuum extraction, was selected as the component of the remedy to address spill contaminated soils because its long-term effectiveness, permanence, and ability to reduce toxicity, mobility, and volume of contaminants through treatment was the most efficient in light of implementability, short-term effectiveness and residual risk concerns. Although alternative TSA-1, excavation and incineration, provides for greater certainty in terms of the time frame required to achieve remediation levels and its ability to reduce toxicity, mobility, and volume of a wider range of contaminants through treatment, these advantages are outweighed by the differences between

the two alternatives in terms of short-term effectiveness, costs, implementability, and residual risks remaining after treatment. A brief discussion of the advantages and disadvantages of each alternative is presented below but is discussed in greater detail in Section IX of this document.

Both alternatives TSA-1 and TSA-3 use treatment technologies which are effective in eliminating the principal contaminants found in the spill area, TCE and its breakdown products. Alternative TSA-1 would achieve the destruction of additional contaminants such as PAHs, which were found at low levels throughout the Site, but the removal of these compounds would not provide greater protection from the primary risks identified for the spill area.

The time frame required to reach the soil remediation levels can be estimated with greater certainty for alternative TSA-1 than for alternative TSA-3. Despite the uncertainties associated with the estimation of the cleanup time frame for TSA-3, the overall time frame for reaching remediation levels throughout the spill area is roughly equivalent for both alternatives and would take approximately 1 to 2.5 years.

Because TSA-1 and TSA-3 are roughly equivalent with respect to the primary balancing criteria of long-term effectiveness and permanence and reduction of toxicity, mobility, or volume through treatment, the differences between the modifying criteria as described below formed the basis of EPA's remedy selection for the spill area.

Alternative TSA-3 poses less potential for adverse short-term effects on the community, environment, and on-site workers. This alternative, which relies on in-situ extraction, does not require the excavation of contaminated soils which contain compounds that are likely to be released into the air. The equipment needed to construct and operate alternative TSA-3 is readily available and requires fewer engineering controls to install and operate, and produces fewer waste streams thereby making it more implementable than TSA-1. The costs for alternative TSA-3 are significantly lower and since it achieves similar long-term effectiveness and permanence through treatment as alternative TSA-1, it provides the greatest degree of protectiveness proportional to its cost.

The final difference relates to the residual risks for both alternatives. Alternative TSA-3 produces spent carbon filters from the treatment of air emissions which require off-site treatment and disposal. The spent carbon can be regenerated and once it has been regenerated it can be reused and would therefore no longer require treatment and disposal. Alternative TSA-1 produces a number of side waste streams which may require treatment. The principal waste is bottom ash which often exhibits a hazardous characteristic. This waste requires treatment before its disposal in a secure landfill. Members of the community did not indicate a preference for one treatment alternative over the other.

In summary, although TSA-1 and TSA-3 are roughly equivalent with respect to the primary balancing criteria of long-term effectiveness and reduction of toxicity, mobility, or volume through treatment, TSA-3 has significant advantages with respect to the modifying criteria, specifically, short-term effectiveness, cost-effectiveness, and implementability. Therefore, TSA-3 was chosen as the component of the selected remedy for the spill area soils.

2. Landfill Area

Alternative LA-3, which includes the excavation of landfill wastes within the floodplain of the Branch River, consolidation of the wastes under a multi-layer cap, and the installation of a leachate collection system, was selected as the component of the remedy to address the existing on-site landfill. Although this alternative does not employ a treatment technology, it prevents direct contact with contaminants, controls further downward and off-site migration of leachate, and minimizes dust erosion and surface runoff. LA-3 therefore meets all the remediation goals for the landfill.

Alternative LA-1, excavation and incineration, provides much greater long-term effectiveness and permanence since it reduces the toxicity, mobility, or volume of most contaminants through treatment. The advantages of this alternative are tempered somewhat for this Site because of the concerns for its short-term effectiveness, implementability, and costs.

The excavation, separation, and materials handling required by LA-1 prior to incineration has the potential to generate air emissions during the three-year period of operation. Because of the proximity of residences, the air emission would potentially create odor problems and potential health risks to the public and on-site workers despite the use of engineering controls and air monitoring. The substantive requirements to be met for the test burn and disposal of waste streams associated with incineration would make this alternative less implementable than capping.

Of these two alternatives that are protective and attain ARARs, LA-1 and LA-3, alternative LA-3 has the more cost-effective components. LA-3 provides a degree of protectiveness proportionate to its costs. Additionally, the generation of bottom ash, which potentially requires further treatment because of the presence of metals in the landfill wastes, creates another residue requiring disposal. Some members of the community voiced their preference for a permanent solution eliminating the contaminants in the landfill. EPA also has a preference for a permanent solution. However, when balancing the overall effectiveness of incineration with the disadvantages discussed above as well as the cost-effectiveness of incineration in achieving the protectiveness objective, EPA has selected consolidation and capping of the wastes as the remedy for the landfill area.

3. Groundwater Extraction and Treatment

Alternative GW-4, which uses the innovative technology of ultraviolet light and hydrogen peroxide, was selected as the component of the remedy for the treatment of contaminated groundwater because of its long-term effectiveness, permanence, and ability to reduce the toxicity, mobility, and volume of contaminants through treatment. Alternatives GW-1 and GW-2 provide similar long-term effectiveness and permanence in their ability to eliminate known contaminants, but produce waste streams which require off-site treatment and/or disposal. An additional disadvantage of alternatives GW-1 and GW-2 is that the activated carbon used to supplement treatment in GW-1 and provide primary treatment in GW-2, is not effective in reducing the toxicity of vinyl chloride. Vinyl chloride, a breakdown product of TCE, has been found at very low levels at the Site up to now, but due to transformations brought about by natural biological reactions it may be found at a greater concentration in the future. Alternative GW-4 destroys vinyl chloride and other known contaminants in the groundwater, while producing only carbon dioxide, water and free chlorides which go on to form small quantities of salts.

GW-4 therefore has significant advantages over GW-1 and GW-2 with respect to the reduction of toxicity, mobility, and volume of known and probable contaminants, and cost-effectiveness. In addition, the community did not indicate a preference for another alternative. Consequently, EPA has selected GW-4, the innovative technology of ultraviolet light and hydrogen peroxide, as the remedy for the groundwater.

4. Overall Site

Alternative OS-3, which addresses the physical and health hazards associated with the conditions of the overall Site by demolishing on-site structures, sealing and filling the raceways, locating and removing the contents of the septic tank, and grading the overall Site, was selected as the component of the remedy for the treatment of the overall Site. It differs from OS-4 primarily in that alternative OS-4 would require the excavation of contaminated soils from the "hot spot" and raceway sediments. These excavated materials would be tested and treated and/or disposed of off-site. The "hot spot" contains elevated levels of PAHs. Whatever the source of PAHs, the levels detected in the "hot spot" were too low to pose a significant risk to public health and the environment. EPA believes that the filling and sealing of the raceways would prevent the further migration of the sediments into the Branch River. This would eliminate the future risk posed to public health and the environment without the need for excavation of the sediments.

Another potential problem associated with alternative OS-4 is related to the cost. An important assumption made in the FS and reflected in the costs for OS-4 was that the excavated soil and raceway residues would be managed on-site by combining it with landfill wastes. Based upon subsequent comments from the State, it appears that this material

would have to be treated and disposed of off-site which would significantly increase the costs shown. Since the quantity of material to be excavated from the "hot spot" and raceways is unknown, a more refined cost estimate cannot be provided. Because the long-term protectiveness of both alternatives is very similar and because OS-3 provides the greater degree of protectiveness proportional to its cost, EPA has selected OS-3 as the remedy for the overall Site.

E. The Selected Remedy Satisfies the Preference for Treatment Which Permanently and Significantly reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element

The principal elements of the selected remedy are source control and management of migration. These elements address the primary threats at the Site, contamination of the soil and the groundwater with TCE and other VOCs. The selected remedy satisfies the statutory preference for treatment as a principal element by 1) treating contaminated soils using soil vacuum extraction and reducing the concentration of VOCs in soils to levels which will not impair drinking water standards and 2) treating the extracted groundwater using an innovative ultraviolet light and hydrogen peroxide technology which will result in the removal of VOCs to levels protective of human health and the environment.

XII. DOCUMENTATION OF NO SIGNIFICANT CHANGES

EPA presented a proposed plan (preferred alternative) for remediation of the Site on July 10, 1990. The source control portion of the preferred alternative included:

1. In-Situ treatment of TCE spill area soils;
2. Excavation of landfill materials in the flood plain;
3. Stabilization of landfill slopes;
4. Installation of a landfill leachate collection system;
5. Capping of the landfill;
5. Location of the septic tank and removal of its contents.

The management of migration portion of the preferred alternative included:

1. Groundwater extraction and treatment;
2. Sealing of raceway entrances and exists and backfilling raceways.

No significant changes from the Proposed Plan have been made to the selected remedy as detailed in the Record of Decision. However, the following discussion is presented as a point of clarification.

