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NIROP FRIDLEY
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Subsurface Investigation Report
and
Soil Removal Action Plan
for
Hazardous Materials Building Addition
Naval Industrial Reserve Ordnance Plant
Fridley, Minnesota

Submitted to:

FMC Corporation

Submitted by:

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1.0 INTRODUCTION

At the request of FMC Corporation (FMC), Bay West, Inc., has conducted a subsurface investigation beneath the proposed hazardous materials building addition at the Naval Industrial Reserve Ordnance Plant (NIROP) in Fridley, Minnesota. The goals of the investigation were to:

1. Identify the distribution and volume of fuel oil contamination in the soil at concentrations greater than or equal to 1 part per million (ppm).
2. Identify the distribution and volume of fuel oil and low level trichloroethene (TCE) contaminated soil (TCE less than 1.82 mg/kg, as determined by EPA Method 8010 extractions).
3. Identify the distribution and volume of TCE contaminated soil at concentrations greater than the Land Disposal Restriction (LDR) level for TCE of 1.82 mg/kg as determined by EPA method 8010 extractions.

Details regarding the subsurface investigations are contained below. Per FMC's request, Bay West has also prepared a conceptual plan for completing a Soil Removal Action at the referenced site.

1.1 Site Location

NIROP's proposed hazardous materials building addition (herein referred to as "the site") is located at 4800 East River Road, Fridley, Minnesota. The site is situated in the NW 1/4 of the SW 1/4 of Section 27, Township 30 North, Range 23 West (Figure 1). The latitude and longitude of the site (to the nearest 30 seconds) are 45°3'30" and 93°17'00". The site is approximately 300 feet east of East River Road and is located adjacent to NIROP's existing facility operated by FMC (Figure 2).

1.2 General Facility Background Information

Historical manufacturing operations and past disposal practices at NIROP have resulted in contamination of the surficial aquifer by select chlorinated hydrocarbons. Ground water monitoring instituted as a result of the above-described contamination indicates that the surficial ground water flows across the facility in a southerly direction. In order to contain the surficial ground water contamination, NIROP has proposed to the Minnesota Pollution Control Agency (MPCA) and U.S. Environmental Protection Agency (EPA) to install a ground water recovery/containment system on the property. The proposed location of one of the recovery wells is approximately 100 feet southwest of the site.

1.3 Previous Site Investigations

During the completion of a foundation footing boring at the site, Twin Cities Testing observed a "foreign" chemical odor from approximately 1 foot below grade (bg) to the completion depth of the boring (22 feet). At the request of FMC, Bay West completed a series of subsurface investigations to characterize the contamination previously detected beneath the site.

Bay West's subsurface investigations have primarily involved the completion of soil borings to allow for the collection and analysis of soil samples. Bay West completed a total of 42 soil borings beneath the site between July and September 1991.

A series of 13 soil borings was completed on July 15-16, 1991. The results of the July 1991 investigation are summarized in Bay West's August 5, 1991 report entitled "Subsurface Investigation Report, Hazardous Materials Building Addition, Naval Industrial Reserve Ordnance Plant, Fridley, Minnesota."

To further define the subsurface contamination, Bay West completed an additional 8 soil borings at the site on August 9, 1991. Data generated during the completion of the August 1991 investigation are contained in Bay West's August 30, 1991 report entitled "Subsurface

Investigation Report, August 9, 1991 Field Work - Hazardous Materials Building Addition, Naval Industrial Reserve Ordnance Plant, Fridley, Minnesota."

The results of the above investigations suggested that subsurface contamination consisting primarily of fuel oil-based hydrocarbons and low concentrations of chlorinated hydrocarbons (namely TCE) exists beneath the site. To further identify the distribution and volume of fuel oil- and TCE-based soil contamination, and, consistent with the MPCA and EPA's request, Bay West completed 21 additional soil borings on September 25 - 30, 1991. The September 1991 investigation was completed in accordance with Bay West's Work Plan dated September 20, 1991. The September 20, 1991 Work Plan was approved for implementation by the MPCA in correspondence dated September 24, 1991.

2.0 METHODOLOGY

2.1 Soil Borings

Soil borings were conducted with a truck-mounted auger drill rig equipped with 2.75-inch or 3.25-inch inside diameter (I.D.) hollow stem augers (HSAs) and/or a 3-inch outside diameter (O.D.) hand auger. The borings were completed in general accordance with ASTM D 1452 "Soil Investigation and Sampling by Auger Borings."

During the completion of soil borings using HSAs, representative soil samples were typically collected at 5-foot intervals from approximately 3 - 4.5 feet below grade (bg) to the water table interface using a 2-inch O.D. split-barrel sampler in general accordance with ASTM D 1856 "Penetration Tests and Split-Barrel Sampling of Soils." During the completion of borings using the hand auger, soil samples were collected on a continuous basis.

All soil samples were logged by a qualified geologist in the field. Information collected during the completion of the soil borings includes:

- o soil classification
- o structural features
- o vertical extent of sediment zones
- o depth to water-bearing zones
- o visual and olfactory characterization of contamination
- o blow counts, color and grain-size distribution

All HSAs and hand augers, split-barrel samplers, and other drilling tools were steam-cleaned prior to use at the site and each boring location. Split-barrel samplers and hand augers were decontaminated between sampling events with a detergent (alconox) wash followed by a tap water rinse.

2.2 Soil Headspace Analysis

Jar headspace analysis was conducted during the completion of the soil borings in accordance with the MPCA's "Jar Headspace Analytical Screening Procedure." Headspace analysis was performed on samples collected during the completion of the borings using either a HNU Photoionization Detector (PID) or OVM organic vapor analyzer equipped with a 10.2 eV lamp.

2.3 Soil Chemical Analyses

Representative soil samples were collected from the soil borings for laboratory confirmation of the field observations and headspace analytical results. Soil samples were analyzed at Bay West's Analytical Laboratory for volatile organic compounds according to EPA Methods 8010 and 8020, and total petroleum hydrocarbons (TPH) as #2 fuel oil according to EPA Method 5030/8015 modified.

3.0 RESULTS

3.1 Site Stratigraphy

A total of 42 soil borings (SB-1 - SB-42) were completed at the site to depths between 6 and 25 feet bg. Soil boring locations are illustrated in Figure 3. Soil boring logs are contained in Appendix 1 of the Attachment.

Although variable in texture and grain-size distribution, the sediments encountered beneath the site are primarily composed of a light-gray, poorly to moderately sorted medium to coarse sand. Also encountered within several borings to a depth of 4 to 8 feet bg was a brown to black, organic-rich, silty clay to clayey silt.

Ground water (free ground water or water-saturated soils) was encountered at depths of approximately 19 to 21 feet bg. Historical ground water elevation data suggest that the water table fluctuation zone may extend to 16 - 17 feet bg. The predominant water-bearing strata appears to be the medium to coarse sand unit. Previous investigations in the vicinity of the site suggest that the surficial ground water flows in a southerly direction.

3.2 Headspace Analytical Results

Headspace readings were collected to assist in delineating the extent of subsurface contamination. Headspace results are summarized in Table 1. Headspace logs are contained in Appendix 2 of the Attachment. Cross-sections illustrating the headspace results are contained on Figures 4 - 7. Cross-section locations are depicted on Figure 8.

To summarize the results, headspace readings ranged from <1 ppm in several borings to 471 ppm in a sample collected from SB-39 at a depth of 4 - 5 feet bg.

Headspace analytical data suggest that elevated (headspace readings greater than 10 ppm) levels of ionizable hydrocarbons are primarily associated with soils from grade to 10 feet bg. In most borings, the levels of ionizable hydrocarbons decreased markedly with

increasing depth from grade. However, headspace readings from "deep" soil borings (completed to the water table interface) SB-5, SB-21, SB-25, and SB-35 increased with increasing depth.

Several soil borings exhibited an increase in ionizable hydrocarbons at or near the water table interface. This increase is likely attributed to contaminants associated with the surficial ground water and/or water table fluctuation zone.

3.3 Soil Chemical Analyses

To document the concentration and distribution of the subsurface soil contamination, selected soil samples were submitted for chemical analysis. Soil samples were analyzed for volatile organic hydrocarbons and total hydrocarbons as #2 fuel oil. A summary of detected compounds is contained in Table 1. Copies of the analytical reports and chain-of-custody forms are contained in Appendix 3 of the Attachment. Cross-sections illustrating the analytical results are contained on Figures 4 - 7. Cross-section locations are contained on Figure 8.

To summarize the results, the primary non-chlorinated volatile organic compounds detected beneath the site were xylenes, and ethyl benzene ranging in concentrations from 0.044 mg/kg (xylenes - SB-12 18-20 ft) to 39 mg/kg (xylenes - SB-29 4.5-6.5 ft). Toluene was also detected in SB-9 3-5 ft at a concentration of 0.091 mg/kg.

TCE was the primary chlorinated hydrocarbon detected beneath the site. TCE was detected above the detection limit in soil borings SB-10, SB-12, SB-14, SB-17, SB-19, SB-27, SB-28, SB-30 - SB-33, SB-37, and SB-38 in concentrations ranging from 0.03 mg/kg (SB-10 18-20 ft) to 75 mg/kg (SB-14 6 ft). In addition, vinyl chloride and t,1-2,dichloroethene were detected in a soil sample collected from SB-15 (6 ft) at concentrations of 1.2 mg/kg and 0.26 mg/kg, respectively, and tetrachloroethene was detected in SB-33 (4.5-5.5 ft) at a concentration of 0.053 mg/kg.

TPH as #2 fuel oil was detected in several borings completed beneath the site. TPH as #2 fuel oil ranged in concentrations from 2.1 mg/kg (SB-33 19.5-21.5 ft) to 4,900 mg/kg (SB-14 6 ft). TPH as fuel oil was not detected in soil borings SB-1 - SB-4, SB-8, SB-11, SB-17 - SB-20, SB-24, SB-26, and SB-34.

4.0 DISCUSSION AND CONCLUSIONS

Based on soil headspace and chemical analytical data obtained during the subsurface investigations, subsurface contamination consisting primarily of fuel oil-based hydrocarbons (including xylenes and ethyl benzene) exists beneath the site. Chemical analysis also detected chlorinated hydrocarbons (primarily TCE) in selected soil samples collected from beneath the site.

Available information regarding historical facility operations suggests that the fuel oil-based hydrocarbon contamination may be associated with past scrap metal loading operations within the site. Headspace and soil chemical analyses indicate that the highest levels of subsurface contamination are primarily located within 10 feet of grade.

In most borings, headspace concentrations decreased with increasing depth from grade. However, headspace results from borings SB-5, SB-21, SB-25, and SB-35 completed in the vicinity of the sump and southernmost former track drain increased with increasing depth. These results suggest that the former track drain and/or sump were major contributors to the subsurface contamination encountered at the water table interface in the southern portion of the site.

Analysis of soil samples collected from several borings completed in the immediate vicinity of the former railroad tracks detected fuel oil-based hydrocarbons and chlorinated hydrocarbons (primarily TCE). Fuel oil-based hydrocarbons ranged in concentration from 2.1 mg/kg to 4,900 mg/kg. Except for an area centered approximately 15 feet north of the former sump and approximately 10 feet west of the former railroad tracks, the concentrations of TCE in the soil were less than the federally promulgated Land Disposal

Restriction (LDR) concentration. The LDR concentration for TCE is 0.091 mg/L using the Toxicity Characteristic Leaching Procedure (TCLP). The EPA method 8010-generated LDR concentration, incorporating a "20 times" factor (Ann Bidwell {MPCA}, personal communication on July 30, 1991) to equate TCLP and EPA Method 8010 extractions, would be 1.82 mg/kg.

5.0 SOIL REMOVAL ACTION

Consistent with 40 CFR Part 300.415, a Removal Action has been proposed for the site to minimize the migration of the near surface soil contamination. The Removal Action will also allow for the construction of the Hazardous Materials Building addition proposed for the site. The proposed Removal Action consists of soil excavation, soil treatment/disposal, and in-situ vapor extraction, if required. The Removal Action, if conducted, would be completed under an existing Federal Facilities Agreement with the MPCA and EPA. Following conceptual approval of this plan be the MPCA and EPA, a site Health and Safety Plan (HASP) will be developed and implemented for Removal Action activities in accordance with 29 CFR 1910.120. Details regarding the proposed Removal Action are contained below.

5.1 Soil Excavation

Based on data collected during the subsurface investigations, soil beneath the site can be grouped into the following four categories:

I. Soil not impacted by chlorinated volatile organic compounds or fuel oil-based contamination (Figure 9)

II. Soil impacted by fuel oil-based hydrocarbons only (Figure 10)

III. Soil impacted by fuel oil-based hydrocarbons and TCE below the EPA Method 8010 derived LDR level of 1.82 mg/kg (Figure 11)

IV. Soil impacted by fuel oil-based hydrocarbons and TCE above the EPA Method 8010 derived LDR level (Figure 12)

To estimate the depths (and hence the volumes) of soil to be excavated and treated/disposed, the following criteria were used:

Category I Soil

- Category I soil will be removed to the extent necessary to facilitate the removal of Category II - IV soil.

