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July 21, 1992

01-0817-03-1805

Mr. Brian Sato
Project Engineer
Department of Ecology
Northwest Regional Office
3190 - 160th Avenue S.E.
Bellevue, Washington 98008-5452

Subject: Monterey Apartments Pre-Engineering Report

Dear Mr. Sato:

The Pre-Engineering Report for the above-reference site has been modified to reflect your comments of last week. The following changes are noted:

1. A Site Visit Information section was added to present the results of ambient air and groundwater measurements. This work included sounding the monitoring wells, measuring and recording PID, LEL, and O_2 readings in ambient air spaces of the Monterey and Del Roy Apartments, collecting file information from the DOE and Seattle city offices, and evaluating the structural suitability of the Monterey Apartments roof for housing a remediation system.

2. Excavation of the underground gasoline storage tanks is addressed in the Unsaturated Zone Remedial Alternatives section. Due to the high cost of soil disposal, and since a remediation system will be installed, a minimal amount of soil excavation is recommended. The viability for free-product recovery will be assessed during the tank excavation; similarly, the amount of contaminated soil to be removed will be made at that time as well. Appropriateness of soil vapor extraction in the on-site soils is also addressed in this section.

3. The necessity to treat air emissions (the estimated emission rates and PSAPCA limit) is made more explicit throughout the report.

4. Use of the on-site recovery wells is discussed in the Saturated Zone Remedial Alternatives section. It is unclear from the available information whether these wells performed poorly in recovering total groundwater or in recovering strictly free product. A pump test was added to the recommendations to determine whether these wells can be utilized.

5. Tank excavation costs were included in the cost estimate.

18706 North Creek Parkway, Suite 110, Bothell, WA 98011 • 206/485-5800 • FAX: 206/485-5566

21 July 1992

If you have any additional questions, please contact me at 206/485-5800. Once we reach acceptance of this report, we can schedule a meeting (or teleconference) with you to begin detailed engineering design.

Sincerely,

Richard W. Greiling, P.E.
enc

cc: L. Lowe, Ecology
B. Morson
K. Baldwin
M. Sands, DPRA

PRE-DESIGN ENGINEERING REPORT

Monterey Apartments
622 First Avenue West
Seattle, Washington

Prepared for:

Washington State Department of Ecology
3190 - 160th Avenue S.E.
Bellevue, Washington 98008

Prepared by:

DPRA Incorporated
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July 1992

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1.0 INTRODUCTION

1.1 PURPOSE

Science Applications International Corporation (SAIC) and its subcontractor, DPRA Incorporated (DPRA), were retained by the Washington State Department of Ecology (Ecology) to prepare a pre-design engineering report for Monterey Apartments, located at 622 First Avenue West in Seattle, Washington. Monterey Apartments and its occupants are being impacted by gasoline vapors migrating into the basement and other living areas, due to contamination of subsurface soils and groundwater, by leaking underground storage tanks (USTs) or piping at an adjoining retail gasoline station. The purpose of this report is to identify and evaluate various remedial technologies, develop and identify a preferred alternative, and prepare a cost estimate for capital construction and annual operation and maintenance of the preferred alternative.

1.2 SITE BACKGROUND

In July 1991, a Phase I Remedial Investigation report for the above-referenced site was submitted to Ecology by Ecology and Environment, Inc. The report reviewed data collected from the earlier installation of eight monitoring wells and two recovery wells located around the Monterey Apartments and the Manhattan Express Texaco (Express) Service Station. Groundwater sampling, aquifer testing, soil-gas surveying, terrain conductivity surveying, and other support tasks were conducted to evaluate and define the concentrations and distributions of petroleum constituents. Ecology and Environment, Inc. made the following conclusions:

- A petroleum release of 5,000 to 8,000 gallons had occurred from the USTs and lines at the Express; however, a basis for this amount was not documented.
- "Fresh" unleaded gasoline existing as liquid-phase is floating on the groundwater table, which exists at a depth of approximately 15 feet below the ground surface (bgs).
- Dissolved hydrocarbon contamination exists in the saturated zone, with one groundwater sample containing a benzene concentration of 25 parts per million (ppm).
- Petroleum vapors exist in the unsaturated zone at concentrations greater than 650 micrograms per liter (μg/L).
- Petroleum vapors were detected in the basement of the Monterey Apartment Complex at concentrations greater than 50 ppm, and are a continuing health risk.

Further site information can be found in "Remedial Investigation Report - Monterey Apartments," submitted to Ecology in July 1991.

2.0 SITE VISIT INFORMATION

On May 26, 1992, DPRA staff performed a site visit to the Monterey Apartments located at 622 First Avenue West, in Seattle, Washington. During this site visit, all accessible on-site groundwater monitoring and recovery wells were gauged. The presence of free product was verified, and the presence of organic vapors was verified in the basement and lower level living units. The structural suitability of placing a remediation system on the roof of the Monterey Apartment building, as well as visually determining whether adequate space at grade level was available for a remediation system was also performed. In addition, file material at Ecology was reviewed and appropriate file materials were photocopied. The following summarizes and presents the information collected during this site visit.

Ten monitoring wells (MW-2 through MW-11) and two recovery wells (RW-1 and RW-2) are present at the Monterey Apartment site and four monitoring wells (MW-1U, MW-2U, MW-3U, and MW-4U) are present at the Unocal Service Station No. 0255. On May 26, 1992, DPRA staff gauged the accessible wells at both sites. Because the manhole covers to monitoring wells MW-8, MW-11, MW-1U, and MW-2U could not be removed, these wells were not gauged. The depth to groundwater and the presence of free product was verified in each accessible well. Due to a malfunctioning oil-water interface probe, the thickness of the free product layer could not be determined. The depth to groundwater in each well is summarized in Table 1. Since the monitoring wells at Unocal Service Station No. 0255 have not been tied into the well elevations at the Monterey Apartment site, only depth to groundwater for these wells is presented.

Free product was detected in monitoring wells MW-6 and MW-9 and recovery well RW-1. However, the thickness of the product layer and, consequently, the depth to groundwater, could not be determined due to a malfunctioning oil-water interface probe.

A vapor survey at the Monterey and Del Roy Apartment sites was also performed on May 26, 1992. The survey was performed using a portable HNU photoionization detector (PID) equipped with a 10.7 eV lamp to measure organic vapors and an explosimeter capable of measuring the lower explosive limit (LEL) and oxygen (O_2) levels. These instruments were used in the basement and lower level locations within both buildings. The specific areas where measurements were recorded and the levels found are summarized on Table 2. These measurements indicate that volatile organic vapors (above a background level of 0.0 ppm) are present in many of the building tenant use spaces.

In addition to recording PID, LEL, and O_2 levels within the building, the Monterey Apartment manager was also interviewed to discuss vapor problems within the building. According to the apartment manager, vapors will accumulate in the basement to concentrations such that an alarm located within the laundry room in the basement will continually sound if the door to the outside is not left open and a fan is not left on in the storage room. Free product was observed within a drain outside the door of the laundry room (Drain 1). Tenants of Apartment C, just west of the laundry room, indicated that there was no odor problem. The Del Roy Apartment manager was not available to be interviewed.

Table 1
Groundwater Elevation at Monterey Apartments Site

Well	Date Measured	Top of Casing Elevation(1) (feet)	Depth to Groundwater(2) (feet)	Groundwater Elevation (feet)
MW-2	05/26/92	---	DRY	---
MW-3	05/26/92	100.51	11.22	89.29
MW-4	05/26/92	102.08	12.58	89.50
MW-5	05/26/92	102.92	13.18	89.74
MW-6	05/26/92	113.38	(5)	---
MW-7	05/26/92	104.88	12.88	92.00
MW-8	05/26/92	116.55	(4)	---
MW-9	05/26/92	114.40	(5)	---
MW-10	05/26/92	115.49	14.10	101.39
MW-11	05/26/92	NI	(4)	---
RW-1	05/26/92	112.06	(5)	---
RW-2	05/26/92	104.54	10.66	93.88
MW-1U(3)	05/26/92	NI	(4)	---
MW-2U(3)	05/26/92	NI	(4)	---
MW-3U(3)	05/26/92	NI	9.08	---
MW-4U(3)	05/26/92	NI	9.07	---

(1) Elevations listed are based on a survey by GeoEngineers, Inc. relative to an assumed elevation of 100.00 feet on a utility vault lid located on the sidewalk along the east side of First Avenue West in front of the Alvena Vista Apartments.
(2) Measured from top of well casing.
(3) Monitoring well located on the Unocal Service Station No. 0255.
(4) Monitoring well was inaccessible.
(5) Well contained free product; however, the depth to groundwater and depth of free product could not be determined due to a malfunctioning oil-water interface probe.
NI Not indicated

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Appendix A

CALCULATIONS

CALCULATIONS

* Determine radius of influence and well pumping rate for each recovery well.