As part of the Proposed Plan, landfill wastes which are located in the 100-year floodplain of the Branch River are to be excavated, placed on the landfill above the floodplain, and incorporated under the cap to be constructed. EPA believes that landfill wastes in the floodplain also includes those sediments found in and along the bank of the Branch River adjacent to the landfill and along its southern boundary. The western limit of the sediment to be excavated is the new raceway exit and the eastern limit

is roughly the eastern edge of the landfill. This sediment adjacent to the landfill has been shown to contain elevated levels of landfill-specific contaminants such as dieldrin. Additional downstream locations were tested and the sediment sampled there did not reveal significant levels of landfill-specific contaminants. Therefore, in order to achieve the cleanup goals for the landfill which includes mitigating the release of contaminants to the Branch River and thereby protecting human health and the environment, these sediments will be excavated along with other landfill wastes within the 100-year floodplain and placed under the landfill cap. During the excavation of the sediments appropriate steps will be taken to minimize the redistribution of contaminants into the Branch River by installing silt barriers or using other appropriate engineering controls.

XIII. STATE ROLE

The Rhode Island Department of Environmental Management has reviewed the various alternatives and has indicated its support for the selected remedy. The State has also reviewed the Remedial Investigation, Risk Assessment and Feasibility Study to determine if the selected remedy is in compliance with applicable or relevant and appropriate State Environmental laws and regulations. The State of Rhode Island concurs with the selected remedy for the Stamina Mills Site. A copy of the Declaration of Concurrence is attached as Appendix D.

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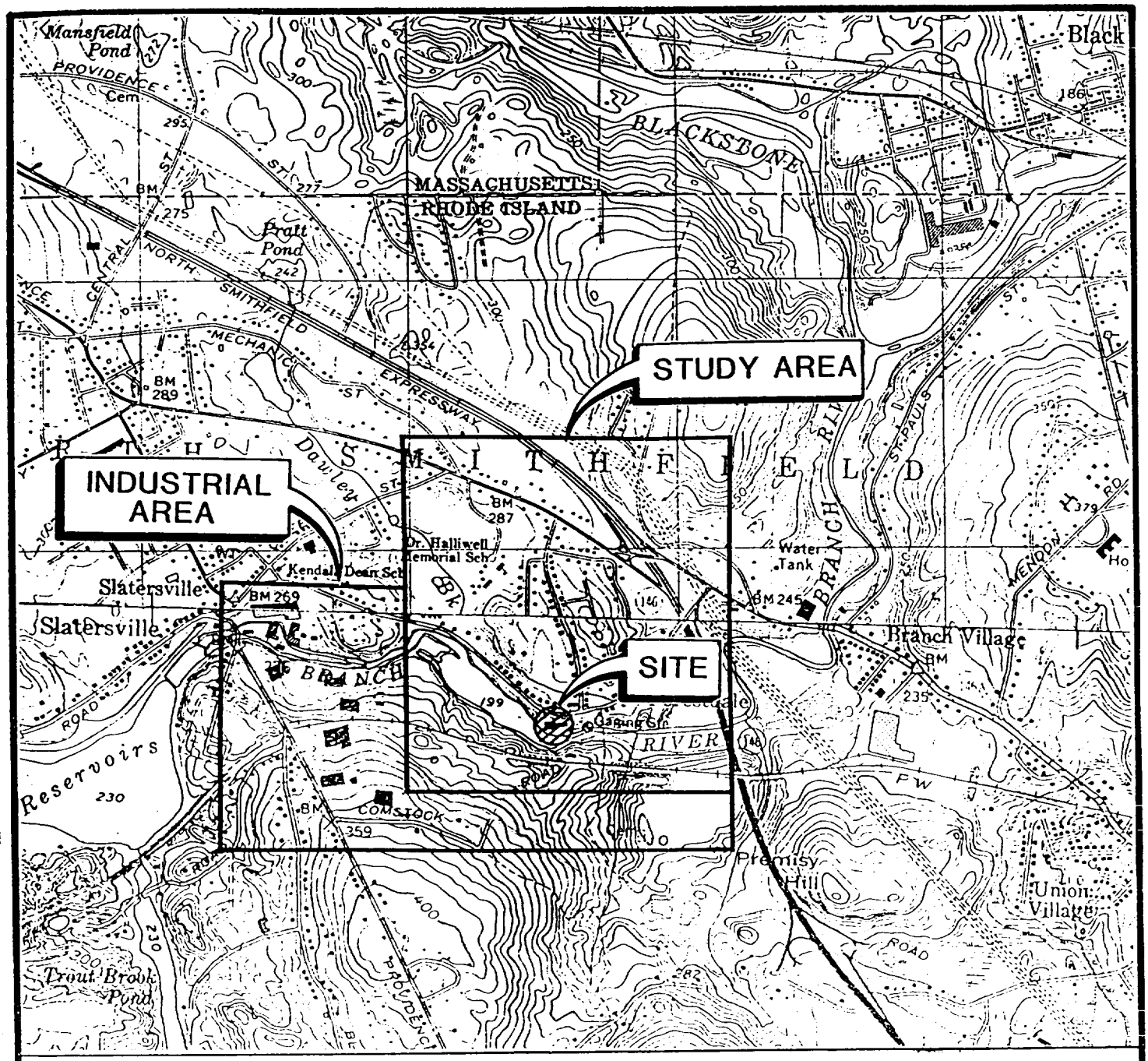
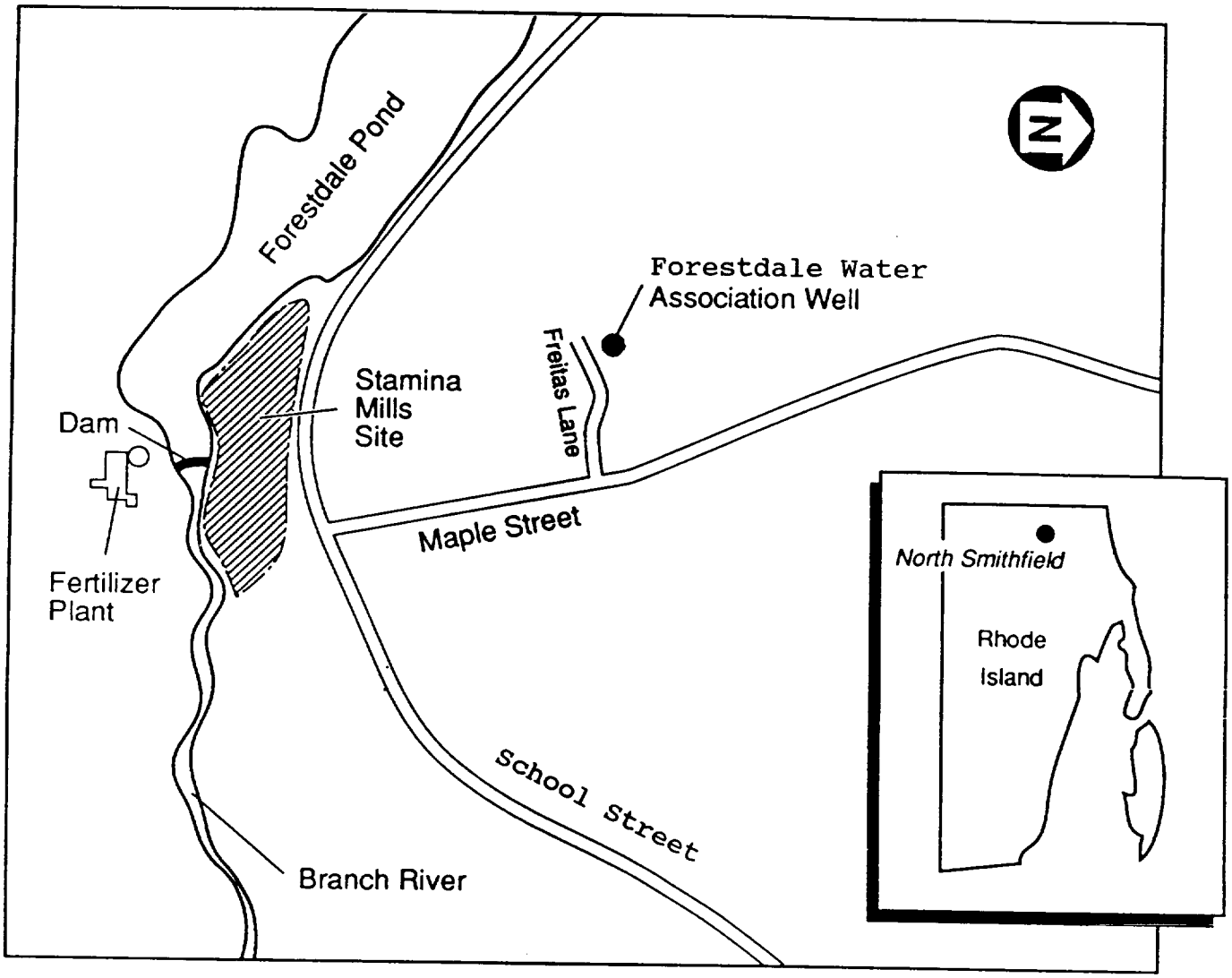
APPENDIX A

FIGURES



N	PROJECT: STAMINA MILLS REMEDIAL INVESTIGATION	GHR ENGINEERING ASSOCIATES, INC. 109 RHODE ISLAND ROAD LAKEVILLE, MA 02347
	CLIENT: U.S. ARMY CORPS OF ENGINEERS	
	TITLE: FIGURE 1 – STAMINA MILLS SITE LOCUS AND REMEDIAL INVESTIGATION STUDY AREA	
QUADRANGLE LOCATION	BLACKSTONE, MASS.– R.I. GEORGIAVILLE, R.I. QUADRANGLE NAME	PROJECT NUMBER 3108-027