Category II Soil

- In the absence of soil chemical data, the depths at which the soil headspace concentration is below 1 ppm were generally used as the lower extent of contamination.
- Where chemical data is available, the depths at which the chemical analyses indicated that total petroleum hydrocarbons as fuel oil is below the analytical detection limit were used as the lower extent of contamination.
- At the southern portion of the site, a maximum excavation depth of approximately 15 - 16 feet bg was selected based on capabilities of standard excavating equipment and the location of the uppermost zone of ground water fluctuation.
- At the northern and eastern portions of the site immediately adjacent to existing buildings, an excavation depth of approximately 6 feet bg (approximate depth to existing footings) with a 1:1 slope to approximately 8 to 9.5 feet bg away from the buildings was selected to minimize potential damage to the structures.

Category III Soil

- The depths at which TCE was not detected following the sampling interval where TCE was detected (below the LDR level), were used as the lower extent of contamination.

Category IV Soil

- The depths at which TCE was not detected following the sampling interval where TCE was detected above the LDR level, were used as the lower extent of contamination.

Incorporating the above criteria, the estimated volumes of Category II - IV soil within the proposed "foot print" of the building are as follows: Category II - 1,300 cubic yards, Category III - 650 cubic yards, and Category IV - 40 cubic yards. In addition, approximately 300 cubic yards of Category II soil located immediately south of the building footprint will be excavated as part of the Removal Action.

In order to minimize soil slumping and cross-mixing during the excavation operation, soil removal will be conducted using, on average, 3-foot lifts. Excavation of the lifts will proceed from Category IV soil to Category I soil. Category I - III soil will be stockpiled separately at NIROP in 75 - 100 cubic yard piles for confirmatory sampling. Soil samples will be collected from the soil piles according the MPCA's May 1991 guidance document entitled "Excavation of Petroleum Contaminated Soil." Soil samples for Category I-IV soil will be analyzed for total petroleum hydrocarbons and volatile organic compounds according to EPA Methods 8015 and 8010/8020 modified, respectively. In addition, 3 discrete grab samples of Category II soil will be collected and analyzed for total lead to facilitate in-state thermal treatment (see Section 5.2.1).

Category I - Category III soil will be stockpiled on, and covered with, polyethylene sheeting until treatment/disposal is arranged. Category IV soil will be stored in containers (roll-off boxes or transport trailers) until off-site disposal is coordinated. All Category IV soil containers will be lined and covered with polyethylene sheeting to prevent infiltration of precipitation.

Excavation areas and depths will be controlled using "excavation control points." The excavation control points will consist of 2-inch Schedule 40 PVC pipe completed to a depth of 18 feet bg at locations indicated in Figures 9 - 12. The control points will be constructed of 3-foot sections of pipe for easy dismantling as the excavation proceeds to the proposed completion depths. Excavation control points will be installed using 3.25-inch I.D. hollow stem augers.

Soil sampling during the excavation activities will be completed in general accordance with the MPCA's May 1991 guidance document entitled "Excavation of Petroleum Contaminated Soil." To summarize, a soil sample will be collected for vapor headspace (Jar Headspace)

analysis every 10 cubic yards. Upon reaching the proposed excavation completion depth, a soil sample will be collected from the bottom of the excavation for confirmatory chemical analysis at the approximate locations contained in Figure 9-12. Samples will be analyzed for total petroleum hydrocarbons as fuel oil and volatile organic hydrocarbons according to EPA Methods 8015, and 8010/8020 modified, respectively.

5.2 Soil Disposal/Treatment

The following treatment/disposal alternatives will be pursued for the excavated soil:

Category I Soil - Excavation backfill material at the site.

Category II Soil - In-state thermal processing at an MPCA approved facility

Category III Soil - Land Application within NIROP property

Category IV Soil - Incineration at an EPA-licensed hazardous waste treatment, storage, and disposal (TSD) facility

Details regarding the disposal/treatment alternatives for Category II - IV soil are contained below.

5.2.1 In-State Thermal Treatment of Category II Soil

Approximately 1,600 cubic yards of Category II soil will be processed at an in-state thermal treatment facility operating in compliance with a current MPCA air emission permit. In accordance with MPCA guidelines, an application signed by the thermal treatment facility operator outlining the proposed treatment will be submitted to the MPCA, the city of Fridley, and local units of government where the treatment facility is located following the MPCA's conceptual approval of this plan.

Soil disposition logs and post-burn analysis and reporting will be conducted by the treatment facility as outlined in the MPCA's May 1991 guidance document entitled "Thermal Treatment of Petroleum Contaminated Soil."

In the event that Category II soil cannot be processed until spring, the soil will be stockpiled on, and covered with, polyethylene sheeting in a manner to eliminate the migration of soil or leachate into surface water or the underlying native soil and ground water. Soil will be stockpiled in the general vicinity of the proposed land application site (Section 5.2.2).

5.2.2 Land Application of Category III Soil

The proposed treatment alternative for the estimated 650 cubic yards of Category III soil is land application at NIROP. As previously stated, this alternative would only be used for soil impacted by fuel oil-based hydrocarbons and TCE below the LDR concentration.

Land Application Area Location

The proposed land application area is located in the "North Forty" of NIROP (Figure 13). MPCA recommended site characteristics and actual site characteristics are summarized below:

- MPCA-allowed maximum site slope: 6 percent

  Actual site slope: approximately 2 percent

- MPCA-allowed minimum distance to surface water: 100 feet

  Actual minimum distance to surface water: approximately 1,500 feet

- MPCA-allowed minimum distance to residential property lines or buildings: 200 feet

  Actual minimum distance to residential property lines or buildings: approximately 2,500 feet to residential property lines, and 300 feet to occupied buildings

- MPCA-allowed minimum depth to seasonal high water table, tile lines or bedrock: 8 feet for sandy soil

  Actual minimum distance to seasonal high water table, tile lines, or bedrock: approximately 16 feet

- MPCA-recommended soil characteristics: "moderate to high" fertility, unless enhanced by fertilizer application

  Actual soil characterisics: low fertility -- fertility will be enhanced by fertilizer application

In addition, the proposed site is secured by a 9-foot high chain link fence and is restricted to general public access.

Required Permits/Approvals

Following the MPCA's conceptual approval of this plan, applicable National Contingency Plan (NCP) protocol will the adhered to and the following permits/approvals will be obtained before initiating the land application of Category III soil.

- Publish in a local newspaper and make available for public comment the Administrative Record File
- MPCA Permit to Land Apply Petroleum Contaminated Soil
- City of Fridley Permit/Approval to Land Apply Contaminated Soil
- Anoka County Permit/Approval to Land Apply Contaminated Soil

Conceptual Land Application Plan

Subsequent to obtaining the necessary permits/approvals, Category III soil will be land applied at the specified location in a 4-inch lift. Assuming that the total volume of soil to be land applied is approximately 650 cubic yards, the area required for land application is approximately 1.2 acres (approximately 52,300 ft^2).

To minimize sediment runoff during precipitation events, the land application site will be bordered by an anchored, geosynthetic fabric (silt fence) as diagrammed in Figure 14.

To enhance soil fertility and accelerate contaminant degradation, the following nutrients would be applied to the contaminated soil upon the initial application at the site:

- Nitrogen: 108 pounds (90 pounds per acre)
- Sulfur: 48 pounds (40 pounds per acre)
- Phosphorous (P_2O_5): 144 pounds (140 pounds per acre)

To further enhance hydrocarbon breakdown, the soils will be disked at a minimum, on a monthly basis, between April 1 and November 1, for a minimum of 6 months. Site nutrient concentrations will be monitored following the first year of land application to determine if additional fertilizer application is warranted.

Follow-up sampling and reporting will be conducted as outlined in the MPCA's guidance documents entitled "Land Application of Petroleum Contaminated Soil" dated May 1991, and "Soil Monitoring Results for Land-Applied Petroleum Contaminated Soil" dated May 1990. Soil samples will be analyzed for volatile organic hydrocarbons according to EPA Methods 8010 and 8020, and total petroleum hydrocarbons as fuel oil according to EPA Method 5030/8015 modified.

Treatment will continue until TCE is no longer present in detectable concentrations (approximately 0.050 mg/kg as determined from EPA Method 8010 analysis) and total petroleum hydrocarbons as fuel oil concentrations do not exceed 10 mg/kg as determined from EPA Method 8015 modified analysis.

Contaminant Loading and Remediation Time-Frame

Based on a soil volume of 650 cubic yards, and a worst-case TCE concentration of 1.82 mg/kg (EPA Method 8010-derived LDR concentration for TCE), approximately 3.3 pounds of TCE would be degraded (biological, physical, and chemical degradation) during the land application process. It is assumed that the TCE degradation will be completed within one year.

The air emission as a result of TCE volatilization is not expected to be significant. Even in the improbable scenario of the TCE totally volatilizing within 1 day of being land applied, the TCE emission rate of approximately 17,390 ug/sec would still be below the MPCA's TCE significant emission rate (SER) of 22,600 ug/sec.

Based on a soil volume of 650 cubic yards, and an average total petroleum hydrocarbons as fuel oil concentration of 1,500 mg/kg, approximately 2,730 pounds of petroleum-based hydrocarbons will be degraded (biological, physical, and chemical degradation) during the land application process. It is probable that the total petroleum hydrocarbon degradation to levels below 10 mg/kg will be completed within two years.

In the event that the land application process cannot be initiated until the spring of 1992, Category III soil will be stockpiled on, and covered with, polyethylene sheeting to eliminate migration of sediment or leachate into surface water or the underlying native soil and ground water.

5.2.3 Out-State Incineration of Category IV Soil

The proposed disposal alternative for the estimated 40 cubic yards of Category IV soil is out-state incineration at an EPA-licensed hazardous waste TSD facility. Category IV soil will be managed, transported, and disposed as a hazardous waste.

Transportation to the TSD facility will be coordinated such that the Category IV soil will not be stored at NIROP past 90 days following the accumulation date. Properly completed manifests will accompany the Category IV soil to the TSD facility and will be submitted to the MPCA and U.S. EPA.

5.3 In-Situ Vapor Extraction

As a final option, should it be determined by NIROP and the MPCA/EPA that excavation is not feasible to completely remove Category III soil to approximately 15 feet below grade in the vicinity of the northermost former track drain, an in-situ vapor extraction system will be installed. The vapor extraction system will consist of a vapor recovery well located in the vicinity of the former track drain (and SB-27) and a regenerative blower (vacuum source). The proposed location of the vapor extraction point is contained in Figure 15.

The extraction well will be constructed of 2-inch PS stainless steel with 0.030-inch slot openings. Riser pipe material will consist of 2-inch solid black steel pipe. The screened section of the extraction well will be completed from approximately 9 to 16 feet bg.

Discharge piping will be trenched within the clean backfill material to an area outside of the proposed building addition. The discharge stand-pipe will be constructed such that it will extend above the roof of the building addition.

Following installation and system start-up, the potential impact of the air emissions from the venting system will be assessed according to the MPCA's May 1991 guidance document "Air Emission Controls: II. Soil Venting Systems." The need for emission controls will be based on the initial system off-gas analytical results.

System off-gas samples will be collected on a quarterly basis. Emission rates will be reported to the MPCA following the receipt of the quarterly sampling analytical results.