* Reference: "Dewatering and Groundwater Control" TM5-818-5, NAVFAC, p. 4-21.

Assumptions

- From slug test performed on March 6, 1991, the hydraulic conductivity is from 10^{-5} to 10^{-6} ft/sec.
- Isotropic and homogeneous conditions.
- Fully penetrating well.
- Circular water source.
- Well diameter = 8 inches (existing)
- Depth of aquifer from soil borings = 9 feet (maximum drawdown possible)

Equations

$R = C(H-h_w)\sqrt{k}$

R = Radius of Influence

C = Constant (3 for gravity flow)

$H - h_w$ = Drawdown

k = Hydraulic Conductivity x 10^{-4}(cm/sec)

$Q_w = \pi k(H^2 - h_w^2)/\ln(R/r_w)$

Q_w = Pumping Rate

r_w = Radius of Recovery Well

Calculations

$k = 1 \times 10^{-5}$ ft/sec

$k = 3.05 \times 10^{-4}$ cm/sec

$k = 6 \times 10^{-4}$ ft/min

$R = 3(9)\sqrt{3.05}$

R = 47 Feet

$Q = \pi(6 \times 10^{-4})(9^2)/\ln(47/0.33)$

$Q = 0.0308$ ft^3/min

Q = 0.23 gpm

$k = 1 \times 10^{-6}$ ft/sec

$k = 3.05 \times 10^{-5}$ cm/sec

$k = 6 \times 10^{-5}$ ft/min

$R = 3(9)\sqrt{0.305}$

R = 15 Feet

$Q = \pi(6 \times 10^{-5})(9^2)/\ln(15/0.33)$

$Q = 0.004$ ft^3/min

Q = 0.03 gpm

Radius of Influence: 15 to 47 Feet

Pumping Rate (each well): 0.03 to 0.23 gpm

* Determine hydrocarbon loading rate contributed by vapor extraction system (VES) and groundwater treatment system.

Assumptions

- VES Flow Rate = 80 cfm
  This is the maximum flow vacuum blower specified by the S.A.V.E. system can produce. This flow rate will be easily obtained due to the large number of proposed extraction ports.

- Initial VES Air Emission Concentration = 25,000 mg/m^3
  This concentration is based on previous system experience which utilized multi-ports, similar flow rates, and was remediating free product along with contaminated soil.

- Groundwater Flow Rate = 1.0 gpm
  This is based on the flow rate calculated on the previous pages, with a system utilizing three recovery wells.

- Pre-Treated Groundwater Hydrocarbon Concentration = 4,100 mg/L
  This concentration is based on the groundwater sample collected from recovery well RW-1.

- An Air-Stripping Alternative Will Be Utilized That Achieves Nearly 100% Treatment

Calculations

VES Contribution:

$(25{,}000\ \text{mg/m}^3)(0.02832\ \text{m}^3/\text{ft}^3)(80\ \text{ft}^3/\text{min})(60\ \text{min/hour})(1 \times 10^{-6}\ \text{kg/mg})(2.2\ \text{lbs/kg})$

= **7.48 lbs/hour**

Groundwater Contribution:

$(4{,}100\ \text{mg/L})(3.785\ \text{L/gal})(1\ \text{gal/min})(60\ \text{min/hour})(1 \times 10^{-6}\ \text{kg/mg})(2.2\ \text{lbs/kg})$

= **2.05 lbs/hour**

Total Vapor Loading = 9.53 lbs/hour

* After completion of the vapor ports and manifold piping, a vapor pilot test should be conducted to determine the actual flow rate and hydrocarbon concentration.

* A pump test should also be conducted to determine groundwater flow rate and hydrocarbon concentration.

Appendix B

PHOTOGRAPH LOG

WASHINGTON STATE
DEPARTMENT OF ECOLOGY

Send To:
Washington Department of Ecology
Hazardous Waste Information & Planning
Attn: DW Notifications
P.O. Box 47658
Olympia, WA 98504-7658
(206) 459-6387

DEPARTMENTAL USE ONLY

ID	
LOG	
REVIEW	
G/WAC	
	WD988483384

FORM 2

NOTIFICATION OF DANGEROUS WASTE ACTIVITIES
(ADMINISTRATIVE WITHDRAWAL)

1. ☐ A. FIRST NOTIFICATION
(No previous application has been made for this site.)

☒ C. WITHDRAW SITE ID # DATE 12 | 31 | 91
(Complete Sections 1F, 2-8 & 13. Enter existing site ID # in 1F.)

☐ E. CANCEL SITE ID # DATE ___|___|___

☐ B. REVISED NOTIFICATION DATE ___|___|___
(Complete all sections of the form. Enter existing site ID # in 1F.)

☐ D. REACTIVATE SITE ID # (Complete all sections of the form. Enter previously assigned site ID # in 1F.)

☒ F. EXISTING SITE ID # ~~WD~~ WAD 988483384
(Complete for items 1B, C, D & E only.)

2.A. WASHINGTON STATE DEPARTMENT OF REVENUE REGISTRATION (TAX) NUMBER: ___ - ___ - ___

2.B. SIC CODE(S): PRIMARY ___ SECONDARY ___ OTHER ___

2.C. TYPE OF BUSINESS CONDUCTED AT THIS SITE ___

3. NAME OF INSTALLATION
WDOE NRO MANHATTAN EXPRESS

4. LOCATION OF INSTALLATION (Attach site location map.)
Street
631 QUEEN ANNE AVE N

County Name KING

City or Town	State	Zip Code
SEATTLE	WA	98109

5. INSTALLATION MAILING ADDRESS
Street or P.O. Box
3190 160TH AVE SE/MS NB-81

City or Town	State	Zip Code
BELLEVUE	WA	98008-5452

6.A. INSTALLATION CONTACT
Name (last) (first)
Job Title Phone Number

6.B. INSTALLATION CONTACT MAILING ADDRESS
Street or P.O. Box
City or Town State Zip Code

7.A. NAME OF INSTALLATION'S LEGAL OWNER
Street or P.O. Box
City or Town State Zip Code

7.B. PROPERTY OWNERSHIP (Also provide address in section 12 if different from 7A.)

7.C. OWNER TYPE ☐

7.D. PROPERTY TYPE ☐

8.A. NAME OF INSTALLATION **WDOE NRO MANHATTAN EXPRESS** 8.B. SITE ID # ~~WD~~ WAD988483384

12. COMMENTS

13. CERTIFICATION		
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately resonsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.		
SIGNATURE Robin Munroe	NAME AND OFFICIAL TITLE (type or print) Robin Munroe Environmentalist	DATE SIGNED November 8, 1993

Table 2
Ambient Air Quality Measurements at Monterey and Del Roy Apartments
(As sampled 5/26/92)

Location	PID[1] Reading (ppm)	LEL[2] Reading (ppm)	O_2 Reading (%)
MONTEREY APARTMENTS:			
Laundry Room (in basement with door open and fan on)	50	10	20.3
Drain 1	7	---	---
Storage Room (off laundry room)	40	10	20.3
Hallway (in basement)	20	10	21.1
Apartment C (adjacent west of laundry room; doors and windows open)	0	10	21.2
Drain 2 (outside Apartment C)	5	---	---
DEL ROY APARTMENTS:			
Drain 3 (outside basement door on south side)	60	10	21.2
Hallway (in basement)	3	10	21.2
Crawl Space (north side of basement)	5	10	21.2

(1) PID readings are above background levels; PID was equipped with a 10.7 eV lamp.
(2) LEL, converted from 0.001 percent
--- Readings were not measured and/or recorded

During the site visit, the structural suitability of the roof of the Monterey Apartments was also evaluated to determine whether it could hold remediation equipment and a protective structure. It was determined by DPRA staff that the roof was incapable of bearing the load of a remediation system; however, there is adequate grade-level space to place a system.

Photographs of the Monterey and Del Roy Apartments as well as the surrounding areas are presented in Appendix B.

On May 26, 1992, DPRA also visited the Seattle City Office to obtain utility maps; a map of the sanitary sewer system for the area was copied. Additional utilities will be verified by the contractor performing the remediation system installation.