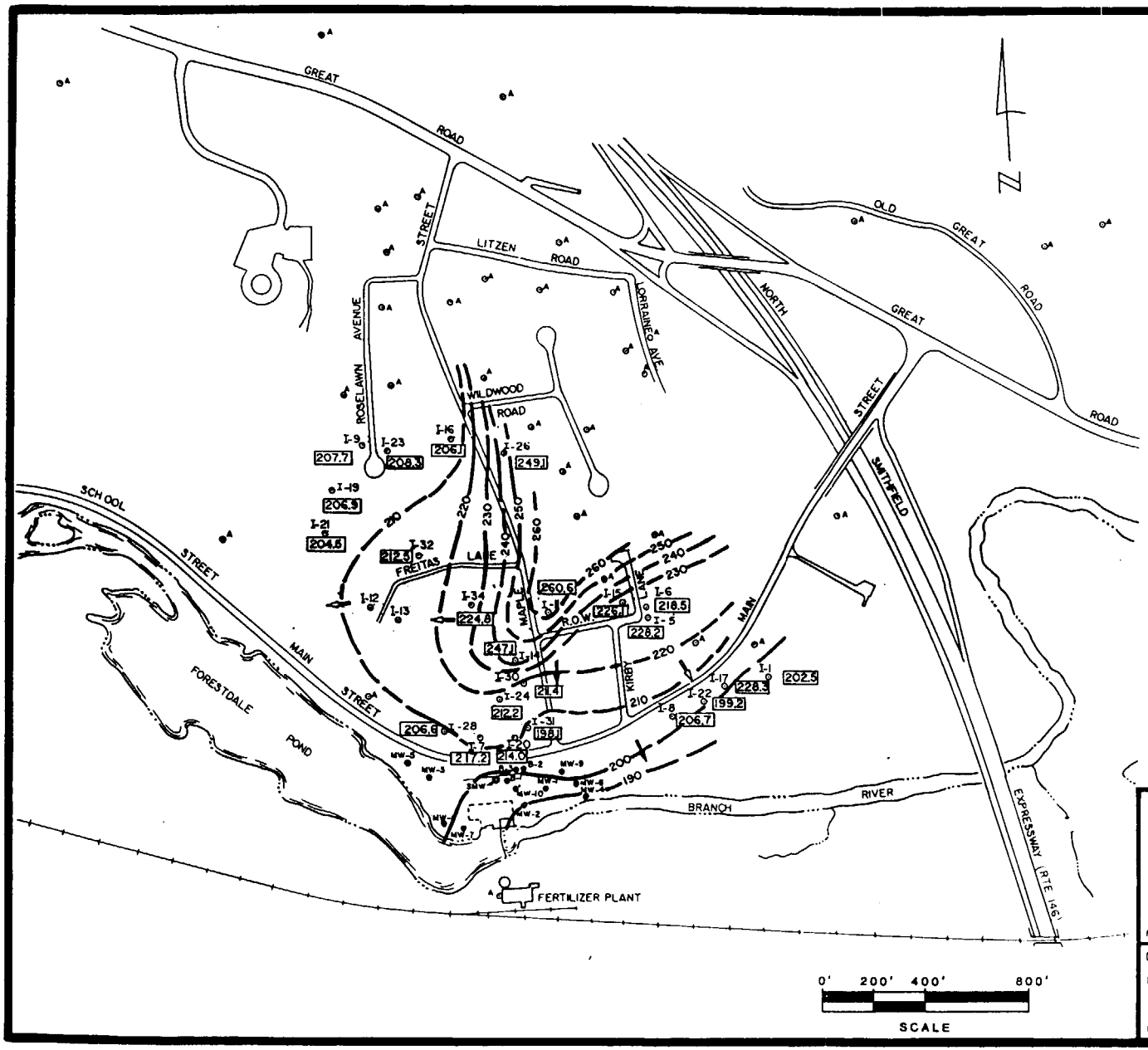
Figure 2
Stamina Mills Superfund Site Location Map



Legend

Stamina Mills Site

Drawing Not to Scale



NOTES:

1. GROUNDWATER ELEVATIONS ARE CALCULATED FROM WATER LEVEL MEASUREMENTS MADE IN SEPT. 15,1986 FLUCTUATIONS IN GROUNDWATER LEVELS MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.
2. GROUNDWATER CONTOURS DEPICTED ARE BASED ON INTERPOLATIONS BETWEEN WIDELY SPACED EXPLORATIONS POINTS. ACTUAL SUBSURFACE CONDITIONS MAY VARY FROM THOSE SHOWN.
3. REFER TO SITE PLAN NO. 6 FOR ADDITIONAL NOTES AND LEGEND.
4. GROUNDWATER ELEVATIONS SHOWN REPRESENT PIEZOMETRIC LEVELS IN OPEN BEDROCK HOLES.
5. GROUNDWATER CONTOURS AND FLOW DIRECTION SHOWN ASSUME HOMOGENEOUS AND ISOTROPIC AQUIFER CONDITIONS AND STEADY STATE HORIZONTAL FLOW
6. PIEZOMETRIC LEVELS WERE DETERMINED IN SHALLOW (10-20 FEET) BEDROCK WELLS ON-SITE AND DEEP (450 FEET MAXIMUM) OPEN ROCK RESIDENTIAL WELLS
7. RESIDENTIAL WELLS SHOWN ARE WELLS FOR WHICH PERMISSION WAS GRANTED FOR SAMPLING. OTHER WELLS EXIST IN AREA.
8. REFER TO FIGURE 5-13 FOR ELEVATION OF GROUNDWATER FROM BEDROCK WELLS ON-SITE

LEGEND

206J	GROUNDWATER ELEVATION
240	GROUNDWATER CONTOUR AND FLOW DIRECTION (CONTOUR DASHED, ARROW OPEN WHERE INFERRED)
I	INACTIVE WELL
A	ACTIVE WELL