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TABLE 1
Summary of Soil Headspace and Chemical Analyses

Sample Number		HS	TPH	TCE	XYL	EB	Other
		Parameter (ppm)					
SB-1	4-6 ft	0	NA	NA	NA	NA	
	8-10 ft	0	NA	NA	NA	NA	
	13-15 ft	0	NA	NA	NA	NA	
	18-20 ft	0.2	NA	NA	NA	NA	
	23-25 ft	3.0	BDL	BDL	BDL	BDL	
SB-2	3-5 ft	0	NA	NA	NA	NA	
	4-6 ft	0.2	BDL	BDL	BDL	BDL	
	8-10 ft	0.2	NA	NA	NA	NA	
	13-15 ft	0	NA	NA	NA	NA	
	18-20 ft	0	BDL	BDL	BDL	BDL	
SB-3	4-6 ft	0	NA	NA	NA	NA	
	8-10 ft	0	NA	NA	NA	NA	
	13-15 ft	0	NA	NA	NA	NA	
	18-20 ft	0	NA	NA	NA	NA	
	23-25 ft	0	BDL	BDL	BDL	BDL	
SB-4	4-6 ft	1.8	NA	NA	NA	NA	
	8-10 ft	1.0	NA	NA	NA	NA	
	13-15 ft	7.1	BDL	BDL	BDL	BDL	
	18-20 ft	1.3	NA	NA	NA	NA	
	23-25 ft	0.5	BDL	BDL	BDL	BDL	
SB-5	3-5 ft	1.2	NA	NA	NA	NA	
	8-10 ft	5.4	NA	NA	NA	NA	
	13-15 ft	128	740	BDL	0.91	0.53	
	18-20 ft	150	3400	BDL	2.9	2.0	
	23-25 ft	128	NA	NA	NA	NA	
SB-6	3-5 ft	3.0	NA	NA	NA	NA	
	8-10 ft	25	47	BDL	BDL	BDL	
	13-15 ft	0.6	NA	NA	NA	NA	
	18-20 ft	0.5	BDL	BDL	BDL	BDL	
	23-25 ft	2.8	NA	NA	NA	NA	

Notes:

HS - Jar Headspace Concentration
TPH - Total Petroleum Hydrocarbons as Fuel Oil
TCE - Trichloroethene
XYL - Xylenes
EB - Ethyl Benzene
NA - Not Analyzed
BDL - Not Detected Above Detection Limit

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TABLE 1 (cont.)
Summary of Soil Headspace and Chemical Analyses

Sample Number		HS	TPH	TCE	XYL	EB	Other
				Parameter (ppm)			
SB-7	3-5 ft	6.8	5.4	BDL	BDL	BDL	
	8-10 ft	0.2	NA	NA	NA	NA	
	13-15 ft	0	NA	NA	NA	NA	
	18-20 ft	0.5	BDL	BDL	BDL	BDL	
SB-8	3-5ft	1.8	BDL	BDL	BDL	BDL	
	8-10 ft	0.2	NA	NA	NA	NA	
	13-15 ft	0	NA	NA	NA	NA	
	18-20 ft	0.1	BDL	BDL	BDL	BDL	
SB-9	3-5 ft	4.8	4.7	BDL	0.16	0.062	TL-.091
	8-10 ft	0.2	NA	NA	NA	NA	
	13-15 ft	0	NA	NA	NA	NA	
	18-20 ft	0.1	BDL	BDL	BDL	BDL	
SB-10	3-5 ft	121	3800	0.12	15	5.6	
	8-10 ft	3.8	NA	NA	NA	NA	
	13-15 ft	2.1	NA	NA	NA	NA	
	18-20 ft	1.2	BDL	0.033	BDL	BDL	
SB-11	3-5 ft	1.0	BDL	BDL	BDL	BDL	
	8-10 ft	0.8	NA	NA	NA	NA	
	13-15 ft	0.2	NA	NA	NA	NA	
	18-20 ft	0.2	BDL	BDL	BDL	BDL	
SB-12	3-5 ft	84	1700	0.12	1.2	1.5	
	8-10 ft	41	NA	NA	NA	NA	
	13-15 ft	5.3	NA	NA	NA	NA	
	18-20 ft	13.4	500	0.1	0.044	BDL	

Notes:

HS - Jar Headspace Concentration
TPH - Total Petroleum Hydrocarbons as Fuel Oil
TCE - Trichloroethene
XYL - Xylenes
EB - Ethyl Benzene
TL - Toluene
NA - Not Analyzed
BDL - Not Detected Above Detection Limit

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TABLE 1 (cont.)
Summary of Soil Headspace and Chemical Analyses

Sample Number	HS	TPH	Parameter (ppm) TCE	XYL	EB	Other
SB-13 3-5 ft	153	1300	BDL	23	4.3	
8-10 ft	40	NA	NA	NA	NA	
13-15 ft	1.5	NA	NA	NA	NA	
18-20 ft	0.4	BDL	BDL	BDL	BDL	
SB-14 3 ft	18	NA	NA	NA	NA	
6 ft	400	4900	75	24	6.4	
			0.99 mg/L*			
SB-15 3 ft	19	NA	NA	NA	NA	
6 ft	50	58	BDL	7.5	1.2	VC-1.2
						DC-.26
SB-16 3 ft	14	NA	NA	NA	NA	
6 ft	18	6.1	BDL	BDL	BDL	
SB-17 3 ft	1.8	BDL	0.10	BDL	BDL	
6 ft	1.5	NA	NA	NA	NA	
SB-18 3-5 ft	0.2	BDL	BDL	BDL	BDL	
8-10 ft	0.3	NA	NA	NA	NA	
SB-19 3-5 ft	1.8	BDL	0.29	BDL	BDL	
8-10 ft	0.4	NA	NA	NA	NA	
SB-20 3-5 ft	4.1	BDL	BDL	BDL	BDL	
8-10 ft	0.4	NA	NA	NA	NA	
SB-21 3-5 ft	0.2	NA	NA	NA	NA	
8-10 ft	185	NA	NA	NA	NA	
13-15 ft	215	1400	BDL	24	BDL	
18-20 ft	215	NA	NA	NA	NA	

Notes:

HS - Jar Headspace Concentration
TPH - Total Petroleum Hydrocarbons as Fuel Oil
TCE - Trichloroethene
XYL - Xylenes
EB - Ethyl Benzene
VC - Vinyl Chloride
DC - t,1-2,Dichloroethene
NA - Not Analyzed
BDL - Not Detected Above Detection Limit
* - As Determined by TCLP Analysis

Bay West

TABLE 1 (cont.)
Summary of Soil Headspace and Chemical Analyses

Sample Number		HS	TPH	TCE	XYL	EB	Other
				Parameter (ppm)			
SB-22	4.5-6.5 ft	3	7.1	BDL	BDL	BDL	
	9.5-11.5 ft	1	BDL	BDL	BDL	BDL	
	14.5-16.5 ft	0.1	NA	NA	NA	NA	
	19.5-21.5 ft	0.1	NA	NA	NA	NA	
SB-23	4.5-6.5 ft	9	7.0	BDL	BDL	BDL	
	9.5-11.5 ft	0.1	NA	NA	NA	NA	
	14.5-16.5 ft	0	NA	NA	NA	NA	
	19.5-21.5 ft	0	NA	NA	NA	NA	
SB-24	4.5-6.5 ft	0.4	BDL	BDL	BDL	BDL	
	9.5-11.5 ft	0.4	NA	NA	NA	NA	
	14.5-16.5 ft	0.1	NA	NA	NA	NA	
	19.5-21.5 ft	0.4	NA	NA	NA	NA	
SB-25	4.5-6.5 ft	30	2100	BDL	BDL	BDL	
	9.5-11.5 ft	39	750	BDL	2.9	BDL	
	14.5-16.5 ft	73	3300	BDL	14	BDL	
	19.5-21.5 ft	80	1100	BDL	7.0	BDL	
SB-26	4.5-6.5 ft	11	BDL	BDL	BDL	BDL	
	9.5-11.5 ft	1.5	BDL	BDL	BDL	BDL	
	14.5-16.5 ft	0.2	NA	NA	NA	NA	
	19.5-21.5 ft	1.5	BDL	BDL	BDL	BDL	
SB-27	4.5-6.5 ft	36	1900	BDL	19	5.9	
	9.5-11.5 ft	2.1	BDL	0.051	BDL	BDL	
	14.5-16.5 ft	1.5	BDL	BDL	BDL	BDL	
	19.5-21.5 ft	11.4	BDL	0.075	BDL	BDL	
SB-28	4.5-6.5 ft	40	13.9	BDL	1.5	0.20	
	9.5-11.5 ft	2.1	BDL	BDL	BDL	BDL	
	14.5-16.5 ft	1.3	BDL	BDL	BDL	BDL	
	19.5-21.5 ft	1.7	BDL	0.035	BDL	BDL	

Notes:

HS - Jar Headspace Concentration
TPH - Total Petroleum Hydrocarbons as Fuel Oil
TCE - Trichloroethene
XYL - Xylenes
EB - Ethyl Benzene
NA - Not Analyzed
BDL - Not Detected Above Detection Limit

Bay West

TABLE 1 (cont.)
Summary of Soil Headspace and Chemical Analyses

Sample Number	HS	TPH	TCE	XYL	EB	Other
			Parameter (ppm)			
SB-29 4.5-6.5 ft	56	2400	BDL	39	7.4	
9.5-11.5 ft	3.2	BDL	BDL	BDL	BDL	
14.5-16.5 ft	9.0	BDL	BDL	BDL	BDL	
19.5-21.5 ft	1.2	BDL	BDL	BDL	BDL	
SB-30 4.5-6.5 ft	264	2100	15	2.0	1.9	
9.5-11.5 ft	9.1	2.2	BDL	BDL	BDL	
14.5-16.5 ft	2.8	BDL	BDL	BDL	BDL	
19.5-21.5 ft	27.0	BDL	BDL	BDL	BDL	
SB-31 4.5-6.5 ft	185	2000	2.6	4.9	3.8	
9.5-11.5 ft	9.4	BDL	BDL	BDL	BDL	
14.5-16.5 ft	28.6	BDL	BDL	BDL	BDL	
19.5-21.5 ft	52.3	BDL	BDL	BDL	BDL	
SB-32 4.5-6.5 ft	115	2200	1.2	10	1.7	
9.5-11.5 ft	24	43	0.15	BDL	BDL	
14.5-16.5 ft	4.9	3.1	BDL	BDL	BDL	
19.5-21.5 ft	47	BDL	0.067	BDL	BDL	
SB-33 4.5-6.5 ft	28	500	0.041	0.16	0.21	PC-.053
9.5-11.5 ft	24	450	BDL	0.65	0.36	
14.5-16.5 ft	4.3	8.9	BDL	BDL	BDL	
19.5-21.5 ft	6.0	2.1	BDL	BDL	BDL	
SB-34 4.5-6.5 ft	3.1	BDL	BDL	BDL	BDL	
9.5-11.5 ft	2.5	BDL	BDL	BDL	BDL	
14.5-16.5 ft	3.8	BDL	BDL	BDL	BDL	
19.5-21.5 ft	6.4	BDL	BDL	BDL	BDL	
SB-35 4.5-6.5 ft	87	1300	BDL	4.8	0.82	
9.5-11.5 ft	97	1100	BDL	1.6	BDL	
14.5-16.5 ft	135	2200	BDL	11	4.0	
19.5-21.5 ft	144	990	BDL	2.4	1.3	

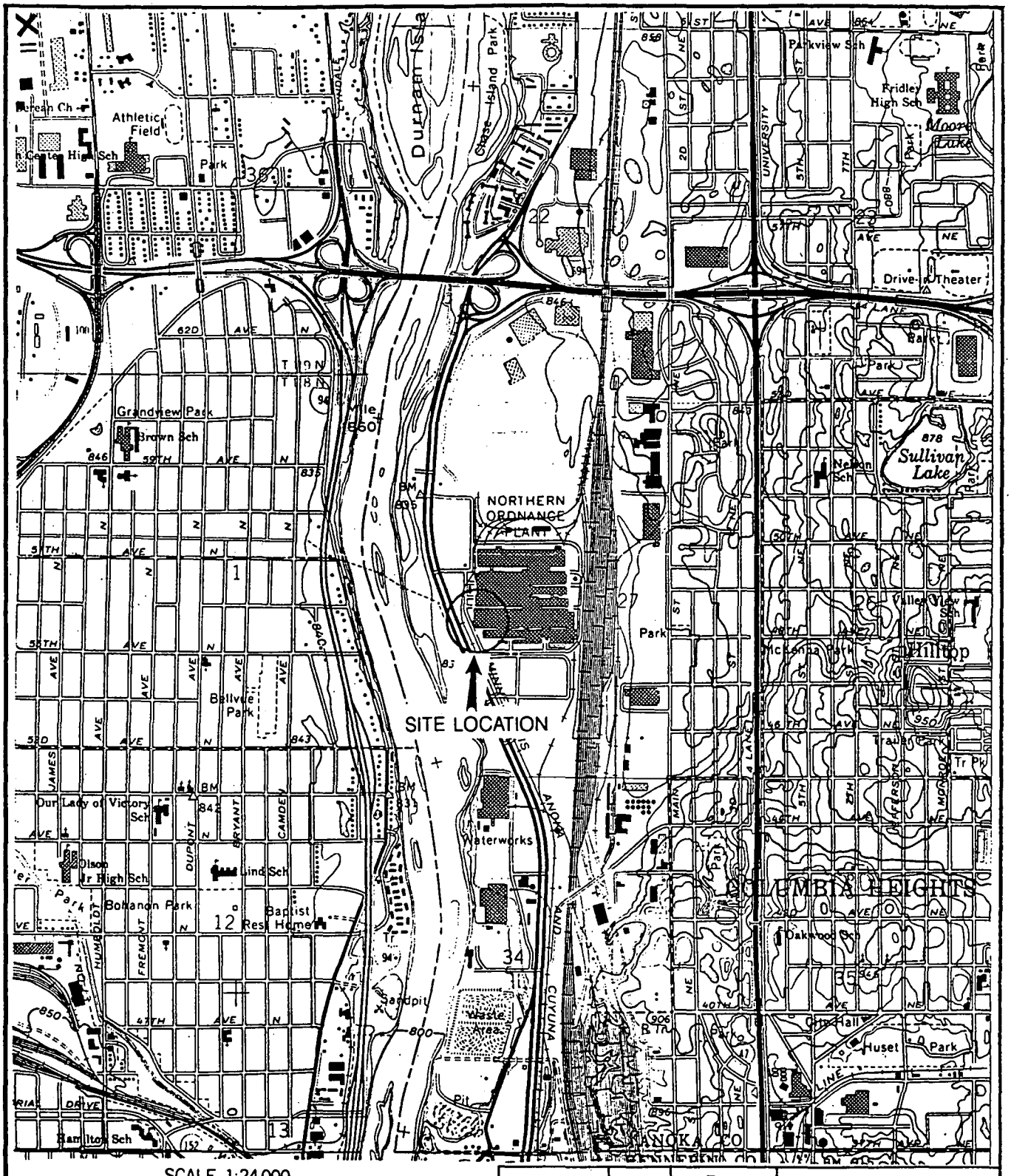
Notes:
- HS - Jar Headspace Concentration
- TPH - Total Petroleum Hydrocarbons as Fuel Oil
- TCE - Trichloroethene
- XYL - Xylenes
- EB - Ethyl Benzene
- PC - Tetrachloroethene
- NA - Not Analyzed
- BDL - Not Detected Above Detection Limit