In concluding the site visit on May 27, 1992, DPRA staff visited the Northwest Regional Office of Ecology to review and collect available reports and information on file. Neither building design nor construction plans of the Monterey, Lindberg, Alvena Vista, and Del Roy Apartments were available.

3.0 CLEANUP OBJECTIVES

To effectively evaluate the treatment options for remediating the soil and groundwater, the goals or cleanup levels within these media need to be established. In addition, the discharge standards for the media into which contaminants will be transferred also need consideration. The following presents the recommended cleanup levels as established by Ecology in the soil and groundwater. The sanitary sewer and air emission standards are also presented.

3.1 SOIL AND GROUNDWATER RESIDUALS

In March 1991, the Washington DOE published a Petroleum Contamination Remediation Guidance document which presents cleanup standards for typical petroleum contaminants in the soil and groundwater. Soil and groundwater remediation must result in residual concentrations no higher than the following levels:

Constituent	Soil Level (μg/kg)	Groundwater Level (μg/L)
Benzene	500	5
Toluene	40,000	40
Ethylbenzene	20,000	30
Xylenes	20,000	20
Total Petroleum Hydrocarbons	100,000	1,000
Lead	250,000	5

3.2 GROUNDWATER DISCHARGE STANDARDS

The Metropolitan Seattle Industrial Waste Section has established contaminant concentrations that are not to be exceeded by any waste water discharged to the sanitary sewer. These limits are:

Constituent	Concentration (mg/L)
Benzene	0.13
Toluene	1.5
Ethylbenzene	1.4
Non-fatty oil and grease	100

3.3 AIR EMISSION STANDARDS

Air emissions in Seattle, Washington are regulated by the Puget Sound Air Pollution Control Agency (PSAPCA). The current acceptable air emission limit from a petroleum-related remediation system is 15 pounds of total volatile organic compounds (VOCs) per day.

4.0 UNSATURATED ZONE REMEDIAL ALTERNATIVES

Hydrocarbon contamination has been detected in the soil extending from a depth of 5 feet to the groundwater table, which exists at a depth of approximately 15 feet bgs. The source of this contamination has been determined to be the existing USTs and associated dispenser lines. The USTs and dispenser lines should be excavated and removed to eliminate this continued contaminant source before any further remediation occurs. During excavation, if saturated soils and/or free product are encountered, they will be removed and disposed properly.

The volume of contaminated soil is approximately 15,000 cubic yards. This estimate is based on the assumption that the entire area enclosed by the 3 μg/L contour on the soil-gas survey concentration map is contaminated to a depth of 15 feet. This map is located in the Phase I Remedial Investigation Report, dated July 1991, prepared by Ecology and Environment, Inc. There are three alternatives for remediating this soil contamination: vapor extraction, excavation and treatment/disposal, and in-situ biodegradation.

4.1 VAPOR EXTRACTION

A vapor extraction system (VES) has a high probability of successfully remediating the soil contamination beneath the Monterey and Del Roy apartment buildings. Previous experience indicates that a VES not only remediates soil contamination but will also reduce the amount of free product from the groundwater interface and decrease dissolved hydrocarbon concentrations from the groundwater. The free product removal is effective due to the large surface area of free product that can be influenced by a VES.

Vapor extraction is an in-situ soil treatment method that involves the removal of VOCs from subsurface soils by mechanically drawing or venting air through the soil matrix. Slotted or screened pipe is often utilized in conjunction with a vacuum pump. The screened pipe allows air to flow through the contaminated area, yet restricts the movement of soil particles. Vapor extraction is most effective when utilized in sandy soil, as the large grain and pore sizes allow high air flow rates. The volatility of the contaminant is a factor in determining the effectiveness of a VES; compounds with high volatilities, such as unweathered gasoline, are remediated efficiently using vapor extraction systems.

There are at least five advantages to utilizing a VES at the Monterey Apartments site. First, large volumes of contaminated soil can be treated at a relatively low cost: $15 to $30 per cubic yard. (Note, however, treatment of exhaust emissions can significantly increase the total project costs.) Second, soil that is inaccessible, such as the soil under existing buildings or other structures, as is the case at this site, can be influenced and remediated. Third, on-site boring logs indicate the existing soil is primarily sand with a little silt; therefore, a vapor extraction system will operate effectively in soils beneath the Monterey Apartments due to the pore and grain sizes. Fourth, the petroleum release at the project site involves unweathered gasoline, which is highly volatile.

A fifth advantage in using a VES involves the duration of operating the system to achieve the desired cleanup level. Since the VES remediates both the source of contamination (the contaminated soil and free product immediately above the groundwater table) and groundwater, soil and groundwater cleanup levels can often be met more quickly than when performing groundwater remediation only.

The primary *disadvantage* to soil vapor extraction is that treatment of exhaust vapors is often required, as is expected at this project site. The estimated air emission rate from the VES at this site is 189 lbs/day; the PSAPCA allowable point source air emission limit is 15 lbs/day. Air emission calculations and estimates are located in Appendix A. Exhaust air treatment systems will raise the cost of vapor extraction at the Monterey Apartments, and are discussed in further detail in Section 6.0.

The arrangement of the underground screened portion of the VES through which vapors are withdrawn is also an important consideration in obtaining the desired air flow and area of influence. There are three screen layouts: vertical borings, excavated trenches, and horizontal borings.

4.1.1 Vertical Borings

This method involves advancing vertical soil borings with a drill rig, installing PVC well screen connected to PVC pipe, and backfilling with filter sand. An asphalt or concrete plug is placed near the surface to prevent short circuiting of air flow. These borings are spaced at intervals such that the entire area of contamination can be influenced by the draw induced by the vacuum pump. Each PVC pipe is connected to lateral PVC piping buried at a depth of approximately 3 feet, which manifolds into the vacuum pump.

There are two primary advantages to placing the extraction screens in vertical borings. First, the screens can be installed to the appropriate depths with a minimal amount of surface disruption. Regardless of the depth and extent of vertical contamination, the entire amount of contaminated soil above the groundwater table can be influenced by the VES, including the soil located under the apartment buildings and other structures. Vertical screens can also be placed at depths that intersect the groundwater table, so that the free product on the groundwater interface and the dissolved contamination can be remediated. The other advantage to placing the extraction screens in vertical borings is cost. Each vertical extraction port has an installation cost of approximately $2,000, which leads to a considerably lower cost than deep trenches and the management of large amounts of potentially contaminated soil.

4.1.2 Excavated Trenches

Another screen placement method is to excavate down to the area of highest contamination, place PVC well screen horizontally in the trench, and backfill the trench with the excavated soil. As in the vertical boring method, the screen is connected to the vacuum pump with solid PVC pipe.

Placing the screen in excavated trenches becomes advantageous when the excavation has already been performed for another purpose and the vertical extent of the contamination is relatively shallow (less than 10 feet bgs). The screen can then be placed at the bottom of the excavation for a minimal cost. This situation will occur at the Monterey Apartments site, as horizontal screen can be placed in the excavation that will be performed to remove the USTs. Another advantage is that the contaminated soil encountered during this excavation does not have to be disposed, but can be replaced in the excavation and remediated by the VES.

4.1.3 Horizontal Borings

Vapor extraction screens can also be placed in horizontal borings advanced by drill rigs. Horizontal borings, however, require an extremely steep surface gradient, which does not exist at the Monterey Apartments site.

4.2 EXCAVATION

Once the apparent source(s) of contamination (the leaking underground tank and/or distribution piping) have been eliminated or controlled, this remedial method involves excavating the contaminated soil from the site and treating it by an off-site method such as thermal treatment, landfarming, or landfill disposal. A typical cost for excavation and treatment of petroleum-contaminated soil is $80 to $100 per cubic yard.

There is one primary disadvantage to utilizing excavation at the Monterey Apartments site. Approximately 15,000 cubic yards of contaminated soil may exist at the site; a large portion of this lies beneath two apartment buildings and a service station or paved surfaces between these facilities, and therefore cannot be easily removed. Consequently, excavation of the soil is not a feasible option, since additional remediation would still be necessary for the remaining inaccessible soil.

Petroleum-saturated soils may be removed and disposed if encountered when excavating the USTs; however, due to the high cost of disposal and installation of a remediation system, the amount excavated will be limited.

4.3 BIODEGRADATION

In biodegradation, microorganisms occurring naturally in the soil are stimulated to degrade hydrocarbons. This stimulation is accomplished primarily through the addition of oxygen and nutrients such as nitrogen, phosphorous, and trace metals.