GHR
75 TARKILN HILL ROAD
NEW BEDFORD, MA 02745

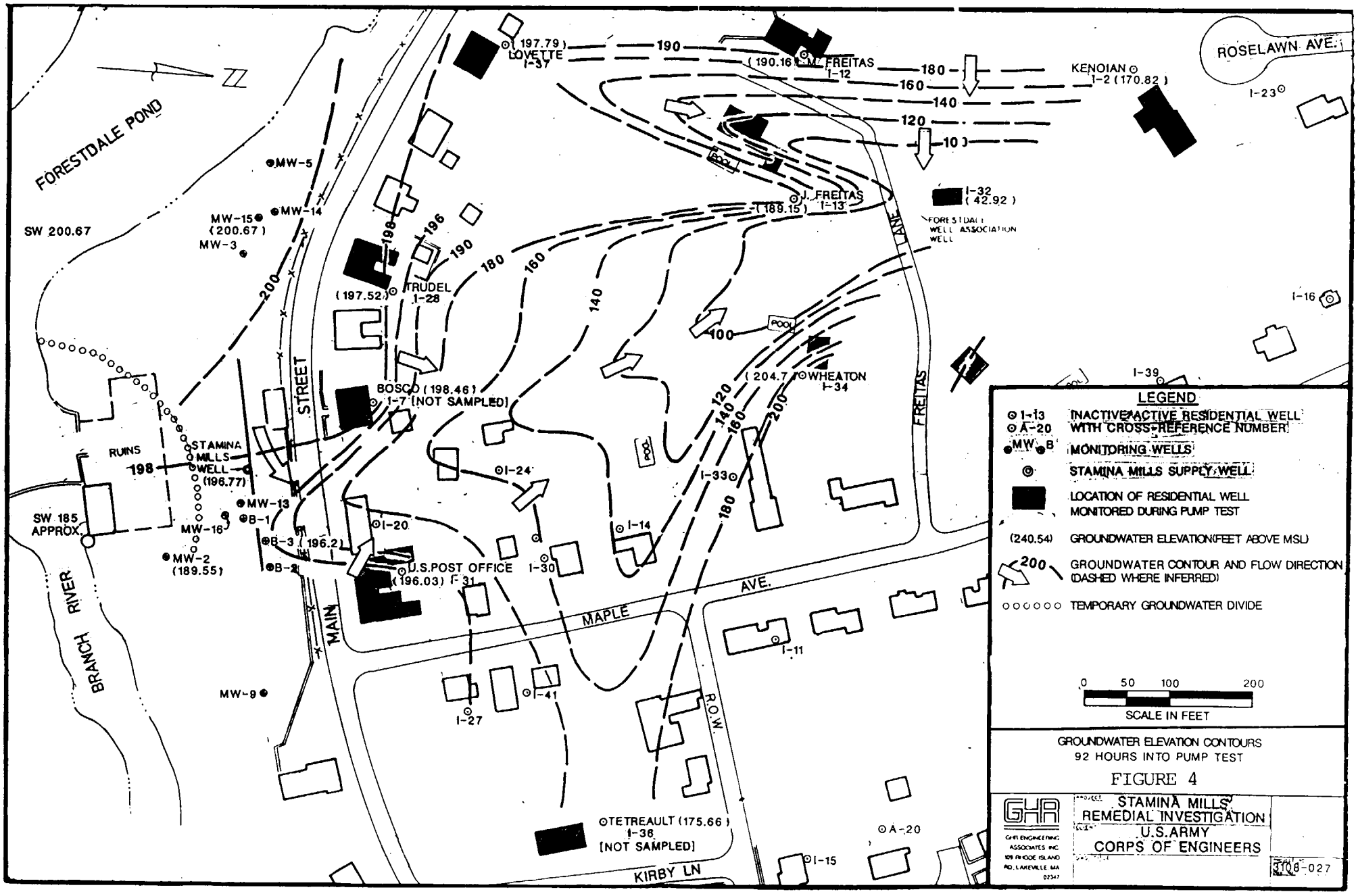
DWN BY DD CHK BY WN
DSGN BY GM/MS APPD BY JG
SCALE 1"= 400'
DATE 12/19/86

PROJECT
STAMINA MILLS
REMEDIAL INVESTIGATION

CLIENT
U.S. ARMY CORPS OF ENGINEERS

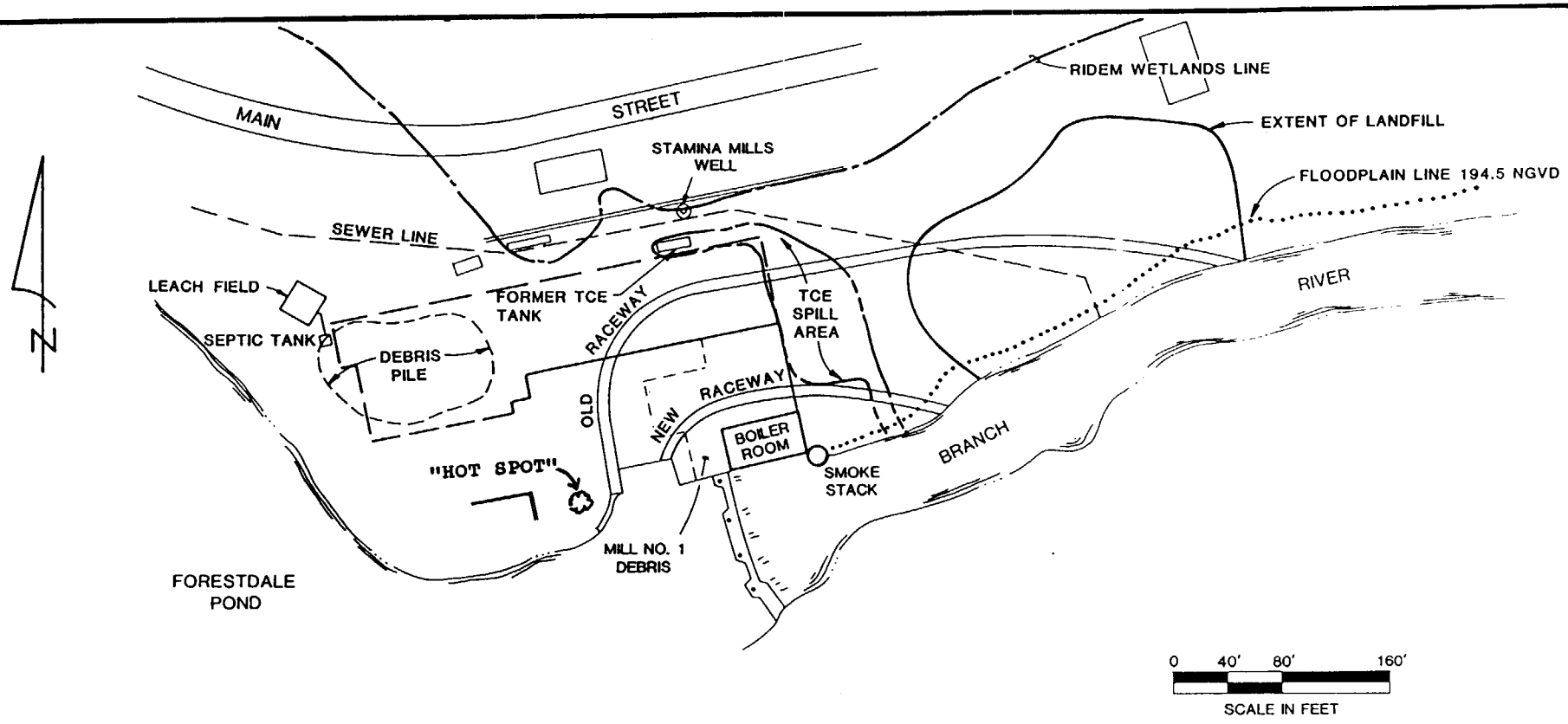
FIGURE 3

DWG TITLE
REGIONAL GROUNDWATER CONTOUR ELEVATIONS IN BEDROCK (ELEVATIONS AS OF 9/15/86)



GROUNDWATER ELEVATION CONTOURS
92 HOURS INTO PUMP TEST

FIGURE 4



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DRAWING TITLE
FIGURE 5
STAMINA MILLS SITE FEATURES

PROJECT
STAMINA MILLS
FEASIBILITY STUDY REPORT

CLIENT
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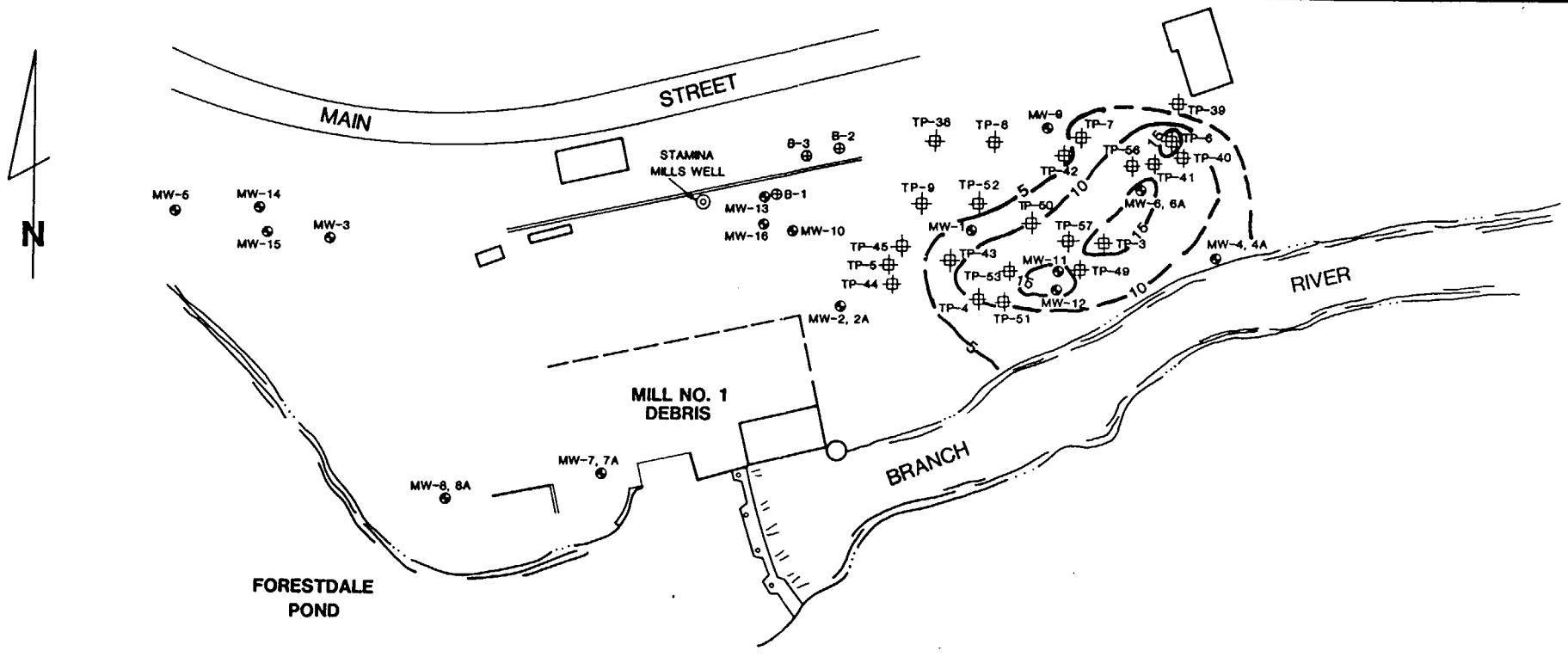

NOTES:

1. THICKNESS OF LANDFILL DEBRIS DETERMINED FROM VISUAL OBSERVATIONS MADE DURING TEST PIT EXCAVATIONS AND MONITORING WELL INSTALLATIONS.
2. CONTOURS OF LANDFILL DEBRIS THICKNESS ARE BASED UPON WIDELY SPACED POINTS. ACTUAL SUBSURFACE CONDITIONS MAY VARY FROM THOSE SHOWN.
3. THICKNESS OF LANDFILL DEBRIS BASED ON TOTAL THICKNESS OF DEBRIS AT EACH POINT REGARDLESS OF DEPTH OF DEBRIS.
4. ONLY TEST PITS IN VICINITY OF LANDFILL ARE SHOWN, REFER TO SITE PLAN SP-6 FOR LOCATION OF ALL EXPLORATION AND SAMPLING POINTS.