Bay West

TABLE 1 (cont.)
Summary of Soil Headspace and Chemical Analyses

Sample Number	HS	TPH	TCE	XYL	EB	Other
			Parameter (ppm)			
SB-36 4.5-6.5 ft	2.0	BDL	BDL	BDL	BDL	
9.5-11.5 ft	5.0	BDL	BDL	BDL	BDL	
14.5-16.5 ft	1.6	BDL	BDL	BDL	BDL	
19.5-21.5 ft	89	16	BDL	BDL	BDL	
SB-37 2-3 ft	90	NA	NA	NA	NA	
3-4 ft	283	3100	BDL	12.9	4.4	
4-5 ft	206	NA	NA	NA	NA	
5-6 ft	97	120	0.77	BDL	BDL	
SB-38 2-3 ft	129	NA	NA	NA	NA	
3-4 ft	162	630	1.5	2.4	0.62	
4-5 ft	75	NA	NA	NA	NA	
5-6 ft	25	330	0.26	BDL	0.09	
SB-39 2-3 ft	202	NA	NA	NA	NA	
3-4 ft	459	NA	NA	NA	NA	
4-5 ft	471	NA	NA	NA	NA	
5-6 ft	379	NA	NA	NA	NA	
SB-40 2-3 ft	294	NA	NA	NA	NA	
3-4 ft	377	3900	BDL	17	5.4	
4-5 ft	336	NA	NA	NA	NA	
5-6 ft	202	380	BDL	1.3	0.48	
SB-41 2-3 ft	14	NA	NA	NA	NA	
3-4 ft	8	NA	NA	NA	NA	
4-5 ft	4.4	NA	NA	NA	NA	
5-6 ft	5.7	NA	NA	NA	NA	
SB-42 2-3 ft	4.6	NA	NA	NA	NA	
3-4 ft	4.6	NA	NA	NA	NA	
4-5 ft	1	NA	NA	NA	NA	
5-6 ft	1	NA	NA	NA	NA	

Notes:
- HS - Jar Headspace Concentration
- TPH - Total Petroleum Hydrocarbons as Fuel Oil
- TCE - Trichloroethene
- XYL - Xylenes
- EB - Ethyl Benzene
- PC - Tetrachloroethene
- NA - Not Analyzed
- BDL - Not Detected Above Detection Limit



0 SCALE 1:24 000 1 MILE

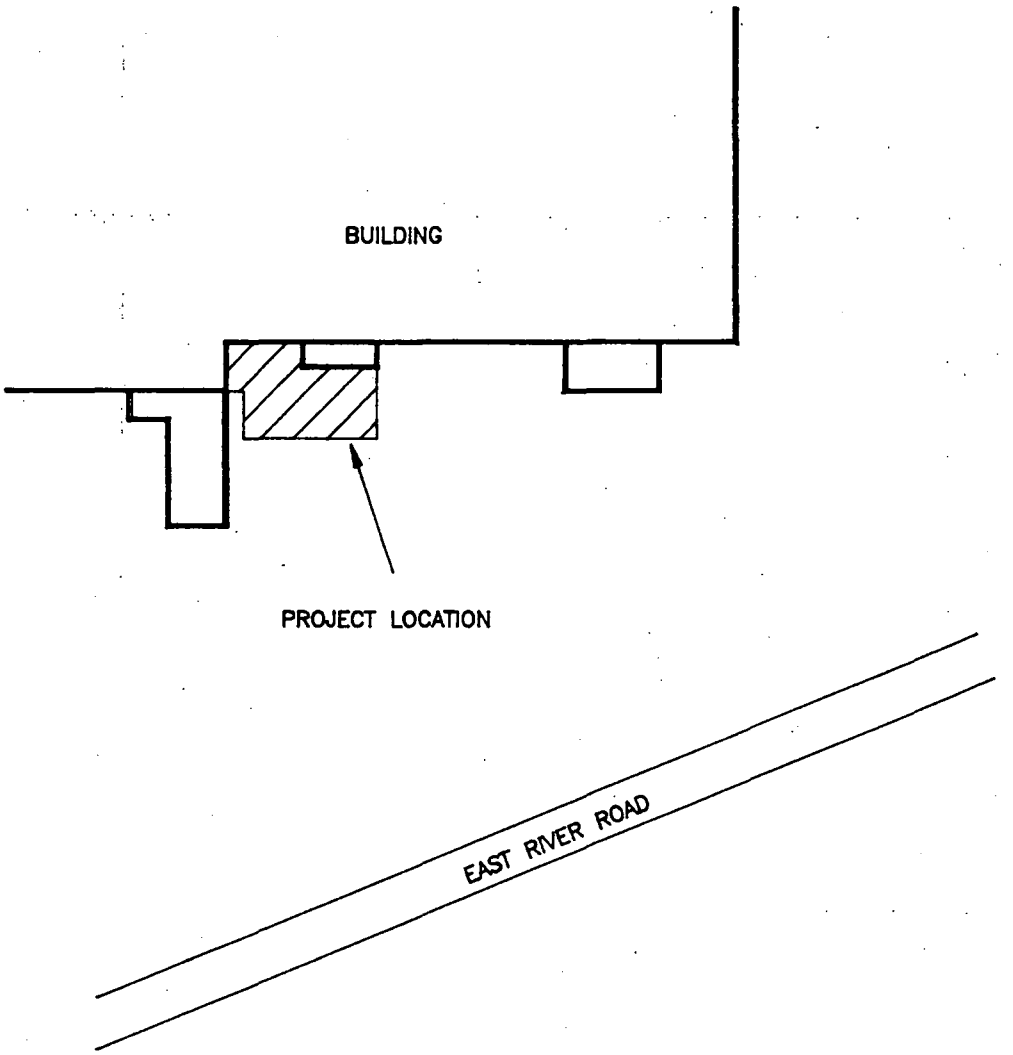
CONTOUR INTERVAL 10 FEET

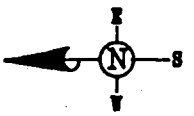
SOURCE:
USGS 7.5 MINUTE
TOPOGRAPHIC
MINNEAPOLIS NORTH, MN.
QUADRANGLE

N

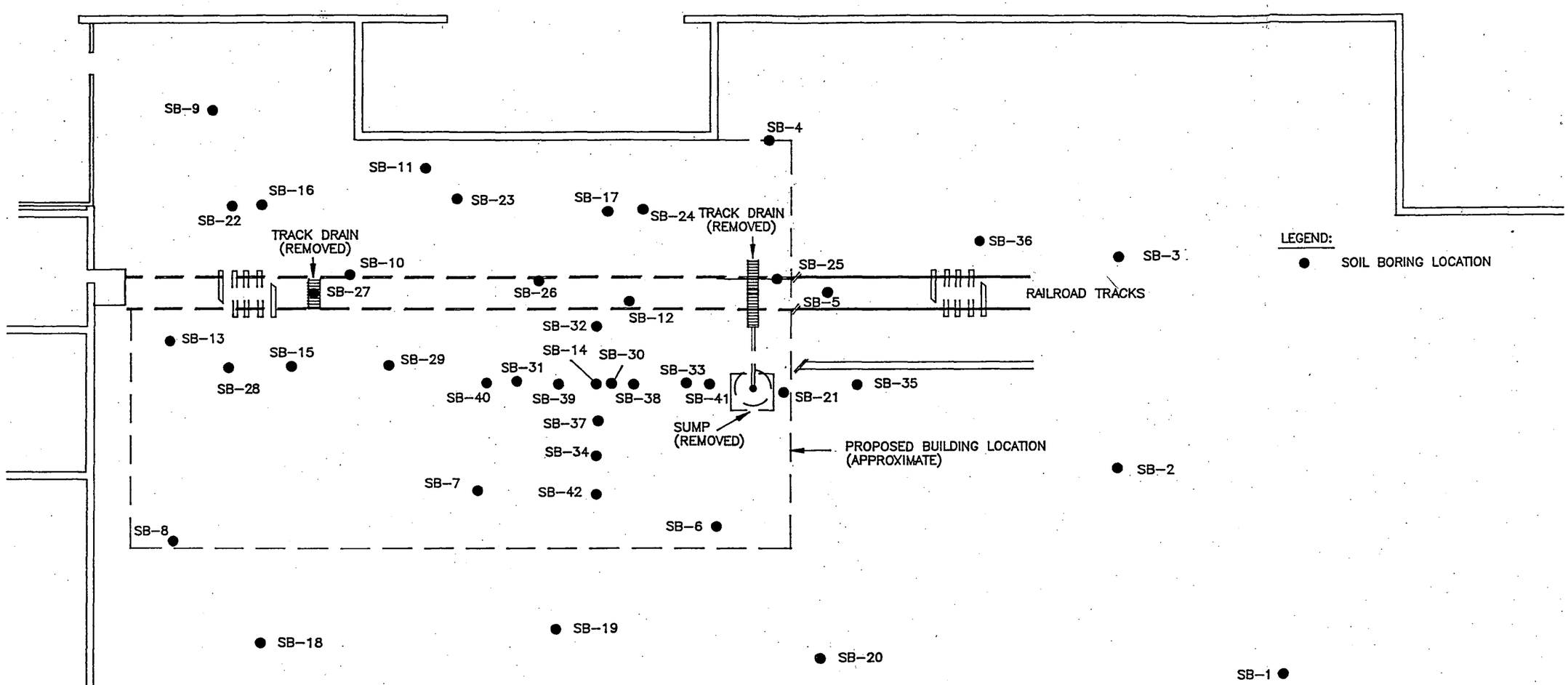
QUADRANGLE LOCATION

ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES St PAUL MN
DRAWN K.M.	7/29/91		
REV.			
PROJECT NAME FMC			
TITLE SITE LOCATION MAP			
DWG. NO. 2299-A1	SCALE	FIGURE # 1	

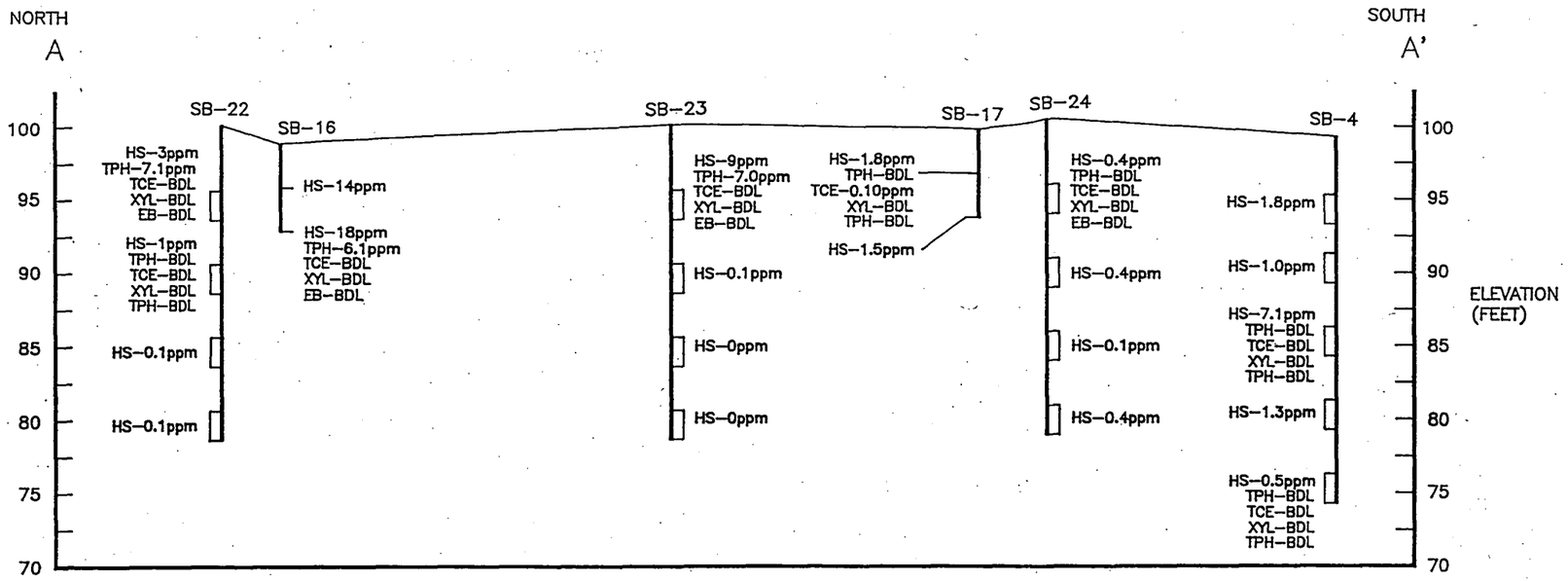




ENGR'G M.W.	DATE	BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL MN	
DRAWN K.M.	7/31/91		
REV. B	10/10/91		
PROJECT NAME FMC			
TITLE SITE LOCATION MAP			
DWG. NO. 2299-A2	SCALE NONE	FIGURE # 2	



ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.
DRAWN K.M.	7/8/91		
REV. E	10/10/91		
PROJECT NAME FMC			
TITLE SOIL BORING LOCATIONS			
DWG. NO. 2299-B1	SCALE 1"=15'	FIGURE # 3	



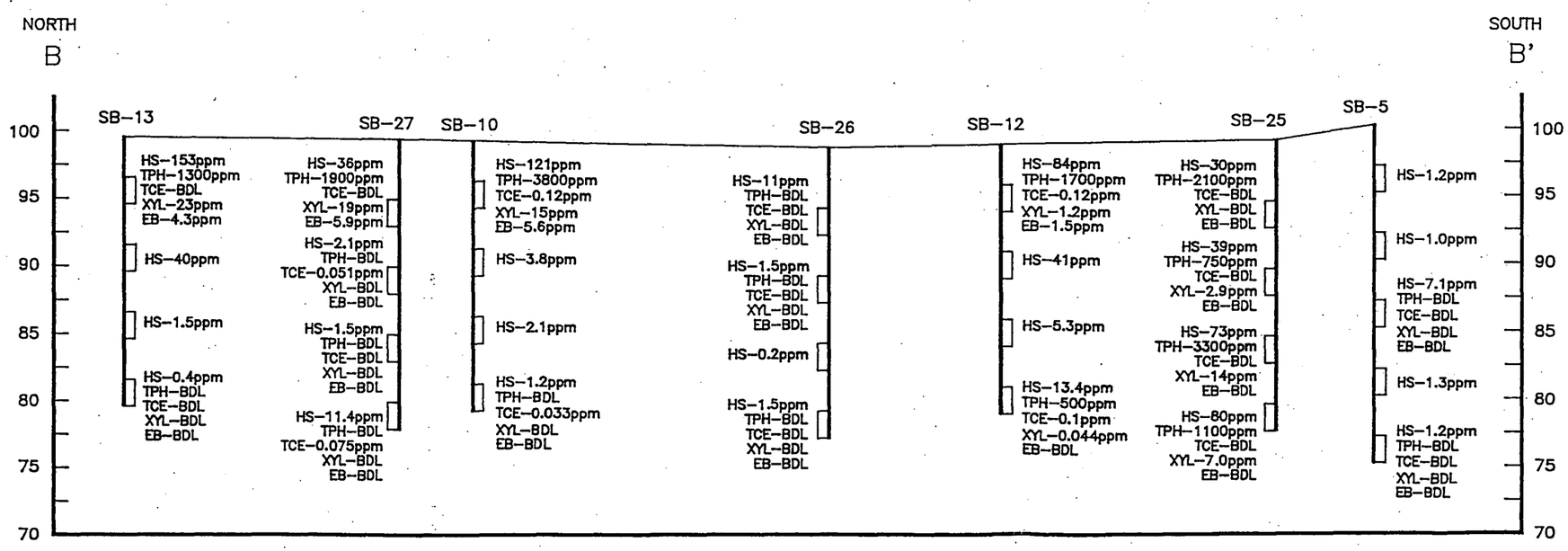
LEGEND:

HS- JAR HEADSPACE CONCENTRATION
TPH- TOTAL PETROLEUM HYDROCARBONS AS FUEL OIL
TCE- TRICHLOROETHENE
XYL- XYLENES
EB- ETHYL BENZENE
BDL- NOT DETECTED ABOVE DETECTION LIMIT

BORING LOCATION

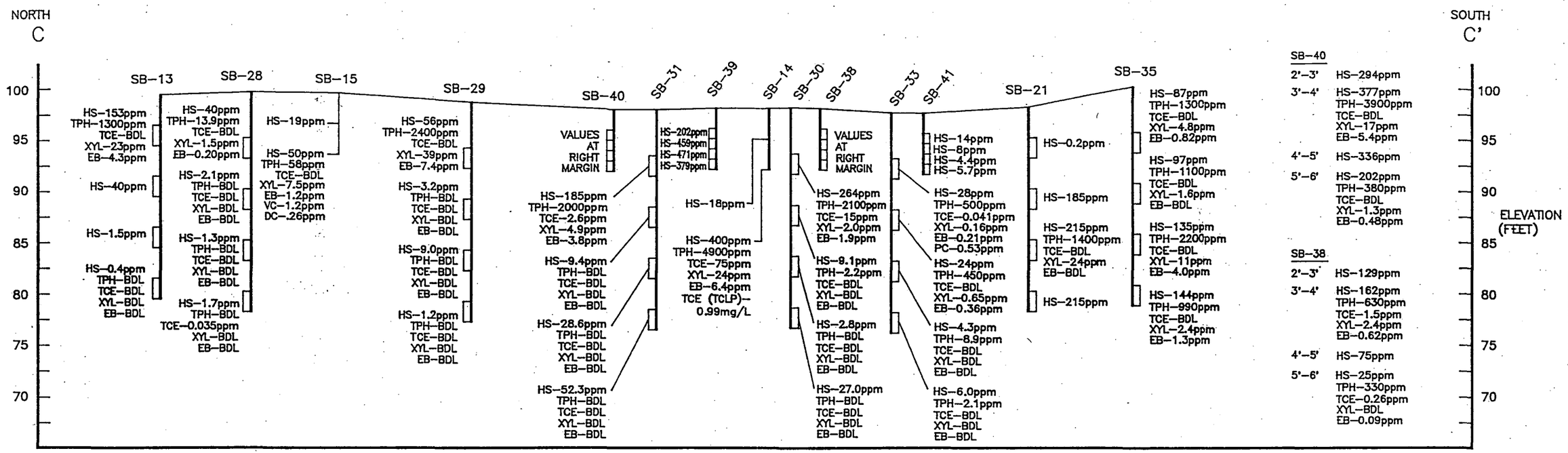
SAMPLING INTERVAL

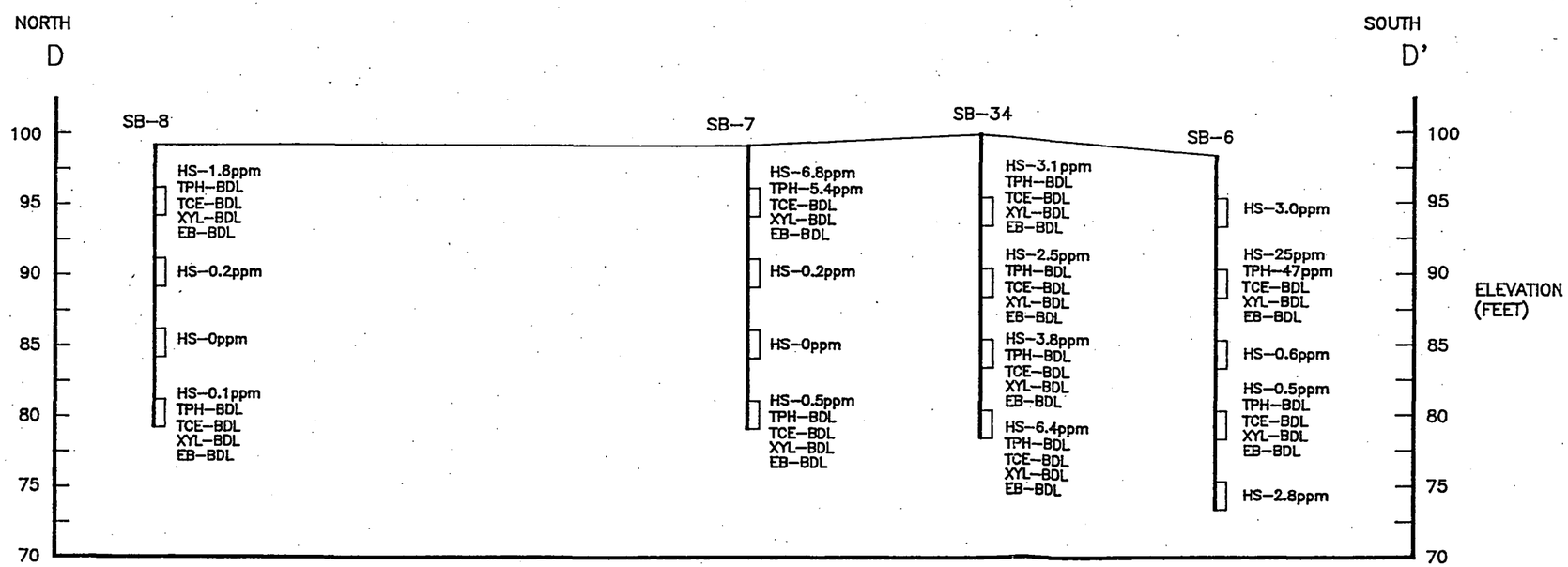
NOTE: BENCHMARK = 100.0 FT.



0 5' 10'
HORIZONTAL AND VERTICAL

ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.
DRAWN K.M.	10/8/91		
REV.			
PROJECT NAME FMC			
TITLE CROSS-SECTIONS A-A' AND B-B'			
DWG. NO. 2299-XS1	SCALE 1"=10'	FIGURE # 4	





LEGEND:

HS- JAR HEADSPACE CONCENTRATION
TPH- TOTAL PETROLEUM HYDROCARBONS AS FUEL OIL
TCE- TRICHLOROETHENE
XYL- XYLENES
EB- ETHYL BENZENE
PC- TETRACHLOROETHENE
TCLP- AS DETERMINED BY TCLP ANALYSIS
BDL- NOT DETECTED ABOVE DETECTION LIMIT
VC- VINYL CHLORIDE
DC- 1-2, DICHLOROETHANE