The first step in the operation of a biodegradation system involves transporting groundwater from the recovery wells via submersible pumps into a large mixing tank. In this mixing tank, nutrients are added to the groundwater along with hydrogen peroxide. The hydrogen peroxide then decomposes, providing the groundwater with the necessary oxygen. The nutrient and oxygen-laden water is then reintroduced to the soil via infiltration galleries or injection wells. This groundwater then flows back down to the groundwater table, "flushing" degradable hydrocarbons along the way. The key to effectiveness of this method is that the flow of the water must come into contact with all soils containing hydrocarbon contamination. The cost for utilizing biodegradation is high; treatment costs range from $66 to $123 per cubic yard.

There are two primary reasons why biodegradation is not a feasible option for treating the contaminated soil at the Monterey Apartments site. First, due to the limited or restricted access in the area, a large portion of contaminated soil would not come in contact with the nutrient-enriched infiltrating water and this contact is necessary for biodegradation to remediate the soil. Second, while biodegradation works very efficiently at sites with high hydrocarbon concentrations, the microorganisms metabolize low concentrations at a slow rate. The cleanup standards required by Ecology could not be met in a reasonable time frame; another soil treatment technology would be necessary.

5.0 SATURATED ZONE REMEDIAL ALTERNATIVES

5.1 GROUNDWATER TREATMENT

Groundwater treatment is generally required when state-regulated groundwater standards for petroleum contaminants are exceeded. Depending on the level of contamination, groundwater recovery will be required and in order to discharge this water to the sanitary sewer or other discharge source, treatment will be required.

Based on the project site soil types and a slug test performed on March 6, 1991, the estimated groundwater pumping rate will be 0.03 to 0.23 gallons per minute. The actual pumping rate should be verified by a pump test performed in the field. Other assumptions include that the groundwater is perched and is approximately nine feet thick. Calculations are presented in Appendix A.

The following subsections summarize methods of groundwater treatment and free product recovery appropriate to this site. The methods of groundwater treatment include air stripping, carbon adsorption, and biological treatment. Free product recovery methods include trench and well pumping.

5.1.1 Air Stripping

Air stripping is a method of removing VOCs by providing contact between air and water to allow the volatile substances to diffuse from the liquid to the gaseous phase. There are several methods of air stripping including diffused aerators, tray aerators, spray aerators, and packed towers. The types of air stripping considered in this report include diffused aeration and spray aeration.

A diffused aeration system consists of injecting air into water through a diffuser or sparging device that produces fine air bubbles. The contaminants are removed via mass transfer across the air-water interface of the bubbles until they leave the water or become saturated with contaminant. This type of aeration is usually performed in a contact chamber, which is also referred to as a bubble tank or sparge tank.

Mass transfer rates can be improved by producing smaller bubbles, increasing the air-water ratio, improving basin geometry, or using a turbine to increase turbulence within the tank. Increasing the depth of the liquid will also improve the mass transfer rate if the bubbles do not reach saturation before exiting into the atmosphere.

Spray aeration removes VOCs by sparging fine water droplets through a nozzle into the air. Mass transfer of the contaminant takes place across the air-water surface of the water droplet as opposed to diffused aeration where mass transfer occurs across the air bubble. Spray aeration is most often performed over a pond or basin but can also be performed within a contact chamber. Mass transfer rates can be improved by passing the water through the nozzles multiple times, heating the liquid and/or air, and reducing the pressure so that the volatilization temperature is also reduced.

There are three main advantages of air stripping. The primary advantage of both types of air stripping is the relatively low capital and operation and maintenance (O&M) costs as compared to other groundwater treatment options. Typical treatment costs on a volume-treated basis range from $0.05 to $0.25 per 1,000 gallons; however, many factors affect the total cost. These factors include length of cleanup time, groundwater flow rate, desired removal efficiency, and air-water ratio.

The second advantage of air stripping is the relative ease of operation. Once the equipment is in place and operating, the facility is essentially self-operating. In general, there is no recurring maintenance that requires the service of an engineer beyond normal maintenance.

The third advantage is the ability of air stripping to reduce VOCs to applicable discharge levels. The removal efficiency is also dependent on a number of factors, including the water temperature, influent VOC concentration, physical properties of the contaminants, and air-water ratio. In general, spray aeration results in a higher removal efficiency of VOCs than diffused aeration.

Disadvantages of air stripping include the limited types of chemicals treatable by air stripping, the potential air pollution impacts, and the increased cost associated with reducing the air emissions. Air stripping is applicable to the removal of volatile compounds. The major constituents of interest in gasoline--benzene, toluene, ethylbenzene, and xylenes--are all fairly volatile and therefore easily removed. The potential air pollution impacts result since air stripping does not destroy the contaminant but transfers it from the liquid to the gaseous phase. The current focus on air emissions requires air emissions treatment for air stripping systems, and as a result, costs of the overall remediation system increase. The estimated air emission rate from the air stripper is 49 lbs/day; the PSAPCA air emission limit is 15 lbs/day. Treatment of exhaust vapors is discussed in Section 6.0.

5.1.2 Carbon Adsorption

Carbon adsorption is a process by which molecules of a dissolved compound collect on and adhere to the surface of an adsorbent solid by either chemical or physical forces. This treatment is performed in drums or tanks (often called beds) packed with activated carbon. Activated carbon is used because of its large surface area resulting from the unique internal pore structure.

The primary advantage of carbon adsorption is the high attainable removal efficiencies; activated carbon is capable of removing a variety of compounds in gasoline to nondetectable levels (greater than 99.99 percent removal). While not the most efficient use of the carbon's absorptive capacity, it is well suited for reducing low influent concentrations to meet stringent effluent discharge quality limitations. Nevertheless, the disadvantages outweigh this advantage.

The disadvantages include the high capital and O&M costs, the increased carbon usage rates when gasoline additives are present, the decreased effectiveness of the carbon due to precipitation in and on the carbon when some metals are present, and the disposal and/or regeneration of the spent carbon.

Although the cost of activated carbon systems is dependent on a number of factors, such as influent and required effluent concentrations, unit costs range from $0.45 to $2.52 per 1,000 gallons. In general, capital costs may be less than for air stripping systems; however, the O&M costs are approximately four times greater.

The presence of various components within the groundwater can inhibit and rapidly reduce the adsorption capacity of the carbon. Methyl tertiary butyl ether (MTBE) and diisopropyl ether (DIPE) are common gasoline additives. Although they can be removed by carbon adsorption, both have much higher carbon usage rates than do benzene, toluene, ethylbenzene, or xylenes (BTEX). As a result, the cost to remove these constituents becomes prohibitive since disposal or regeneration of the carbon is required more frequently. Inorganic contaminants can also cause fouling of the carbon. For example, although iron and manganese are not adsorbed by the carbon, their presence in concentrations above 5 mg/L results in precipitation onto the carbon. This precipitation will lead to increases in the head losses and decreases in organic removal, and eventually clogging the unit, making it ineffective.

The most prohibitive disadvantage of carbon adsorption is disposal of the spent material. Spent carbon is usually either landfilled or regenerated. Both of these methods are usually performed off site and regeneration is generally economical only for very large projects.

5.1.3 Biological Treatment

Biological treatment, also referred to as biorestoration, is a method of degrading dissolved gasoline components through the use of naturally occurring microorganisms which have been genetically altered or selectively adapted. Unlike air stripping and carbon adsorption, which transfer the contaminants from one media to another, biological treatment destroys the contaminants; the end products are carbon dioxide and water. This treatment can be performed either in-situ or in a bioreactor.

The primary advantage of biological treatment is its ability to completely destroy the contaminants. Nevertheless, this effectiveness, though significant in laboratory studies, is variable in the field. The success of this technology is dependent on site-specific factors. The factors that can decrease the effectiveness include insufficient and variable supply of oxygen, temperature variations, nutrient availability, and component concentration. Microbial toxicity may occur directly beneath a floating petroleum layer. In addition, biological treatment has not been widely applied and, in general, site cleanup takes longer than air stripping or carbon adsorption.

5.2 FREE PRODUCT RECOVERY

Free product recovery can be performed via two methods: trench and well pumping. The trench method consists of digging a trench down to the water table to intercept the flow of the floating gasoline. This method is most practical when the water table is relatively shallow (less than 10 feet bgs). It is impractical at this site since the groundwater table at this site is approximately 15 feet bgs. In addition, the on-site space limitations prohibit an open hole excavation and two groundwater recovery wells currently exist on site. Therefore, only pumping methods are considered.