LEGEND:

- ◎ STAMINA MILLS SUPPLY WELL
- B-1 ⊕ MONITORING WELL INSTALLED BY GZA, 1982.
- MW-12 ⊕ MONITORING WELL INSTALLED BY GHR, 1986 AND 1988. REFER TO BORING LOGS IN APPENDIX E FOR LANDFILL DEBRIS THICKNESSES
- TP-57 ⊕ TEST PIT EXCAVATED DURING REMEDIAL INVESTIGATION REFER TO TEST PIT LOGS IN APPENDIX A FOR LANDFILL DEBRIS THICKNESS
- —10— CONTOUR OF THICKNESS OF LANDFILL DEBRIS (DASHED WHERE INFERRED) REFER TO TEST PIT LOGS IN APPENDIX A FOR LANDFILL DEBRIS THICKNESSES

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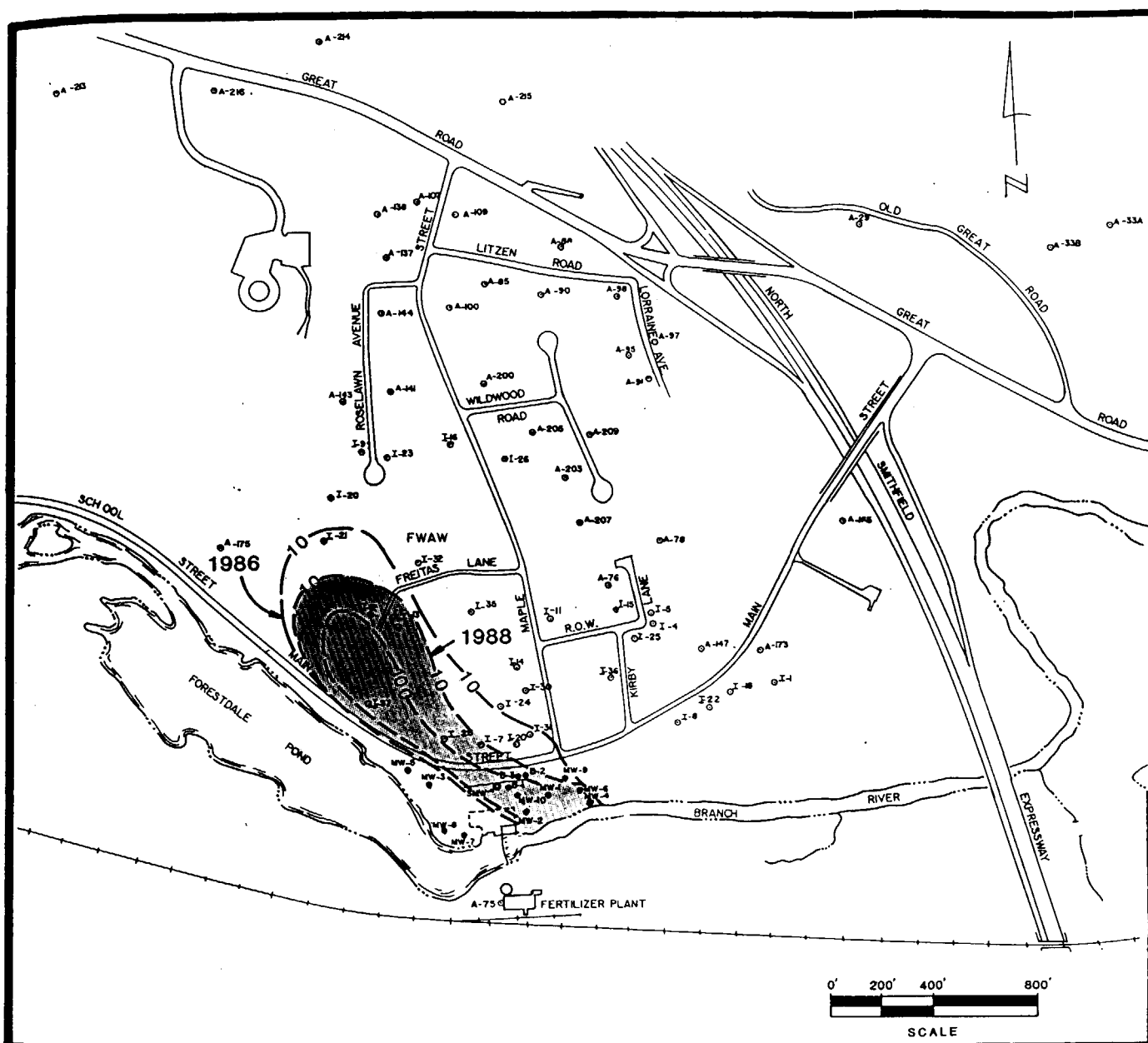
DRAWING TITLE FIGURE 6
AREAL EXTENT AND THICKNESS OF LANDFILL DEBRIS
STAMINA MILLS SITE
NORTH SMITHFIELD, RHODE ISLAND

PROJECT
STAMINA MILLS
REMEDIAL INVESTIGATION

CLIENT
U.S. ARMY CORPS OF ENGINEERS



LEGEND

- I-13 IN ACTIVE RESIDENTIAL WELLS
- FWAW I-32 FORESTDALE WATER ASSOCIATION
- A-200 ACTIVE RESIDENTIAL WELLS
- 100 CONTOUR OF TCE IN GROUNDWATER (ppb) (DASHED WHERE INFERRED)

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DWG TITLE
FIGURE 7
LOCATION OF OFF-SITE GROUNDWATER CONTAMINANT PLUME 1986 & 1988

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STAMINA MILLS FEASIBILITY STUDY REPORT

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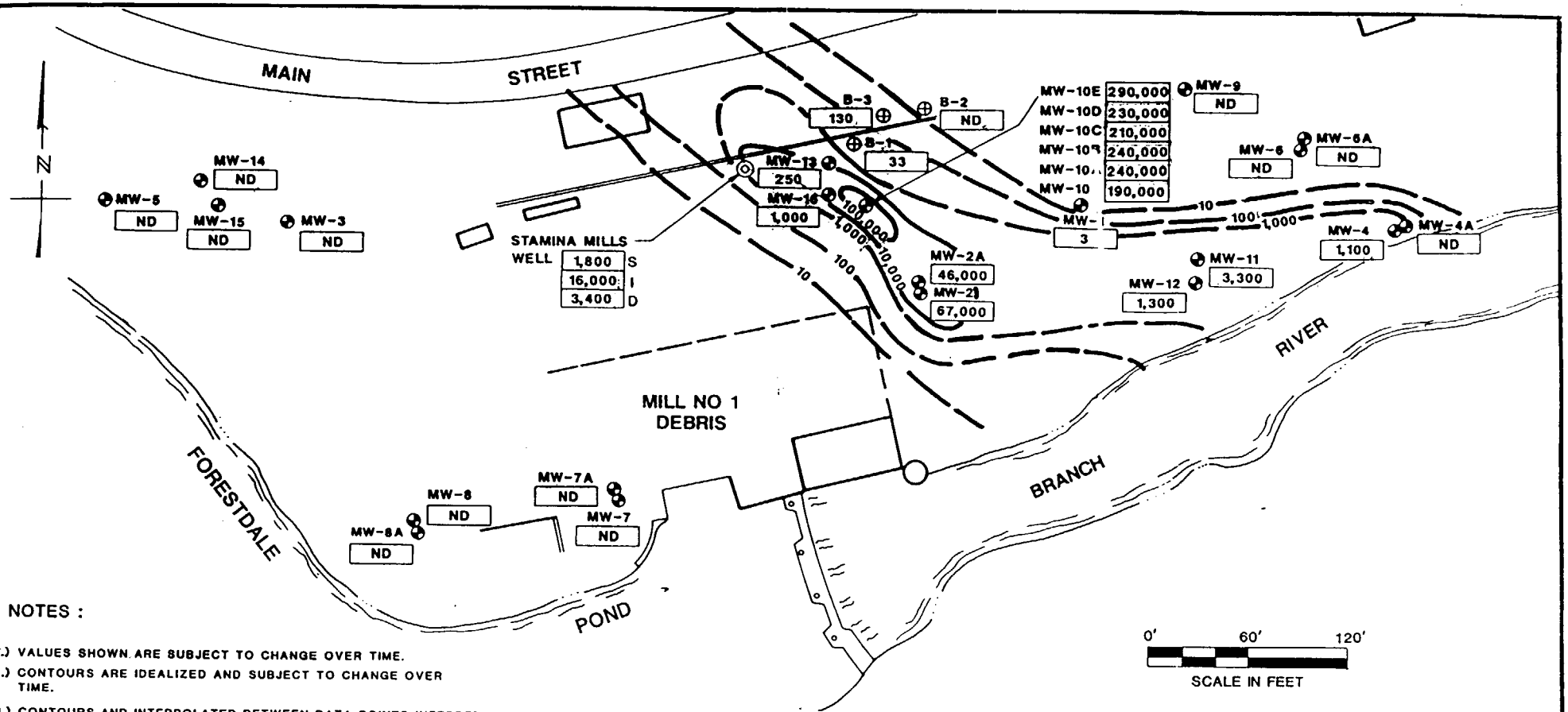

NOTES :

1.) VALUES SHOWN ARE SUBJECT TO CHANGE OVER TIME.

2.) CONTOURS ARE IDEALIZED AND SUBJECT TO CHANGE OVER TIME.

3.) CONTOURS AND INTERPOLATED BETWEEN DATA POINTS INFERRED IN OTHER AREAS.