BORING LOCATION

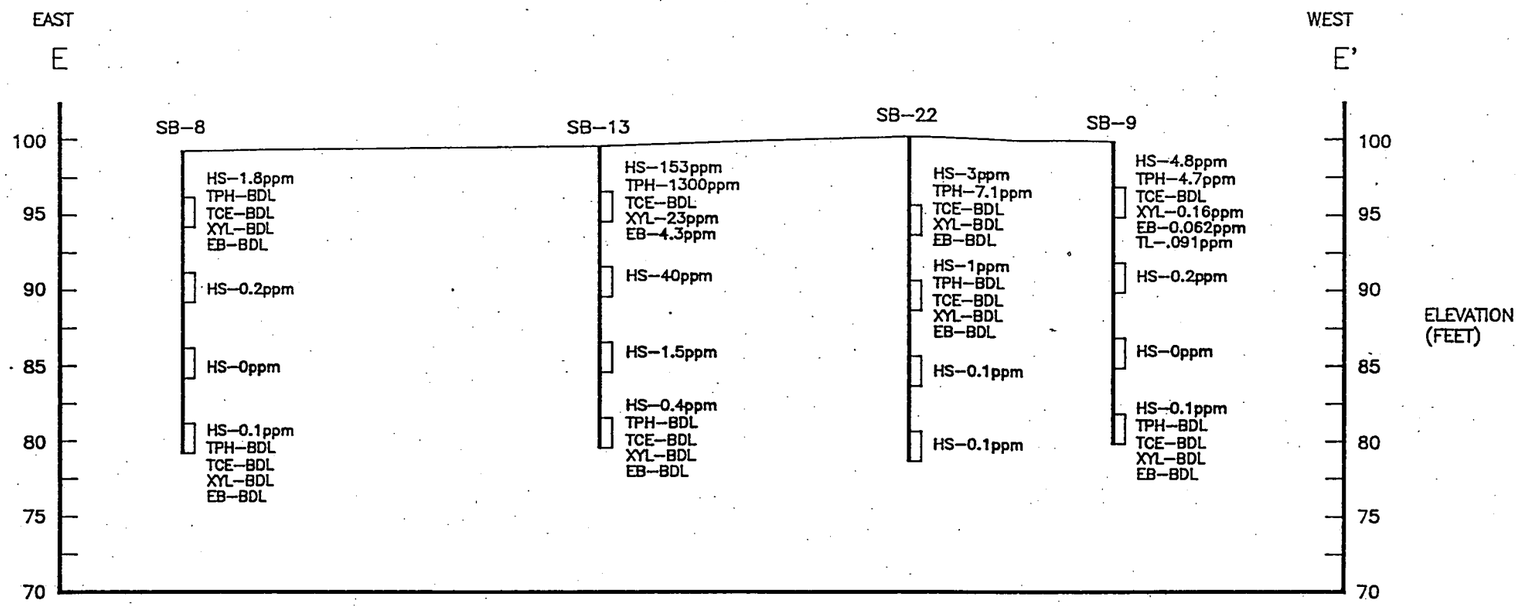
SAMPLING INTERVAL

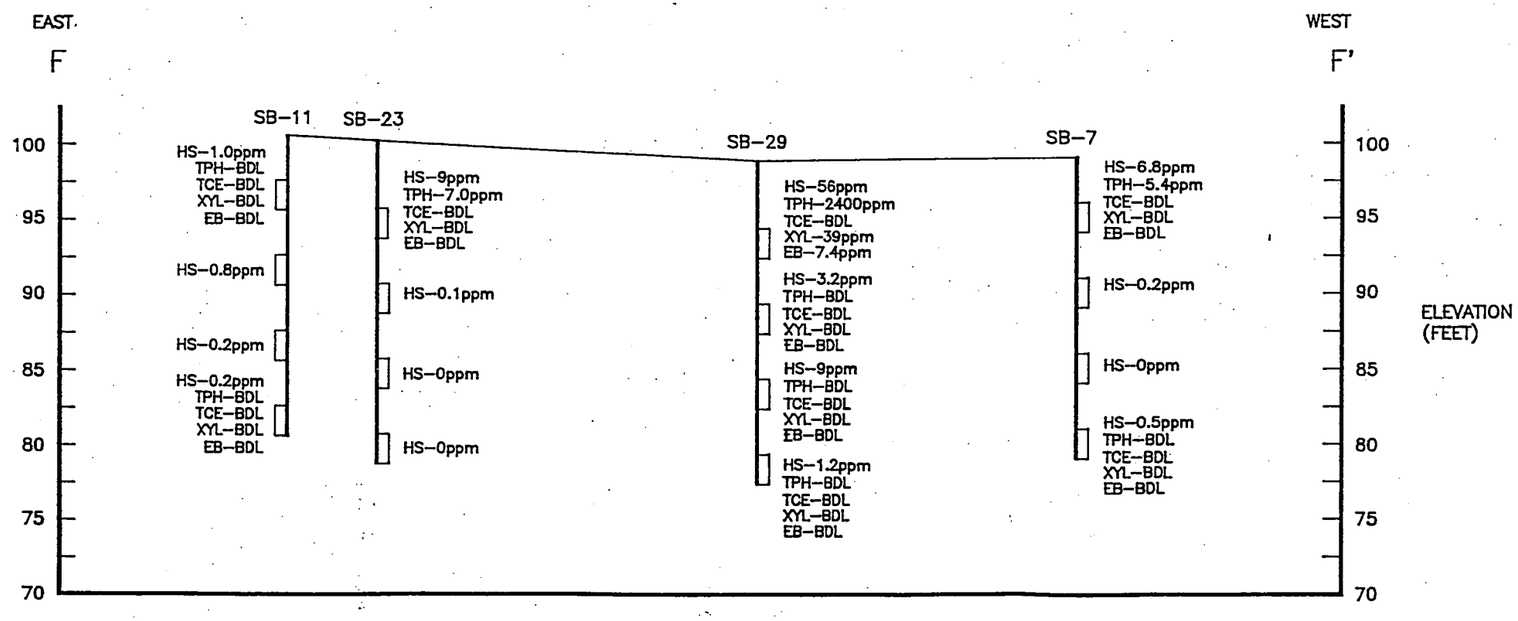
NOTE: BENCHMARK = 100.0 FT.

0 5' 10'

HORIZONTAL AND VERTICAL

ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.
DRAWN K.M.	10/8/91		
REV.			
PROJECT NAME FMC			
TITLE CROSS-SECTIONS C-C' AND D-D'			
DWG. NO. 2299-XS2	SCALE 1"=10'	FIGURE # 5	





LEGEND:

HS- JAR HEADSPACE CONCENTRATION
TPH- TOTAL PETROLEUM HYDROCARBONS AS FUEL OIL
TCE- TRICHLOROETHENE
XYL- XYLENES
EB- ETHYL BENZENE
TL- TOLUENE
BDL- NOT DETECTED ABOVE DETECTION LIMIT

BORING LOCATION

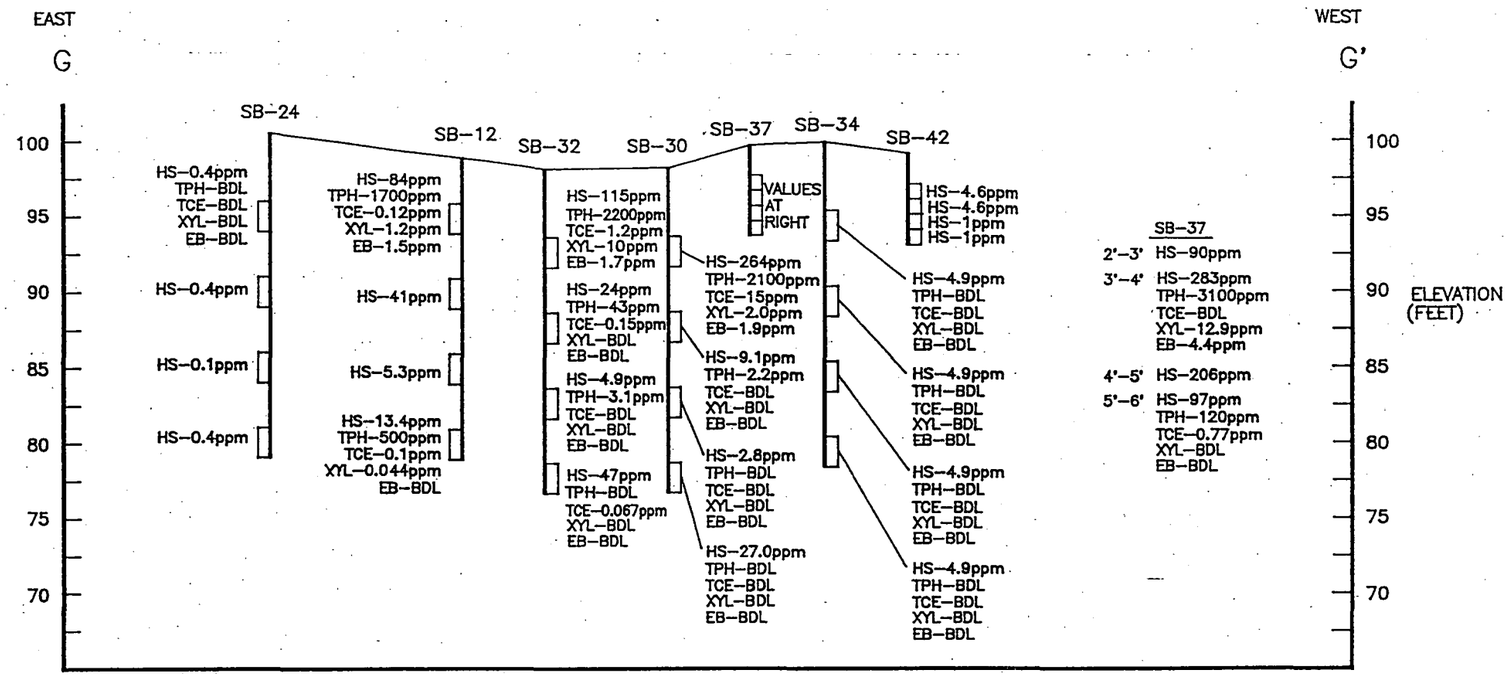
SAMPLING INTERVAL

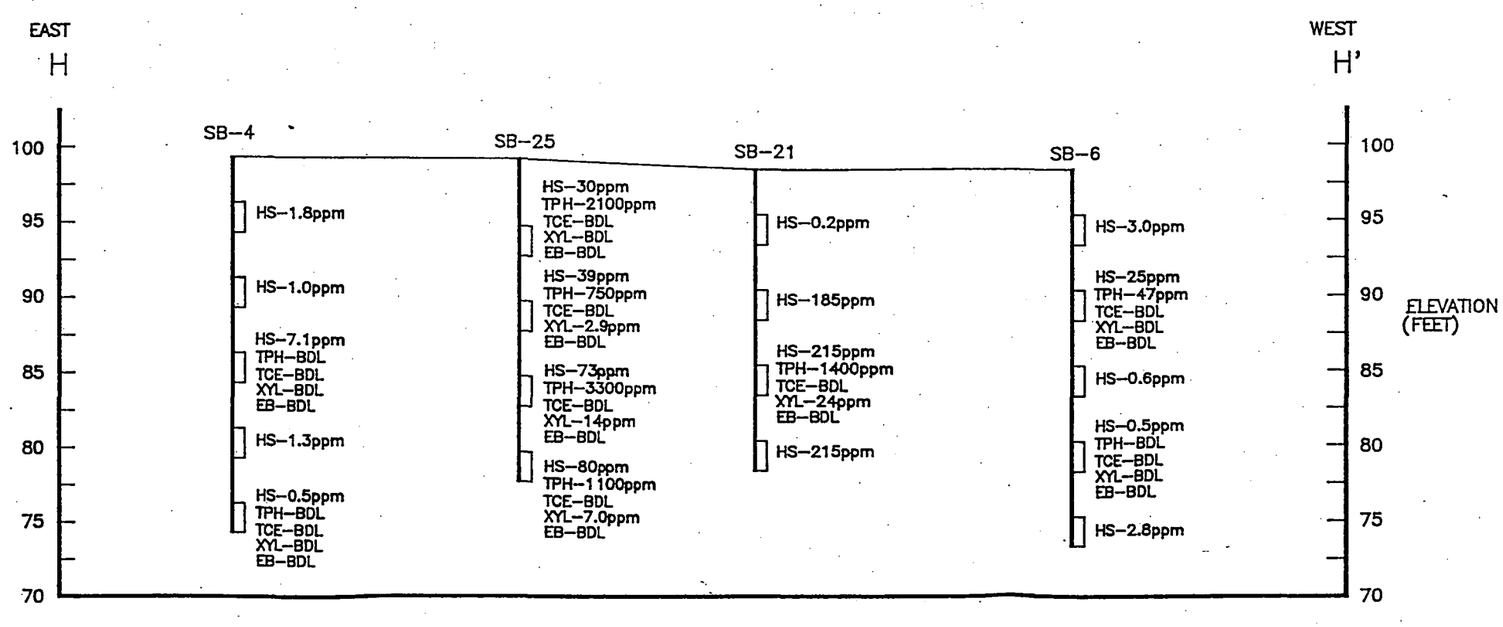
NOTE: BENCHMARK = 100.0 FT.

0 5' 10'

HORIZONTAL AND VERTICAL

ENGR'G M.W.	DATE	BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.	
DRAWN K.M.	10/8/91		
REV.			
PROJECT NAME FMC			
TITLE CROSS-SECTIONS E-E' AND F-F'			
DWG. NO. 2299-XS3	SCALE 1"=10'	FIGURE # 6	





LEGEND:

HS- JAR HEADSPACE CONCENTRATION
TPH- TOTAL PETROLEUM HYDROCARBONS AS FUEL OIL
TCE- TRICHLOROETHENE
XYL- XYLENES
EB- ETHYL BENZENE
BDL- NOT DETECTED ABOVE DETECTION LIMIT

BORING LOCATION

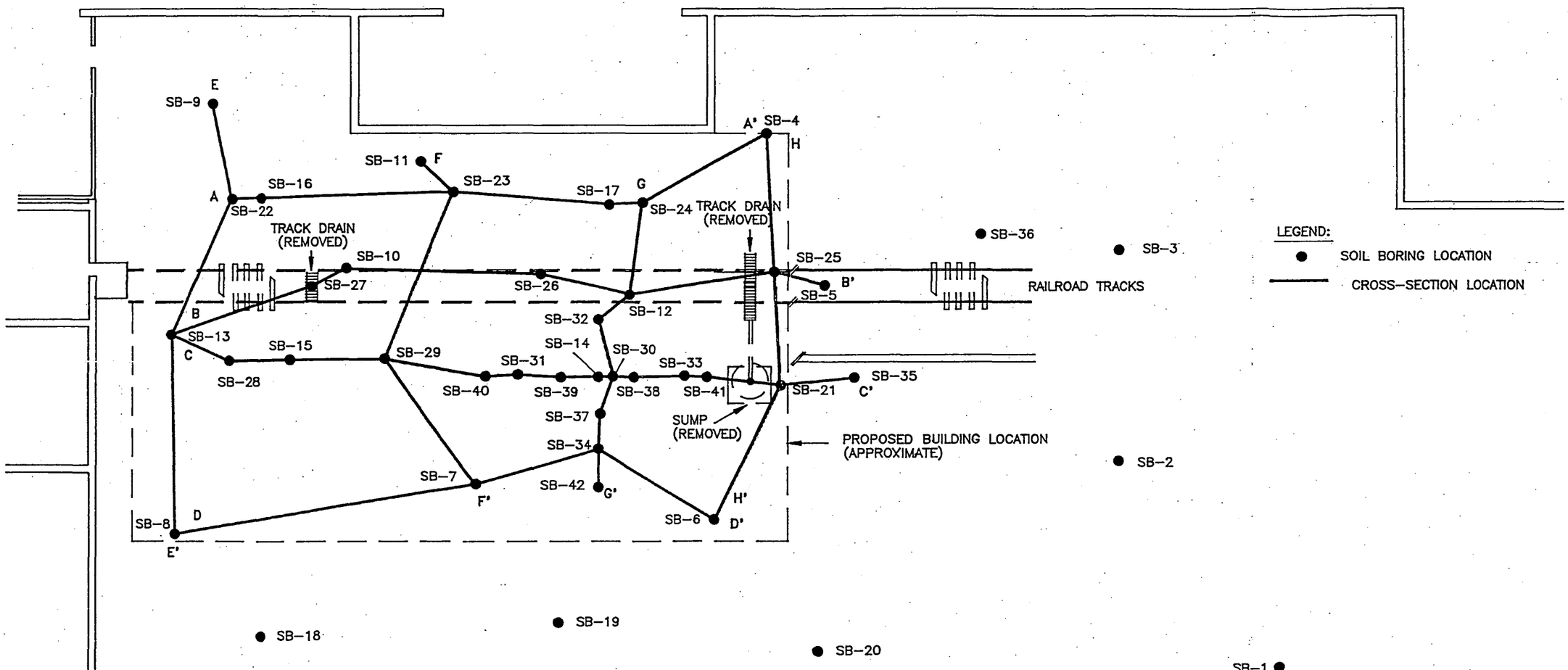
SAMPLING INTERVAL

NOTE: BENCHMARK = 100.0 FT.