> The recovery performance of the two on-site groundwater recovery wells is uncertain. It is unclear from the Phase I Remedial Investigation Report (Ecology and Environment, Inc.) whether strictly free product was attempted to be removed from the wells or a mixed phase was removed. A pump test should be performed to determine the suitability of using these wells.

When groundwater is pumped from a well, depending on whether free product is present, either a single or dual pump system can be used. The amount of free product is also a determinant in choosing a pump system. A single pump system allows recovery of gasoline and water through a single pipeline. The recovered groundwater is discharged to an oil/water separator for free product separation prior to treatment. Dual pump systems are appropriate when large amounts of gasoline must be recovered. Generally, they facilitate separation of gasoline and water in the well and therefore reduce the amount of groundwater to be treated. A dual pump system is impractical when the petroleum layer is relatively thin.

The Remedial Investigation report indicates that the two existing recovery wells were previously utilized to recover only free product, and that this system was ineffective. If groundwater is also pumped from these wells with a dual pump system, a core of depression will form which will enhance free product recovery. The existing recovery wells, when utilized in this manner, should effectively produce groundwater and free product.

6.0 EXHAUST VAPOR TREATMENT

If a vapor extraction system or a form of air stripping system is utilized at the project site, exhaust vapor treatment will be necessary. The PSAPCA has set the air emission limit at 15 pounds of VOCs per day. This air emission limit can not be met without controls such as catalytic conversion, thermal combustion, or carbon adsorption. Air emission estimates indicate the VES emission to be 189 lbs/day and the air diffusion emission to be 49 lbs/day. Calculations are located in Appendix B.

6.1 CATALYTIC CONVERSION

One method of treating air containing hydrocarbons is with a catalytic convertor. In the first step of the catalytic conversion process, air passes through a furnace chamber. This furnace chamber is heated to approximately 650°F, using either electric power or a gasoline motor. While the air is heated, a catalyst, such as platinum, is added and a chemical reaction occurs which converts the volatile hydrocarbons into harmless materials such as carbon dioxide and water. The treated air is then discharged to the atmosphere, containing hydrocarbon concentrations below the discharge requirements.

One limiting factor to the catalytic conversion process is the amount of hydrocarbons that can be destroyed. An average catalytic convertor can break down 8 Btus per cubic foot, which is equivalent to 2.5 pounds of VOCs per day assuming a flow rate of 80 cubic feet per minute. Catalytic convertors alone are not feasible on sites with relatively high petroleum vapor concentrations in the exhaust gas as the duration of the remediation system operation would become excessive.

6.2 THERMAL COMBUSTION

Hydrocarbons can also be removed from exhaust gases utilizing thermal combustion processes. For thermal combustion to occur, the exhaust gas must contain at least 60 Btus per standard cubic foot, which is the LEL for petroleum vapor. If the LEL does not already exist in the pre-treated air (an unlikely expectation based on May, 1992 data which indicate LEL thresholds are exceeded), an auxiliary fuel such as propane is added so that the LEL is obtained. A spark is then induced and the hydrocarbons thermally combust.

There are two methods which utilize the thermal combustion process. Flame units induce the spark in an exhaust stack, thus creating an open flame at the stack apex. At this particular site, this alternative would either expose many multi-story complexes to an open flame or require an exhaust stack with a height of approximately 100 feet. The other method involves having the thermal combustion process take place inside an internal combustion (IC) motor. The primary advantage to using a IC motor is that the energy generated by the motor can be used to power other equipment in the remediation system. The motor's exhaust gases are then treated with a catalytic convertor to reduce the total hydrocarbon emissions to less than one pound per day.

6.3 CARBON ADSORPTION

A third exhaust gas treatment methodology is carbon adsorption. Carbon adsorption of air contaminants is similar to the adsorption of these same contaminants in groundwater. The exhaust gas flows through a large canister containing activated carbon. This treatment system operates efficiently until all of the carbon surface area has hydrocarbon molecules attached to it. At this point, the spent carbon unit must be either replaced or thermally treated off site to restore the carbon to its original condition.

The advantages of carbon adsorption include low emission rates, relatively low cost per unit, and the activated carbon can be reused after it has been thermally treated.

Activated carbon use has one primary disadvantage. High influent contaminant concentrations and large flow rates increase the frequency that the carbon must be thermally treated. Frequent thermal treatment and maintenance costs can become excessive. Using similar site exhaust gas concentrations, the estimated carbon consumption rate would be 1,190 pounds per day.

7.0 CONCLUSIONS

Based upon the data contained in this pre-engineering design report, DPRA and SAIC have reached the following conclusions:

- The USTs and dispenser lines should be excavated and removed as they are potentially ongoing source(s) of contamination that need to be eliminated. If practical, free product and contaminated soil can be removed during tank excavation and a horizontal screen placed in the excavation as a component in the vapor extraction system.

- A pump test should be performed on the existing on-site recovery wells to determine whether they can perform to the expected specifications (0.03 to 0.23 gallons per minute).

- Free product can be recovered from recovery wells that currently exist on site if their performance meets the anticipated specifications. Pneumatic product pumps, utilizing hydrophobic-material and vacuum enhancement, can efficiently remediate the liquid-phase hydrocarbon floating on the groundwater table when used as a fuel pump system component. Earlier recovery well ineffectiveness was due to attempting to pump free product only.

- A vapor extraction system, utilizing vertical borings, is the preferred method of remediating the soil contamination and eliminating the vapor problem existing in the Monterey (and adjoining Del Roy) Apartments. This alternative allows all existing contaminated soil to be influenced by the remediation system, whereas the other unsaturated zone alternatives do not. This method also offers rapid results for a large portion of the contamination, which will reduce the existing health risk.

- The exhaust gas should be treated by a thermal combustion process, utilizing an internal combustion (IC) motor. This method can thoroughly destroy up to 10 pounds per hour of total petroleum hydrocarbons. This alternative also allows energy from the IC motor to be used to power other remediation system components (e.g., soil vapor extraction or product recovery pumps).

- Spray aeration vacuum extraction should be used to treat the petroleum-contaminated groundwater. This process requires little maintenance, yet can obtain a higher removal efficiency than diffused aeration tanks. Treated groundwater can be discharged to the sanitary sewer in accordance with the Metropolitan Seattle Industrial Waste Section guidelines. One disadvantage to utilizing spray aeration vacuum extraction is that contaminated air is one of the byproducts of the groundwater treatment process. This contaminated air requires additional treatment.

8.0 COST ESTIMATES

8.1 Capital Construction Costs

I. Vapor Extraction System

A.	Vapor Ports (12 ports @ $2,300/port)	$ 27,600.00
B.	Lateral Piping (1300 feet @ $9.70/foot)	$ 12,610.00
C.	Manifold	$ 460.00
	Subtotal	$ 40,710.00

II. Groundwater Recovery System

A.	Recovery Well (1 well @ $5,750)	$ 5,750.00
B.	Submersible Pumps (3 pumps @ $950/pump)	$ 2,850.00
C.	Inlet Piping (130 feet @ $9.35/foot)	$ 1,215.00
D.	Discharge Piping (130 feet @ $69/foot)	$ 8,970.00
E.	Excavation	$ 2,300.00
	Subtotal	$ 21,085.00

III. Free Product Recovery

A.	Pneumatic Pumps, Control Panel (3 pumps @ $4,255/pump)	$ 12,765.00
B.	Inlet Piping (130 feet @ $9.35/foot)	$ 1,215.00
C.	Product Storage Tank (1 560-gallon tank @ $8.15)	$ 815.00
D.	Air Compressor and Filter	$ 1,725.00
	Subtotal	$ 16,520.00

IV. Vapor and Groundwater Treatment

A.	Spray Aeration and Vacuum Extraction	$ 68,425.00
B.	Control Panel and Accessories	$ 5,750.00
C.	Condensate Separator	$ 460.00
D.	Building	$ 5,000.00
E.	Start-up Training	$ 1,000.00
	Subtotal	$ 80,635.00

V. Other Labor Costs

A.	Tank Removal	$ 13,000.00
B.	Connecting Remediation System to Items I & II	$ 5,000.00
C.	Sewer Connection (licensed plumber)	$ 1,000.00
	Subtotal	$ 19,000.00
	Capital Construction Total:	$177,950.00
	Contingency (20%):	$ 35,590.00
	Project Total:	$213,540.00

8.2 OPERATION, MAINTENANCE, AND MONITORING COSTS

The operation, maintenance, and monitoring costs have been estimated for the next five years and are presented on the following table:

Year	Annual Cost	Accumulative Cost
1	$4,200	$ 4,200
2	$4,525	$ 8,725
3	$4,810	$13,535
4	$5,000	$18,535
5	$5,200	$23,735

These costs reflect an inflation rate of four percent and variations in auxiliary fuel costs due to decreasing hydrocarbon concentrations. The first year's cost consist of the following items:

• Auxiliary Fuel	$ 200
• System Monitoring	$1,500
• Operation and Maintenance Labor	$1,500
• Equipment Replacement	$1,500

Sampling plans describing system monitoring must be submitted to and approved by Ecology, Metro Industrial Water Treatment, and PSAPCA. For the estimated monitoring costs, monthly pre- and post-treatment groundwater sampling for benzene, ethylbenzene, toluene, and lead was assumed. Air emission monitoring was also assumed to occur on a monthly basis. Monitoring costs may vary as sampling plans are reviewed by the applicable agency. Reporting to the agencies may also be required to maintain a permit; however, reporting is not included in these costs.