4.) TCE CONCENTRATIONS ARE PRESENTED IN ORDER OF DEPTH BELOW GROUND SURFACE, FROM MW-10E (48 FEET) TO MW-10 (172 FEET). SAMPLER INTERVAL IS APPROXIMATELY 25 FEET. SAMPLES FROM STAMINA MILLS WELL ARE AS FOLLOWS : THE SHALLOW SAMPLE (S) IS AT THE WATER, INT. SAMPLE (I), 100 FEET BELOW THE WATER TABLE, THE DEEP SAMPLE (D), AT BOTTOM OF WELL (360 FEET).

5.) TCE CONCENTRATIONS IN GROUNDWATER FROM MW-1 THROUGH MW-10E, B-1 THROUGH B-3 AND THE STAMINA MILLS WELL ARE BASED ON DATA COLLECTED IN MARCH 1988. TCE CONCENTRATIONS FOR WELLS MW-11 THROUGH MW-16 AND ALL SURFACE WATER SAMPLES ARE BASED ON ANALYTICAL DATA COLLECTED IN JUNE 1988.

LEGEND:

⊕ B-2 — MONITORING WELL INSTALLED BY GZA (1982)

MW-4 [100,000] — MONITORING WELL INSTALLED BY GHR (1986) WITH CONCENTRATIONS OF TCE IN GROUNDWATER (ppb)

ND — NOT DETECTED

100 — CONTOUR OF TCE CONCENTRATIONS, (ppb) DASHED WHERE INFERRED

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DRAWING TITLE

FIGURE 8

AREAL DISTRIBUTION OF TCE IN GROUNDWATER IN 1988

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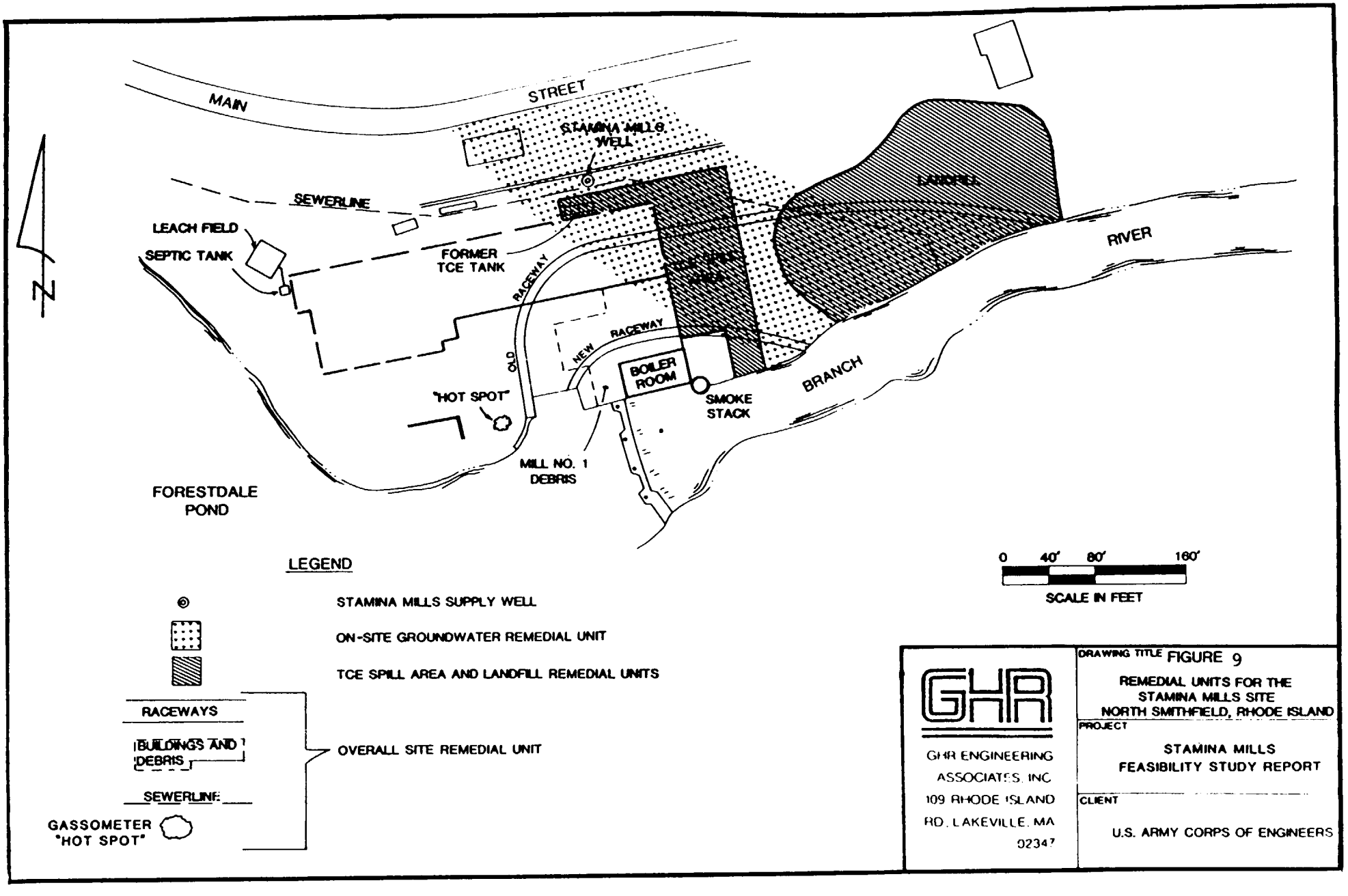
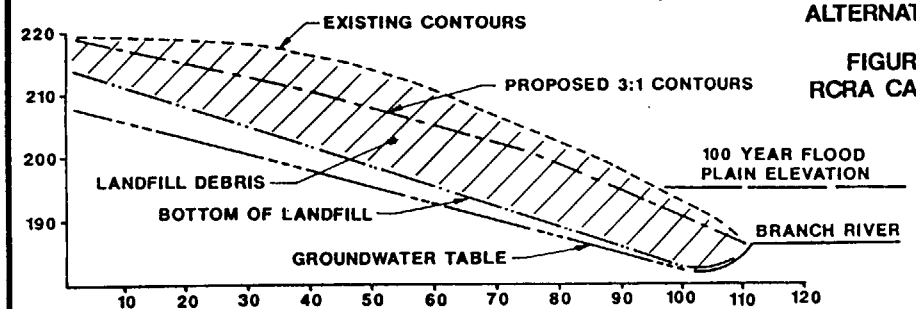
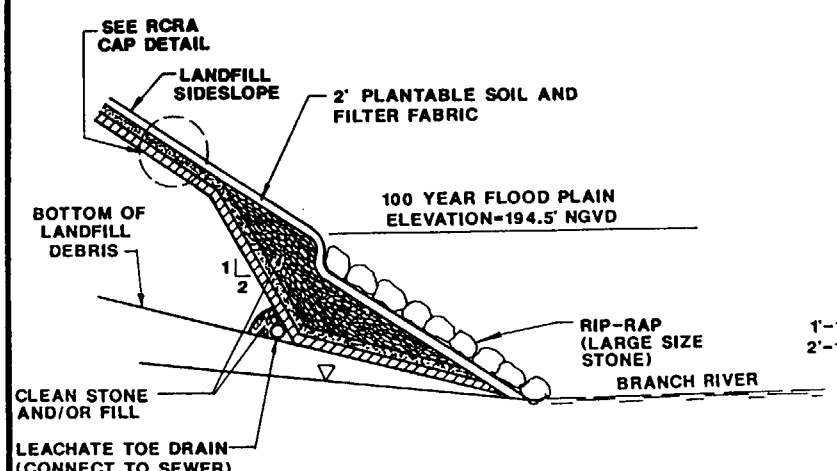

MAIN STREET
STAMINA MILLS WELL
SEWERLINE
LEACH FIELD
SEPTIC TANK
FORMER TCE TANK
OLD RACEWAY
NEW RACEWAY
BOILER ROOM
"HOT SPOT"
MILL NO. 1 DEBRIS
SMOKE STACK
LANDFILL
BRANCH RIVER
FORESTDALE POND
N
LEGEND
STAMINA MILLS SUPPLY WELL
ON-SITE GROUNDWATER REMEDIAL UNIT
TCE SPILL AREA AND LANDFILL REMEDIAL UNITS
RACEWAYS
BUILDINGS AND DEBRIS
SEWERLINE
GASSOMETER "HOT SPOT"
OVERALL SITE REMEDIAL UNIT
0 40' 80' 160'
SCALE IN FEET
GHR
GHR ENGINEERING ASSOCIATES, INC
109 RHODE ISLAND RD, LAKEVILLE, MA 02347
DRAWING TITLE FIGURE 9
REMEDIAL UNITS FOR THE STAMINA MILLS SITE NORTH SMITHFIELD, RHODE ISLAND
PROJECT
STAMINA MILLS FEASIBILITY STUDY REPORT
CLIENT
U.S. ARMY CORPS OF ENGINEERS