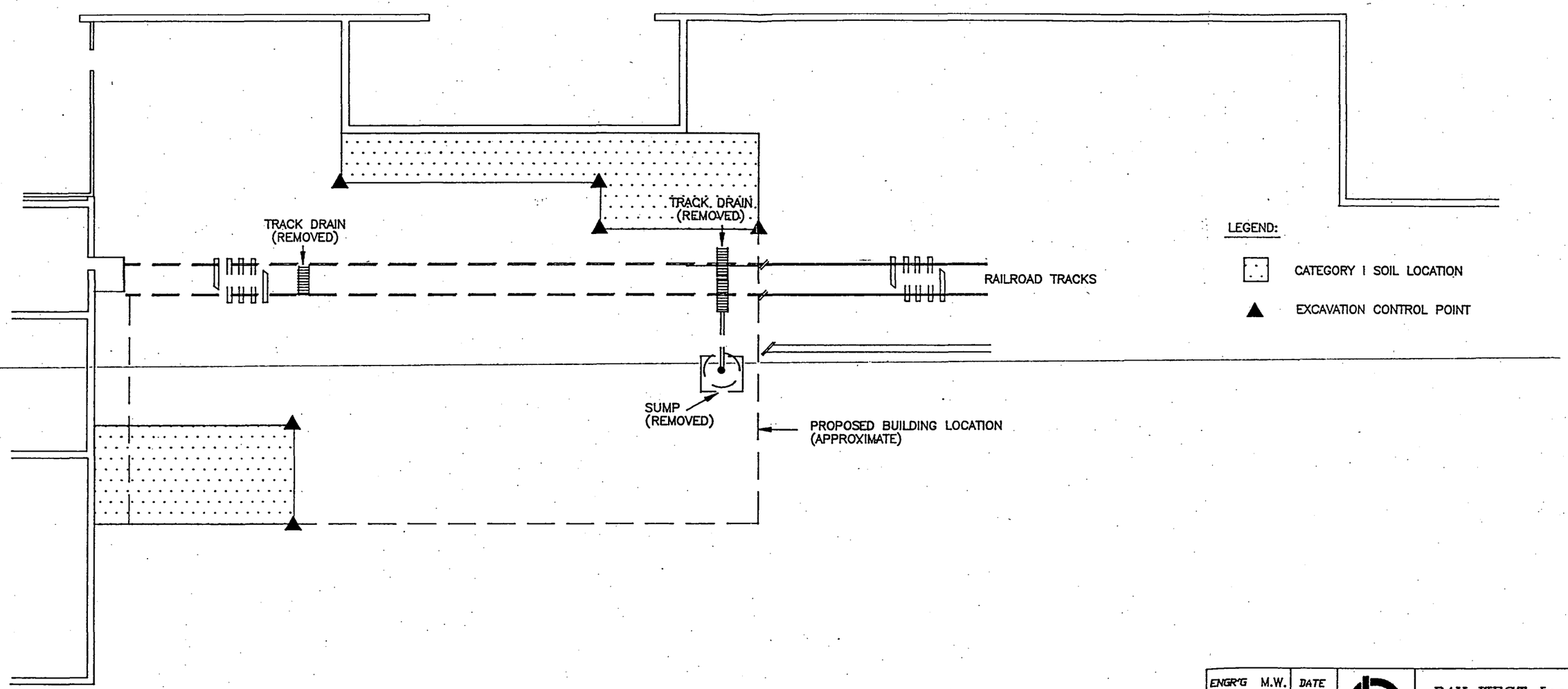
0 5' 10'

HORIZONTAL AND VERTICAL

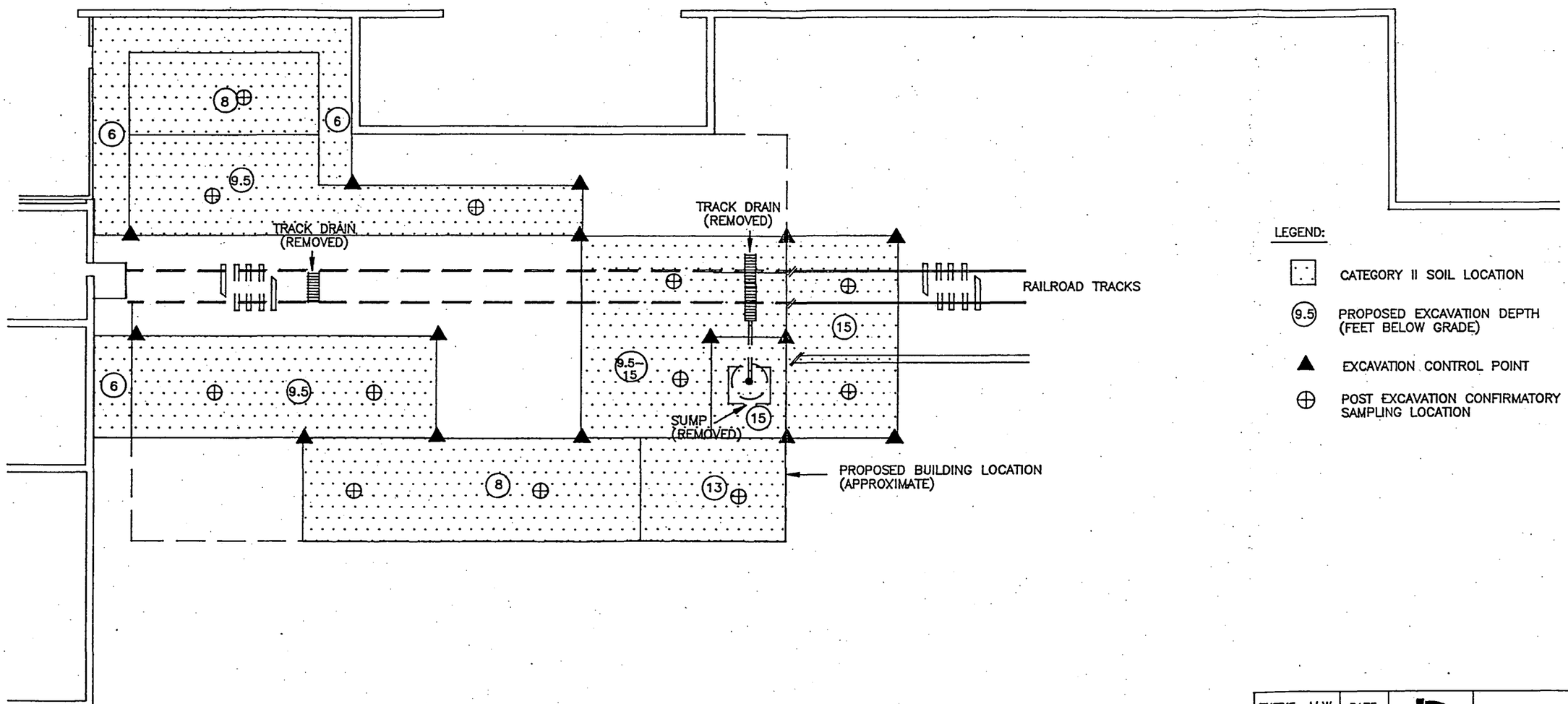
ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.
DRAWN K.M.	10/8/91		
REV.			
PROJECT NAME FMC			
TITLE CROSS-SECTIONS G-G' AND H-H'			
DWG. NO. 2299-XS4	SCALE 1"=10'	FIGURE # 7	



ENGR'G M.W.	DATE	BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.	
DRAWN K.M.	7/8/91		
REV. E	10/10/91		
PROJECT NAME FMC			
TITLE CROSS-SECTION LOCATIONS			
DWG. NO. 2299-B1	SCALE 1"=15'	FIGURE # 8	



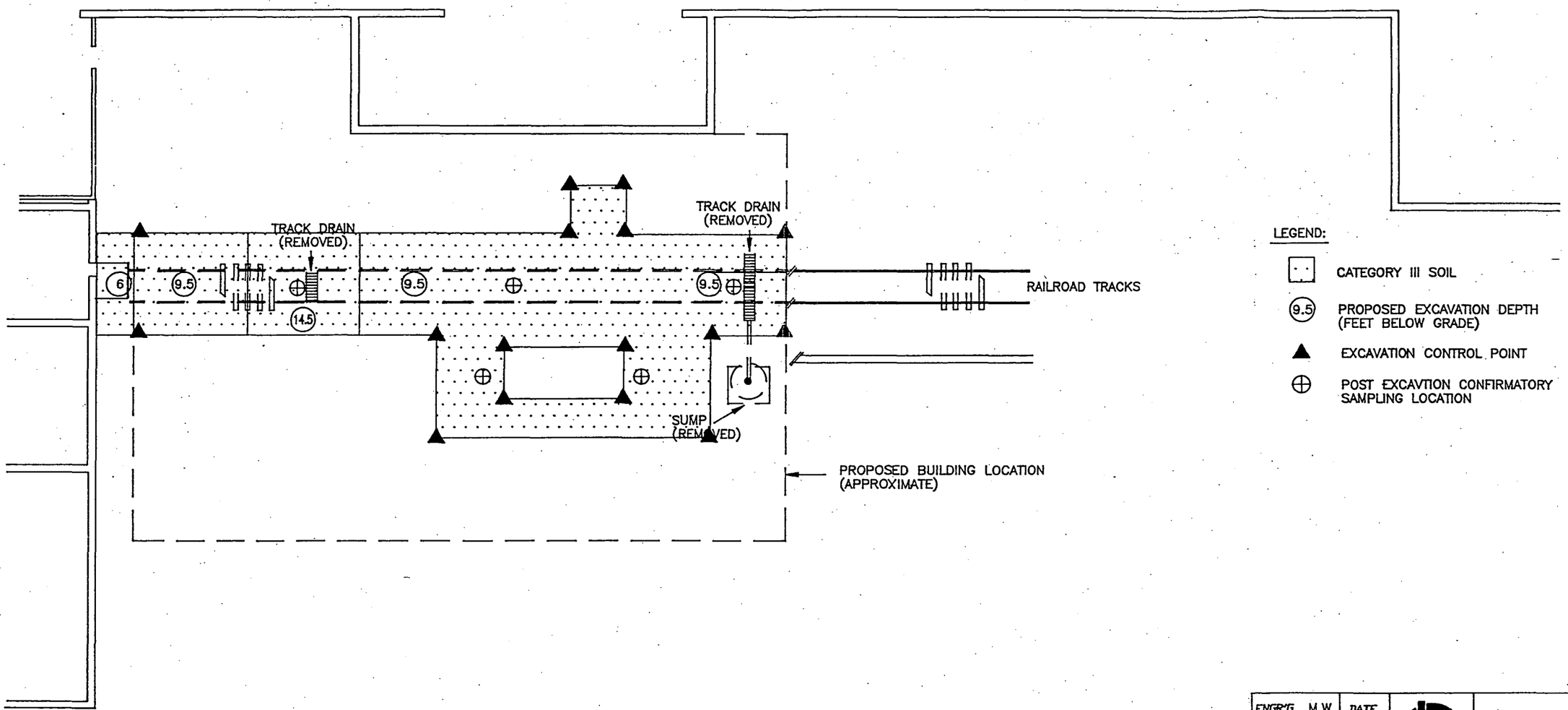
ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.
DRAWN K.M.	7/8/91		
REV. D	9/20/91		
PROJECT NAME FMC			
TITLE CATEGORY I SOIL LOCATION			
DWG. NO. 2299-B1	SCALE 1"=15'	FIGURE # 9	



0 5' 10' 15'