The operation, maintenance, and equipment replacement costs are rough estimates for the technologies that have been recommended. As further remediation system decisions are reached and more information is gathered, a more accurate estimate of these costs will be provided.

9.0 REFERENCES

Assessing UST Corrective Action Technologies: Site Assessment and Selection of Unsaturated Zone Treatment Technologies. U.S. Environmental Protection Agency (EPA). EPA/600/2-90/011. March 1990.

Cleanup of Releases from Petroleum USTs - Selected Technology. U.S. Environmental Protection Agency (EPA). EPA/530/UST-88/001. April 1988.

Remedial Technologies for Leaking Underground Storage Tanks. Electric Power Research Institute and Edison Electric Institute. Lewis Publishers, Inc. 1988.

Toxics Cleanup and Solid and Hazardous Waste Programs - Petroleum Contamination Remediation Guidance. Washington State Department of Ecology. March 4, 1991.

CONTRACT DRAWINGS FOR: CONSTRUCTION OF REMEDIAL TREATMENT SYSTEM MONTEREY APARTMENTS SEATTLE, WASHINGTON

Prepared for:

WASHINGTON STATE DEPARTMENT OF ECOLOGY

CONTRACT NO.: C0089066
WORK ASSIGNMENT: 60
SAIC PROJECT NO.: 01-0817-03-1805

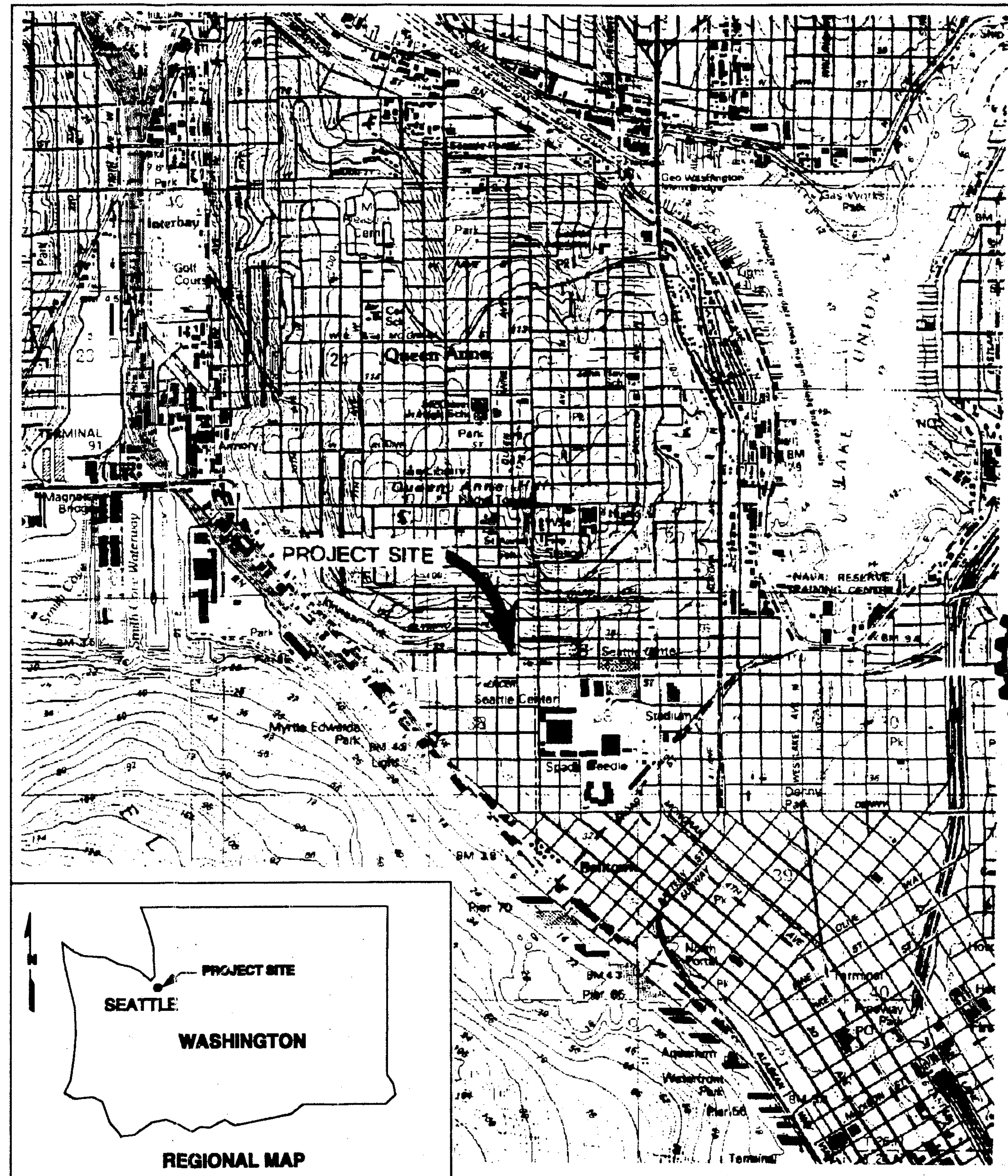
Prepared by:

DPRA | SAIC *An Employee-Owned Company*

DRAWING SCHEDULE	
DRAWING NO.	TITLE
1 of 10	DRAWING SCHEDULE, REGIONAL MAP, & SITE LOCATION MAP
2 of 10	DEMOLITION PLAN
3 of 10	RECOVERY SYSTEM CONSTRUCTION PLAN
4 of 10	REMEDIATION SYSTEM EQUIPMENT LAYOUT PLAN
5 of 10	HORIZONTAL VAPOR EXTRACTION SYSTEM PLAN & PROFILE
6 of 10	RECOVERY WELL & VAPOR PORT DETAILS
7 of 10	DISCHARGE LINE PROFILES
8 of 10	PROCESS SCHEMATICS
9 of 10	SECTIONS & DETAILS
10 of 10	SECTIONS

PLAN, SECTION AND DETAIL LEGEND

TITLE	CALL-OUT
PLAN NUMBER 1 / DRAWING NUMBER 7 — PLAN	1 PLAN NUMBER / 7 REFERENCED TO DRAWING NUMBER
SECTION NUMBER 1 / DRAWING NUMBER 7 — SECTION / PROFILE	1 SECTION NUMBER / 7 REFERENCED TO DRAWING NUMBER
DETAIL NUMBER 1 / DRAWING NUMBER 7 — DETAIL	1 DETAIL NUMBER / 7 REFERENCED TO DRAWING NUMBER



SITE LOCATION MAP

FROM U.S.G.S. 7.5 MIN. x 15 MIN. SERIES QUADRANGLE
SEATTLE NORTH, WASHINGTON

0' SCALE 2000'