STAMINA MILLS FEASIBILITY STUDY REPORT
ALTERNATIVE LA-3

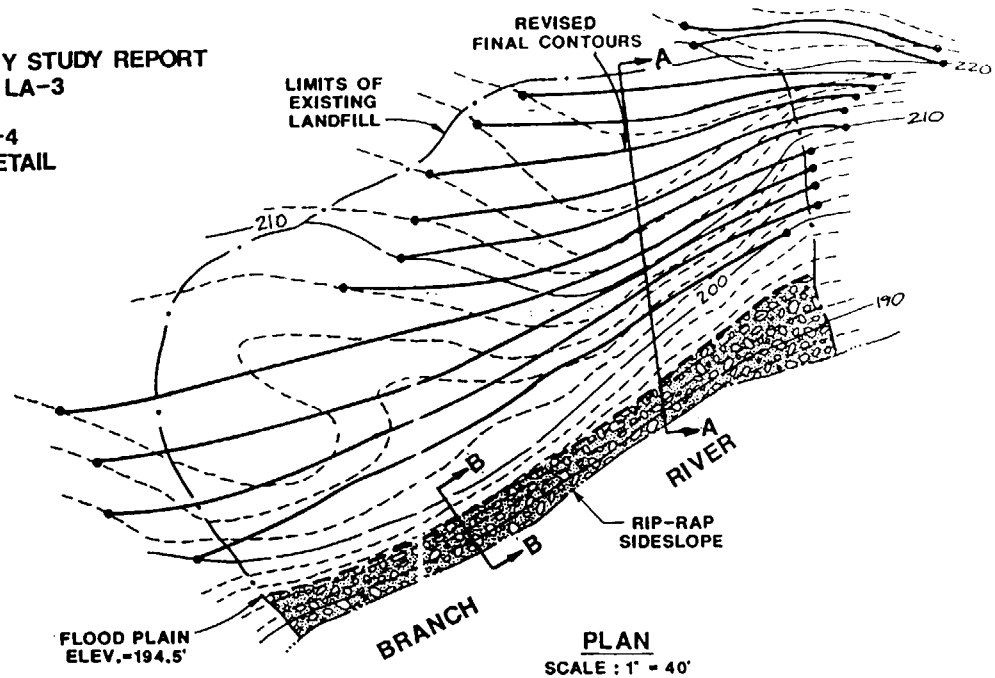
FIGURE 5-4
RCRA CAP DETAIL



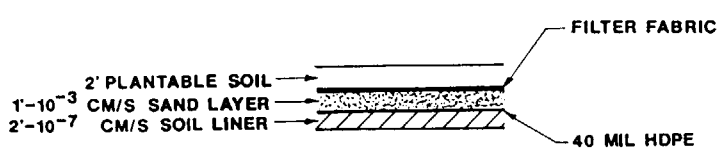
SECTION A-A
SCALE : 1" = 20'



SECTION B-B
NOT TO SCALE



PLAN
SCALE : 1" = 40'



RCRA CAP DETAIL
NOT TO SCALE

FIGURE 10

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APPENDIX B

TABLES

TABLE 1: SUMMARY OF CONTAMINANTS OF CONCERN IN GROUND WATER ZONE 1

CONTAMINANTS OF CONCERN	AVERAGE CONCENTRATION (PPB)	MAXIMUM DETECTION (PPB)	FREQUENCY OF DETECTION
Arsenic	12.2	13.3	2/25
Chloroform	15.5	25	2/24
1,1-Dichloroethylene	20.7	36	3/24
Phthalate,bis(ethyl-hexyl)	98.9	420	9/22
Tetrachloroethylene	4.0	5.0	2/24
Trichloroethylene	171219.4	850000.0	34/34
Vinyl chloride	5.5	6.0	2/24
Barium	54.4	169	25/25
Copper	7.2	12	6/25
1,2-Dichloroethylene	7911.2	31000.0	15/24
Lead	3.4	10.5	7/25
Selenium	3.7	5	2/25
Zinc	46.5	270	22/24

TABLE 1A:
CARCINOGENIC RISKS FOR THE POSSIBLE FUTURE INGESTION
OF GROUND WATER Zone 1

CONTAMINANT OF CONCERN	CONCENTRATION (UG/1) AVG	MAX	CANCER POTENCY FACTOR MG/KG/d-^{1}	EXPOSURE FACTOR 1/MG/d	RISK ESTIMATE AVG	RISK ESTIMATE MAX
Arsenic	12.2	13.3	1.75E+00	2.9E-02	6E-04	7E-04
Chloroform	15.5	25	6.10E-03	2.9E-02	3E-06	5E-06
1,1 Dichloroethylene	20.7	36	6.00E-01	2.9E-02	4E-04	1E-01
Phthalate,bis(2 ethyl-hexyl)	98.9	420	1.40E-02	2.9E-02	1E-04	6E-04
Dieldrin	0.4	0.4	1.60E+01	2.9E-02	3E-04	4E-04
Tetrachloroethylene	4.0	5.0	5.10E-02	2.9E-02	7E-06	9E-06
Trichloroethylene	171219.4	850000.0	1.10E-02	2.9E-02	6E-02	2E-01
Vinyl chloride	5.5	6.0	2.30E+00	2.9E-02	4E-04	4E-04

TABLE 1B:
NONCARCINOGENIC RISKS FOR THE POSSIBLE FUTURE INGESTION
OF GROUND WATER ZONE 1

CONTAMINANTS OF CONCERN	CONCENTRATION (UG/1) AVG	MAX	REFERENCE DOSE MG/KG/d	EXPOSURE FACTOR 1/KG/d	HAZARD INDEX AVG	HAZARD INDEX MAX	TOXICITY ENDOPOINT
Arsenic	12.2	13.3	1.00E-03	2.9E-02	5E-02	5E-02	Keratosis Hyperpigmentation
Chloroform	15.5	25	1.00E-02	2.9E-02	5E-02	8E-02	Liver lesions
1,1-Dichloroethylene	20.7	36	9.00E-03	2.9E-02	1E-01	3E-01	Liver lesions
Dieldrin	0.4	0.4	5.00E-05	2.9E-02	4E-01	5E-01	Liver lesions
Phthalate,bis-(2 ethylhexyl)	98.9	420.0	2.00E-02	2.9E-02	4E-01	2E+00	Liver
Tetrachloroethylene	4.0	5.0	1.00E--02	2.9E-02	2E-02	2E-02	Hepatotoxicity
Barium	54.4	169.0	5.00E-02	2.9E-02	3E-02	1E-01	Increased BP
Copper	7.2	12.0	1.30E+00	2.9E-02	6E-06	9E-06	GI distress
1,2-Dichloroethylene	7911.2	31000.0	2.00E-02	2.9E-02	5E+01	2E+02	Increased serum alkalinephosphatase
Lead	3.4	10.5	5.00E-02	2.9E-02	3E-02	1E-02	CNS effects
Selenium	3.7	5.0	2.00E-03	2.9E-02	2E-02	2E-02	Dermatitis
Zinc	46.5	270.0	2.00E-01	2.9E-02	9E-03	5E-02	Anemia

Hazard Index Sums	Average	Reasonable Maximum Exposure
Liver Lesions	5E+01	2E+02
Increased BP	5E-02	5E-02
CNS Effects	3E-02	1E-01
Dermatitis	2E-02	2E-02
Anemia	9E-03	5E-02

TABLE 2:SUMMARY OF CONTAMINANTS OF CONCERN IN GROUND WATER (ZONE 2 LANDFILL AREA)

CONTAMINANTS OF CONCERN	AVERAGE CONCENTRATION (PPB)	MAXIMUM DETECTION (PPB)	FREQUENCY OF DETECTION
Arsenic	9.0	10.0	2/10
Dieldrin	1.2	4.0	4/8
Phthalate,bis (2ethylhexyl)	80.5	100.0	2/7
Trichloroethylene	15101.7	100000.0	7/12
Vinyl chloride	131.7	220.0	3/12
Barium	103.2	187.0	6/10
Copper	23.9	56.0	8/10
Cresol,p-	8.0	8.0	1/10
Dichloroethylene, 1,2-	2922.5	7100.0	4/12
Lead	13.8	29.0	7/10
Nickel	29.2	29.2	1/5
Selenium	5.4	5.4	1/10
Zinc	187.9	710.0	5/5

TABLE 2A:
CARCINOGENIC RISKS FOR THE POSSIBLE FUTURE INGESTION
OF GROUND WATER Zone 1

CONTAMINANT OF CONCERN	CONCENTRATION (UG/1) AVG	MAX	CANCER POTENCY FACTOR MG/KG/d-1	EXPOSURE FACTOR 1/MG/d	RISK ESTIMATE AVG	RISK ESTIMATE MAX
Arsenic	12.2	13.3	1.75E+00	2.9E-02	5E-04	5E-04
Dieldrin	1.2	4.0	1.60E+01	2.9E-02	1E-03	3E-03
Phthalate, bis(2 ethylhexyl)	80.5	100.0	1.40E-02	2.9E-02	8E-05	1E-04
Trichloroethylene	15101.7	100000.0	1.10E-02	2.9E-02	5E-03	3E-02
Vinyl chloride	131.7	220.0	2.30E+00	2.9E-02	9E-03	1E-02