E N S W

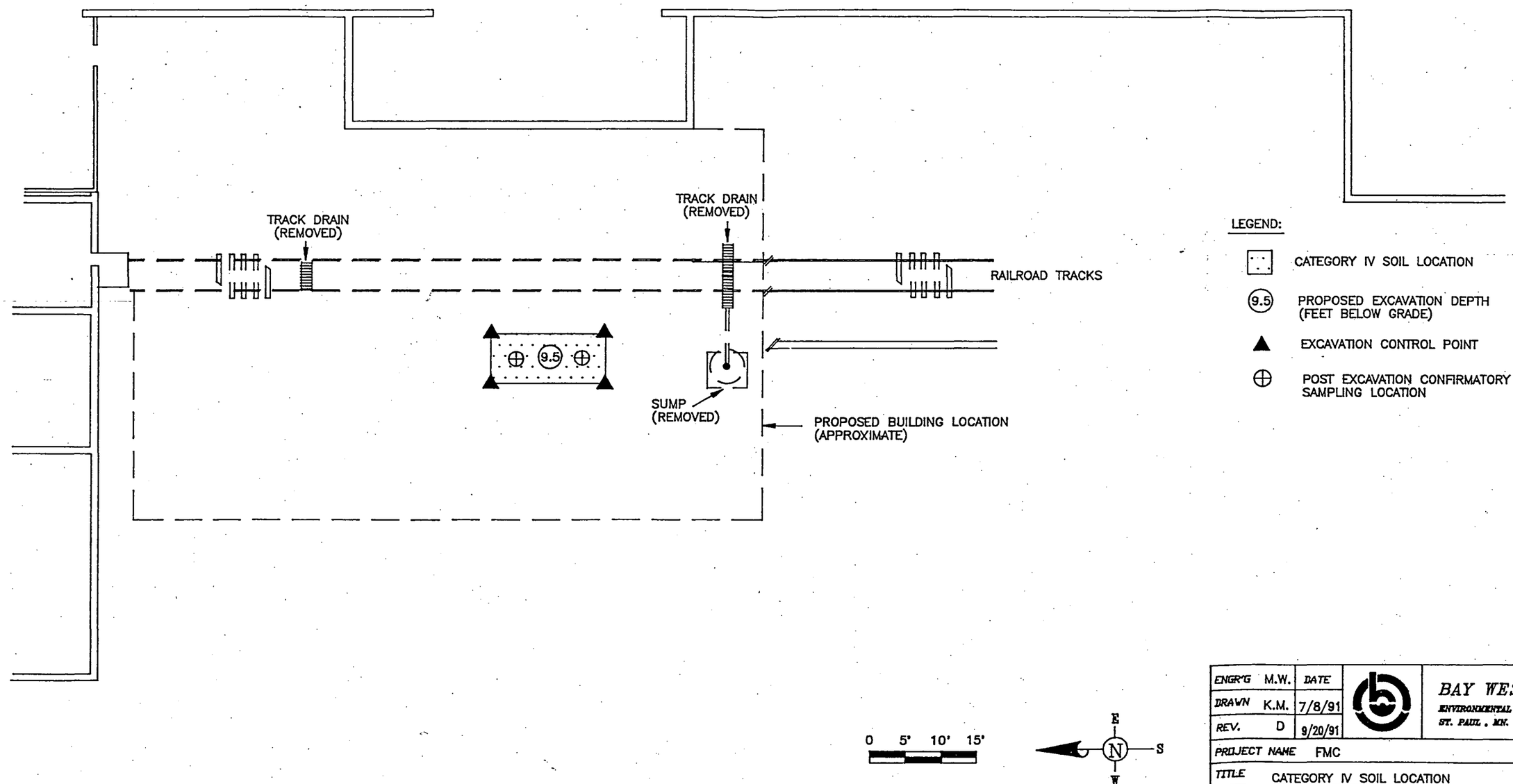
ENGR'G M.W.	DATE	BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.	
DRAWN K.M.	7/8/91		
REV. E	10/10/91		
PROJECT NAME FMC			
TITLE CATEGORY II SOIL LOCATION			
DWG. NO. 2299–B1	SCALE 1"=15'	FIGURE # 10	



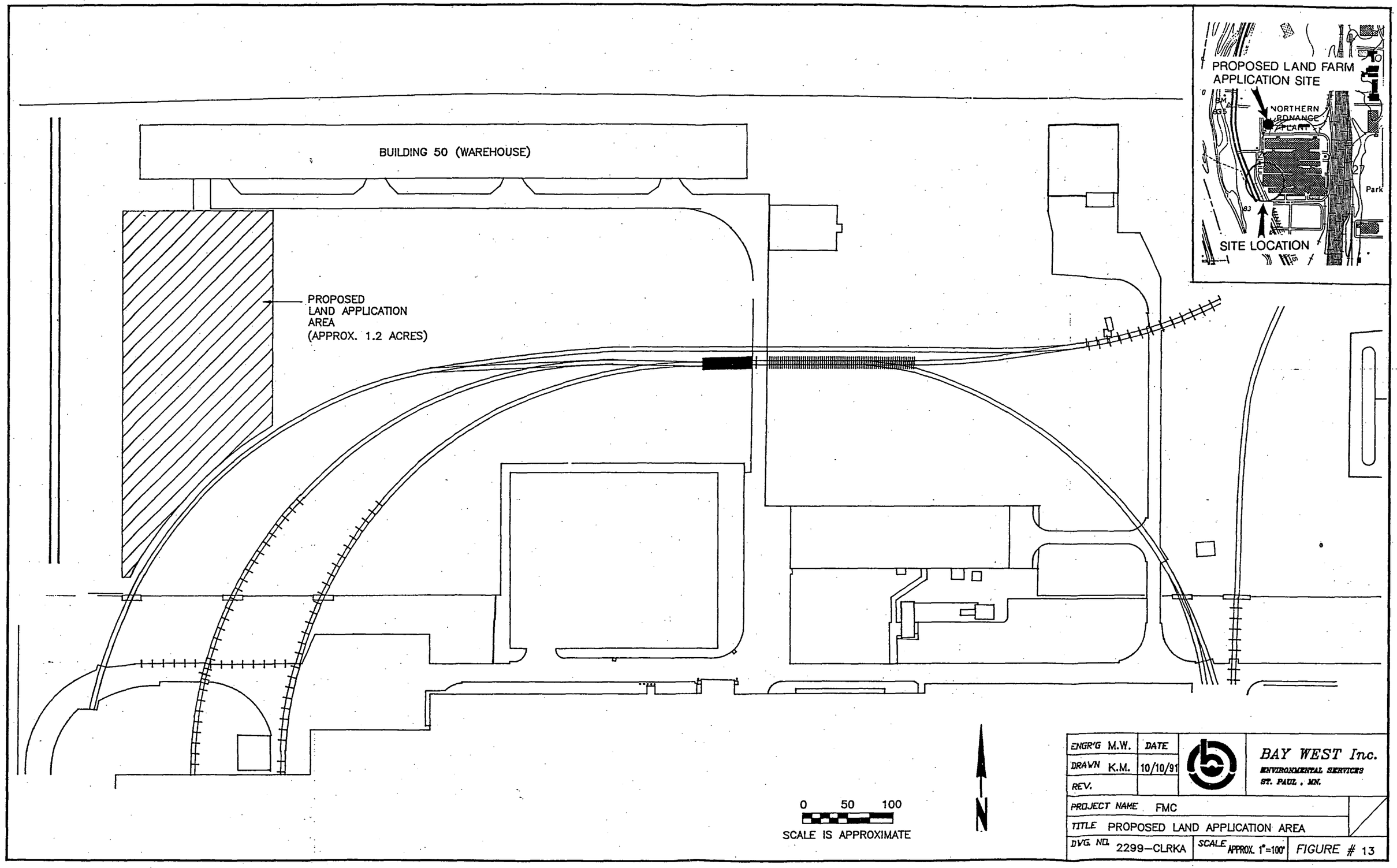
0 5' 10' 15'

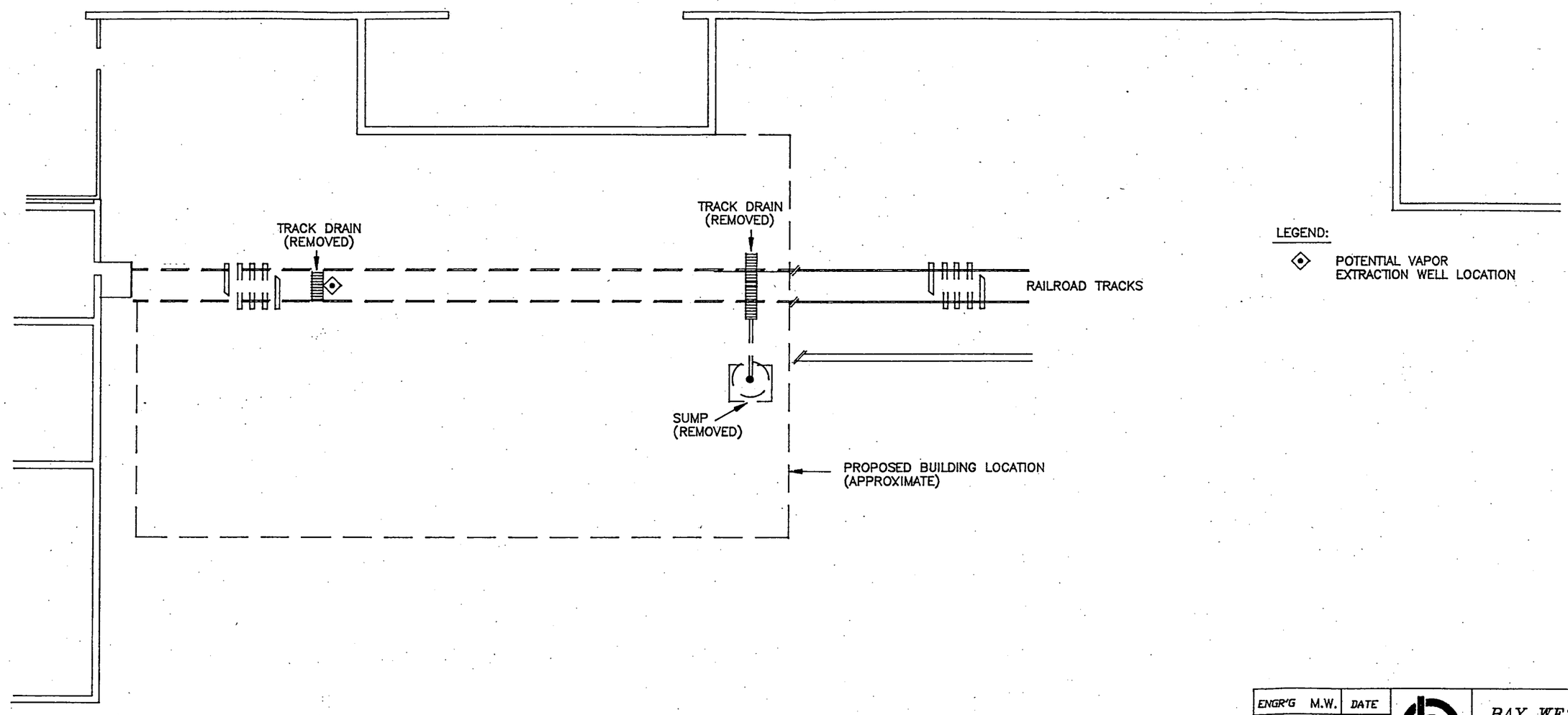
E N S W

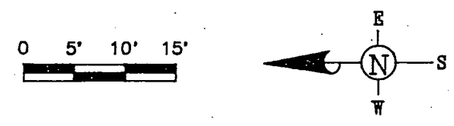
ENGR'G M.W.	DATE	BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.	
DRAWN K.M.	7/8/91		
REV. E	10/10/91		
PROJECT NAME FMC			
TITLE CATEGORY III SOIL LOCATION			
DWG. NO. 2299-B1	SCALE 1"=15'	FIGURE # 11	



ENGR'G M.W.	DATE		BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.
DRAWN K.M.	7/8/91		
REV. D	9/20/91		
PROJECT NAME FMC			
TITLE CATEGORY IV SOIL LOCATION			
DWG. NO. 2299-B1	SCALE 1"=15'	FIGURE # 12	


BUILDING 50 (WAREHOUSE)
PROPOSED
LAND APPLICATION
AREA
(APPROX. 1.2 ACRES)
PROPOSED LAND FARM
APPLICATION SITE
NORTHERN
BOMANGE
PLANT
Park
SITE LOCATION
0 50 100
SCALE IS APPROXIMATE
N
ENGR'G M.W.
DATE
DRAWN K.M.
10/10/91
REV.
BAY WEST Inc.
ENVIRONMENTAL SERVICES
ST. PAUL, MN.
PROJECT NAME FMC
TITLE PROPOSED LAND APPLICATION AREA
DWG. NO. 2299-CLRKA
SCALE APPROX. 1"=100'
FIGURE # 13





ENGR'G M.W.	DATE	BAY WEST Inc. ENVIRONMENTAL SERVICES ST. PAUL, MN.	
DRAWN K.M.	7/8/91		
REV. E	10/10/91		
PROJECT NAME FMC			
TITLE POTENTIAL VAPOR EXTRACTION WELL LOCATION			
DWG. NO. 2299-B1	SCALE 1"=15'	FIGURE # 14	