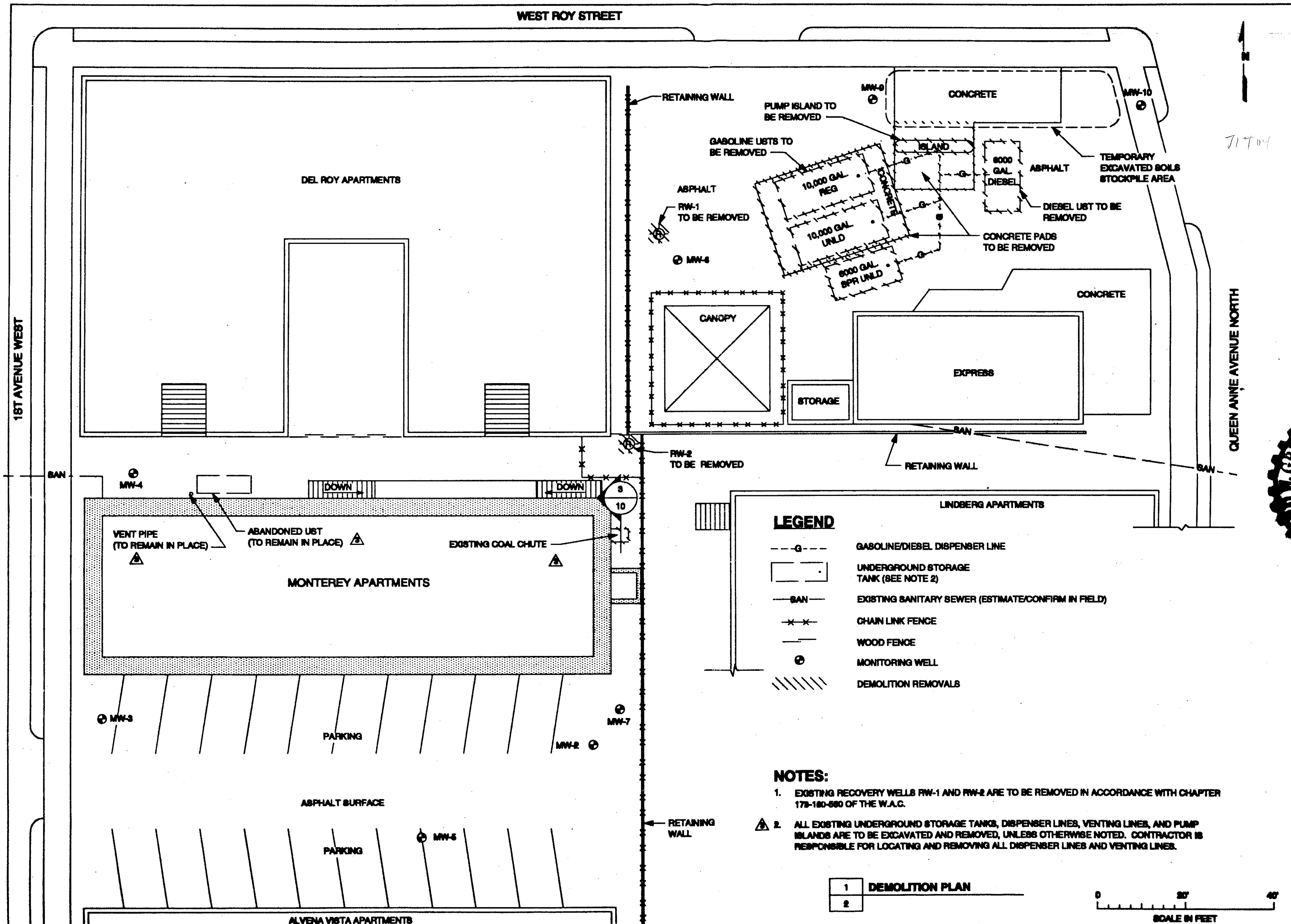
REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
2	EDITS	RWG	SJR	MDS	11/[illegible]/92
1	ORIGINAL DRAWINGS	DLH	SJR	MDS	10/[illegible]/92

DRAWING SCHEDULE, REGIONAL MAP & SITE LOCATION MAP

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

DATE: NOVEMBER 10, 1992
DRAWING NUMBER: 1 of 10

SAIC *An Employee-Owned Company*
DPRA
PROJECT NUMBER: 8761.913



NOTES:

1. EXISTING RECOVERY WELLS RW-1 AND RW-2 ARE TO BE REMOVED IN ACCORDANCE WITH CHAPTER 173-160-560 OF THE W.A.C.

2. ALL EXISTING UNDERGROUND STORAGE TANKS, DISPENSER LINES, VENTING LINES, AND PUMP ISLANDS ARE TO BE EXCAVATED AND REMOVED, UNLESS OTHERWISE NOTED. CONTRACTOR IS RESPONSIBLE FOR LOCATING AND REMOVING ALL DISPENSER LINES AND VENTING LINES.

1	DEMOLITION PLAN
2	

REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
3	ABANDONED UST, COAL CHUTE	DLH	SJR	[illegible]	[illegible]
2	EDITS	[illegible]	SJR	[illegible]	[illegible]
1	ORIGINAL DRAWINGS	DLH	SJR	[illegible]	[illegible]

DEMOLITION PLAN

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

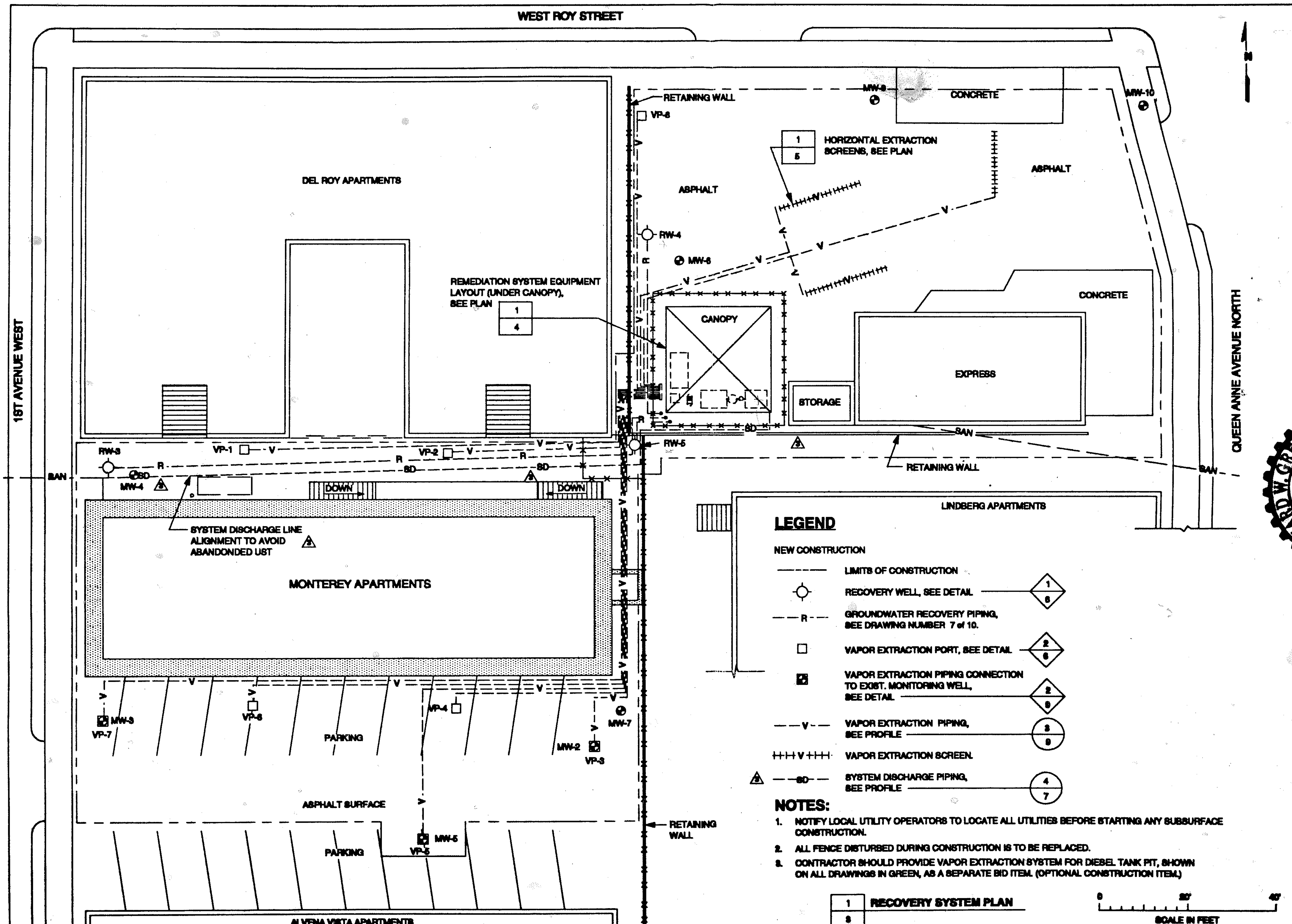
DATE: MARCH 5, 1999

DRAWING NUMBER: 2 of 10

SAIC
An Employee-Owned Company

DPRA

PROJECT NUMBER: 8751.013



LEGEND

NEW CONSTRUCTION

- LIMITS OF CONSTRUCTION
- RECOVERY WELL, SEE DETAIL (1/6)
- GROUNDWATER RECOVERY PIPING, SEE DRAWING NUMBER 7 of 10.
- VAPOR EXTRACTION PORT, SEE DETAIL (2/6)
- VAPOR EXTRACTION PIPING CONNECTION TO EXIST. MONITORING WELL, SEE DETAIL (2/9)
- VAPOR EXTRACTION PIPING, SEE PROFILE (3/9)
- VAPOR EXTRACTION SCREEN.
- SYSTEM DISCHARGE PIPING, SEE PROFILE (4/7)

NOTES:

1. NOTIFY LOCAL UTILITY OPERATORS TO LOCATE ALL UTILITIES BEFORE STARTING ANY SUBSURFACE CONSTRUCTION.
2. ALL FENCE DISTURBED DURING CONSTRUCTION IS TO BE REPLACED.
3. CONTRACTOR SHOULD PROVIDE VAPOR EXTRACTION SYSTEM FOR DIESEL TANK PIT, SHOWN ON ALL DRAWINGS IN GREEN, AS A SEPARATE BID ITEM. (OPTIONAL CONSTRUCTION ITEM.)