TABLE 2B
NONCARCINOGENIC RISKS FOR THE POSSIBLE FUTURE INGESTION OF GROUND WATER

CONTAMINANTS OF CONCERN	CONCENTRATION (UG/1) AVG	MAX	REFERENCE DOSE MG/KG/d	EXPOSURE FACTOR 1/KG/d	HAZARD INDEX AVG	HAZARD INDEX MAX	TOXICITY ENDOPOINT
Arsenic	9.0	10.0	1.0E-03	2.9E-02	4E-02	4E-02	Keratosis Hyperpig-mentation
Dieldrin	1.2	4.0	5.0E-05	2.9E-02	1E+00	4E+00	Liver lesions
Phthalate, bis (2 ethylhexyl)	80.5	100.0	2.0E-02	2.9E-02	3E-01	4E-01	Liver effects
Barium	103.2	187.0	5.0E-02	2.9E-02	6E-02	1E-02	Increased BP
Copper	23.9	56.0	1.3E+00	2.9E-02	2E-05	4E-05	GI distress
Cresol,p	8.0	8.0	5.0E-02	2.92E-02	5E-03	5E-03	Reduced body weight
1,2-Dichloro-ethylene	2922.5	7100.0	2.0E-02	2.9E-02	2E+01	5E+01	Liver effects
Lead	13.8	29.0	2.0E-01	2.9E-02	1E-01	3E-01	CNS effects
Nickel	29.2	29.0	2.0E-02	2.9E-02	4E-02	4E-02	Reduced body and organ wt.
Selenium	5.4	5.4	2.0E-03	2.9E-02	2E-02	2E-02	Dermatitis
Zinc	187.9	710.0	2.0E-01	2.9E-02	4E-02	1E-01	Anemia
Chromium	128.0	190.0	5.0E-03	2.9E-02	7.4E-01	1E+00	Liver lesions

Table 2B Cont'd

Hazard Index Sums	Average	Reasonable Maximum Exposure
Liver Effects	2E+00	5E+01
Keratosis	4E-02	4E-02
Increased BP	6E-02	1E-01
GI Distress	2E-05	4E-05
Reduced body weight	4E-02	4E-02
CNS Effects	1E-01	3E-01
Dermatitis	2E-02	2E-02
Anemia	4E-02	1E-01

TABLE 3: SUMMARY OF CONTAMINANTS OF CONCERN IN GROUND WATER ZONE 3

CONTAMINANTS OF CONCERN	AVERAGE CONCENTRATION (PPB)	MAXIMUM DETECTION (PPB)	FREQUENCY OF DETECTION
Benzo(a)anthracene	3.0	3.0	1/20
Benzo(b)flouoranthene	7.0	7.0	1/20
Phthalate,bis(2 ethylhexyl)	41.0	41.0	1/12
Trichloroethylene	20.0	130.0	5/25
Baruim	49.0	178.0	12/20
Copper	21.4	57.0	5/20
Lead	25.1	77.0	7/20
Nickel	16.4	19.8	2/12
Silenium	11.2	14.0	2/20
Zinc	31.0	53.9	12/13

TABLE 3A:
CARCINOGENIC RISKS FOR THE POSSIBLE FUTURE INGESTION
OF GROUND WATER Zone 1

CONTAMINANT OF CONCERN	CONCENTRATION (UG/1) AVG	MAX	CANCER POTENCY FACTOR MG/KG/d-^{1}	EXPOSURE FACTOR 1/MG/d	RISK ESTIMATE AVG	RISK ESTIMATE MAX
Benzo(a)anthracene	3.0	3.0	1.20E+01	2.9E-02	1E-01	1E-01
Benzo(b)fluoranthene	7.0	7.0	1.20E+01	2.9E-02	7E-01	7E-01
Phthalate, bis(2-ethylhexyl)	41.0	41.0	1.40E-02	2.9E-02	4E-05	4E-05
Trichloroethylene	20.0	130.0	1.10E-02	2.9E-02	7E-06	4E-05

TABLE 3B:
NONCARCINOGENIC RISKS FOR THE POSSIBLE FUTURE INGESTION OF GROUND WATER

CONTAMINANTS OF CONCERN	CONCENTRATION (UG/1) AVG	MAX	REFERENCE DOSE MG/KG/d	EXPOSURE FACTOR 1/KG/d	HAZARD INDEX AVG	HAZARD INDEX MAX	TOXICITY ENDOPOINT
Phthalate, bis-2 ethylhexyl	41.0	41.0	2.00E-02	2.9E-02	2E-02	2E-01	Liver effects
Barium	49.0	178.0	5.00E-02	2.9E-02	3E-02	1E-01	Increased BP
Copper	21.4	57.0	1.3E+00	2.9E-02	2E-05	4E-05	GI Distress
Lead	25.1	77.0	2.00E-01	2.9E-02	3E-01	8E-01	CNS effects
Nickel	16.4	19.8	2.00E-02	2.9E-02	2E-02	3E-02	Reduced body weight
Selenium	11.2	14.0	2.00E-03	2.9E-02	5E-02	6E-02	Dermatitis
Zinc	31.0	53.9	2.00E-01	2.9E-02	6E-03	1E-02	Anemia

Hazard Index Sums	Average	Reasonable Maximum Exposure
Liver effects	2E-01	2E-01
Increased BP	3E-02	1E-01
GI distress	2E-05	4E-05
CNS effects	3E-01	8E-01
Reduced body wt.	2E-02	3E-02
Dermatitis	5E-02	6E-02
Anemia	6E-03	1E-02

TABLE 4:SUMMARY OF CONTAMINANTS OF CONCERN IN SHALLOW SOILS (ZONE 2 LANDFILL AREA)

CONTAMINANTS OF CONCERN	AVERAGE CONCENTRATION (PPB)	MAXIMUM DETECTION (PPB)	FREQUENCY OF DETECTION
Arsenic	7262.5	49000.0	15/20
Benzo(a)anthracene	1329.3	5000.0	15/20
Benzo(a)pyrene	1246.1	4900.0	15/20
Benzo(a)fluoranthene	2092.1	8300.0	15/20
Chrysene	1314.8	5100.0	16/20
Dibenzo(a,h)anthracene	277.7	840.0	7/20
Dieldrin	1892.0	10750.0	17/19
Phthalate,bis (2 ethylhexyl)	173.4	240.0	5/16
Trichloroethylene	24.8	98.0	14/31
Barium	61356.7	247000.0	20/20
Copper	167748.9	213000.0	20/20
Cresol,p	1292.2	4100.0	4/20
Dichloroethylene	12.2	25.0	5/31
Lead	93904.4	457000.0	20/20
Nickel	9313.6	20000.0	14/20
Selenium	800	800	1/20
Zinc	76144.4	244000.0	20/20

TABLE 4A:
CARCINOGENIC RISKS FOR CHILDREN EXPOSED TO SHALLOW SOILS
Zone 2

CONTAMINANT OF CONCERN	CONCENTRATION (UG/1) AVG	MAX	CANCER POTENCY FACTOR MG/KG/d-1	RISK ESTIMATE AVG	RISK ESTIMATE MAX
Arsenic	7262.5	49000.0	1.75E+00	1E-07	1E-06
Benzo(a)anthracene	1329.3	5000.0	1.20E+01	4E-07	3E-06
Benzo(a)pyrene	1246.1	4900.0	1.20E+01	3E-07	3E-06
Benzo(a)fluoranthene	2092.1	8300.0	1.20E+01	6E-01	4E-06
Chyrsene	1314.8	5100.0	1.20E+01	4E-07	3E-06
Dibenzo(a,h) anthracene	277.7	840.0	1.20E+01	7E-08	5E-07
Dieldrin	1892.0	10750.0	1.60E+01	7E-07	8E-06
Phthalate,bis (2,ethylhexyl)	173.4	240.0	1.40E-02	5E-11	2E-10
Trichloroethylene	24.8	98.0	1.10E-02	3E-11	3E-10

TABLE 4B:
NONCARCINOGENIC RISKS FOR CHILDREN EXPOSED TO SHALLOW SOILS ZONE 2

CONTAMINANTS OF CONCERN	CONCENTRATION (UG/1) AVG	CONCENTRATION (UG/1) MAX	REFERENCE DOSE MG/KG/d	HAZARD INDEX AVG	HAZARD INDEX MAX	TOXICITY ENDOPOINT
Arsenic	7262.5	49000.0	1.00E-03	5E-03	3E-02	Keratosis Hyperpig-mentation
Dieldrin	1892.0	10750.0	5.00E-05	5E-01	3E+00	Liver lesions
Phthalate,bis (2 ethylhexyl)	173.4	240.0	2.00E-02	1E-04	2E-04	Liver
Barium	61356.7	247000.0	5.00E-02	6E-03	2E-02	Increased BP
Copper	167748.9	213000.0	7.40E-05	2E-05	3E-04	GI irritation
Cresol,p	1292.2	4100.0	5.00E-02	3E-04	1E-03	Reduced body weight
1,2-Dichloro-ethylene	12.2	25.0	2.00E-02	9E-05	2E-04	Increased serum alka-line phospha-tase
Lead	93904.4	457000.0	5.70-04	5E-02	2E-01	CNS effects
Nickel	9313.6	20000.0	2.00E-02	2E-03	5E-03	Reduced body weight
Selenium	800.0	800.0	3.00E-03	6E-04	6E-04	Dermatitis
Zinc	76144.4	244000.0	2.00E-01	3E-03	9E-03	Anemia

Hazard Index Sums	Average	Reasonable Maximum Exposure
Liver Effects	5E-01	3E+00
Reduced body weight	2E-03	6E-03
Keratosis	5E-03	3E-02
Increased BP	6E-03	2E-02
GI irritation	2E-05	3E-04
Anemia	3E-03	9E-03
Dermatitis	6E-04	6E-04

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