1/8 RECOVERY SYSTEM PLAN

0 20' 40'
SCALE IN FEET

REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
3	SYSTEM DISCHARGE	DLH	SJR	MRB	[illegible]
2	EDITS	RWG	SJR	MRB	11/19/92
1	ORIGINAL DRAWINGS	DLH	SJR	MRB	10/7/92

RICHARD W. GREINING — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER — 17737

RECOVERY SYSTEM CONSTRUCTION PLAN

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

DATE: MARCH 5, 1993

DRAWING NUMBER: 8 of 10

SAIC
An Employee-Owned Company

DPRA

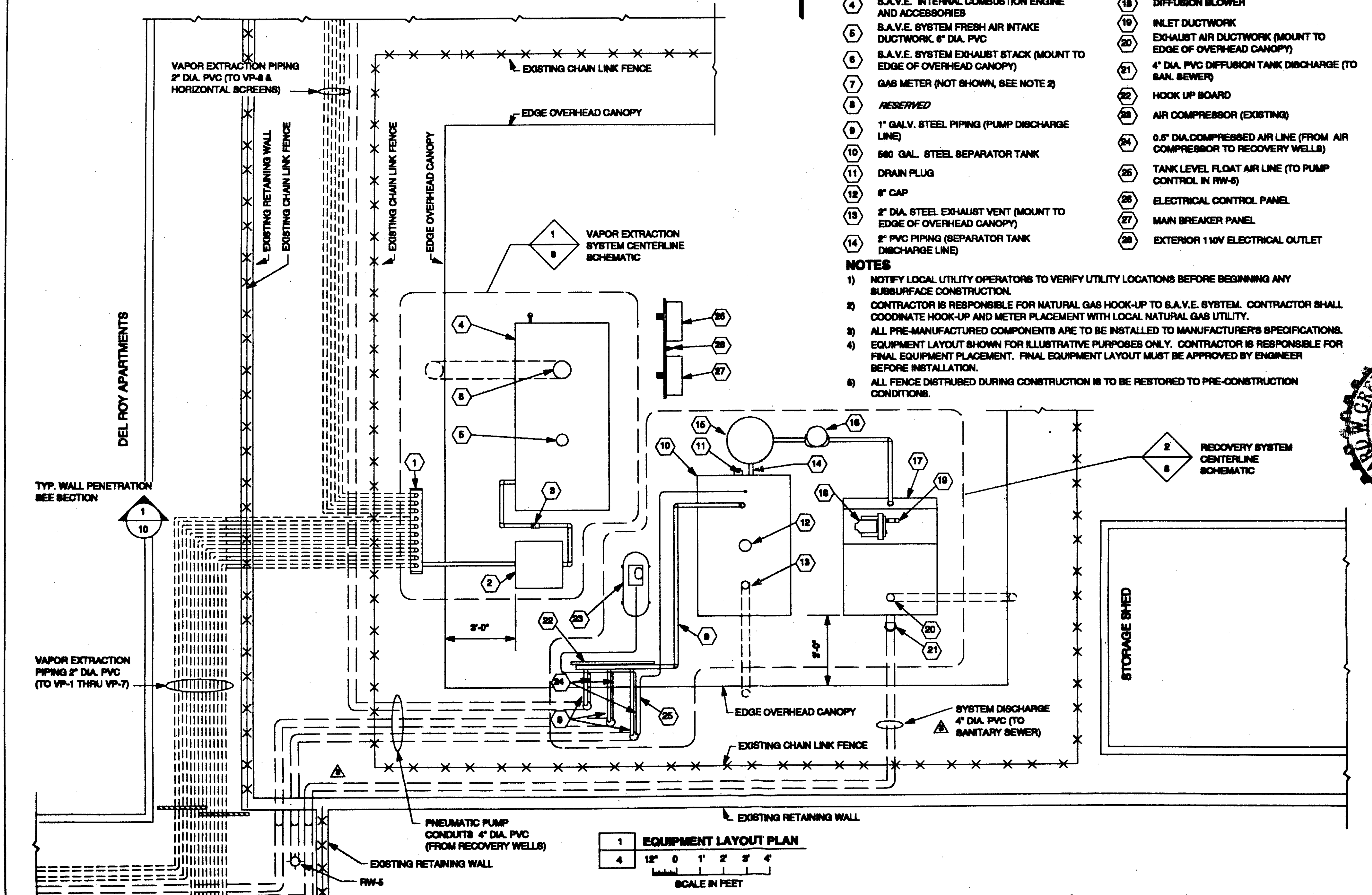
PROJECT NUMBER: 9751.013

KEYNOTES

1. VAPOR PORT INTAKE MANIFOLD
2. CONDENSATE SEPARATOR
3. INLINE PARTICLE FILTER
4. S.A.V.E. INTERNAL COMBUSTION ENGINE AND ACCESSORIES
5. S.A.V.E. SYSTEM FRESH AIR INTAKE DUCTWORK. 6" DIA. PVC
6. S.A.V.E. SYSTEM EXHAUST STACK (MOUNT TO EDGE OF OVERHEAD CANOPY)
7. GAS METER (NOT SHOWN, SEE NOTE 2)
8. *RESERVED*
9. 1" GALV. STEEL PIPING (PUMP DISCHARGE LINE)
10. 560 GAL. STEEL SEPARATOR TANK
11. DRAIN PLUG
12. 6" CAP
13. 2" DIA. STEEL EXHAUST VENT (MOUNT TO EDGE OF OVERHEAD CANOPY)
14. 2" PVC PIPING (SEPARATOR TANK DISCHARGE LINE)
15. TRANSFER STATION
16. TRANSFER PUMP
17. DIFFUSION TANK
18. DIFFUSION BLOWER
19. INLET DUCTWORK
20. EXHAUST AIR DUCTWORK (MOUNT TO EDGE OF OVERHEAD CANOPY)
21. 4" DIA. PVC DIFFUSION TANK DISCHARGE (TO SAN. SEWER)
22. HOOK UP BOARD
23. AIR COMPRESSOR (EXISTING)
24. 0.5" DIA.COMPRESSED AIR LINE (FROM AIR COMPRESSOR TO RECOVERY WELLS)
25. TANK LEVEL FLOAT AIR LINE (TO PUMP CONTROL IN RW-5)
26. ELECTRICAL CONTROL PANEL
27. MAIN BREAKER PANEL
28. EXTERIOR 110V ELECTRICAL OUTLET

NOTES

1) NOTIFY LOCAL UTILITY OPERATORS TO VERIFY UTILITY LOCATIONS BEFORE BEGINNING ANY SUBSURFACE CONSTRUCTION.
2) CONTRACTOR IS RESPONSIBLE FOR NATURAL GAS HOOK-UP TO S.A.V.E. SYSTEM. CONTRACTOR SHALL COODINATE HOOK-UP AND METER PLACEMENT WITH LOCAL NATURAL GAS UTILITY.
3) ALL PRE-MANUFACTURED COMPONENTS ARE TO BE INSTALLED TO MANUFACTURER'S SPECIFICATIONS.
4) EQUIPMENT LAYOUT SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. CONTRACTOR IS RESPONSIBLE FOR FINAL EQUIPMENT PLACEMENT. FINAL EQUIPMENT LAYOUT MUST BE APPROVED BY ENGINEER BEFORE INSTALLATION.
5) ALL FENCE DISTRUBED DURING CONSTRUCTION IS TO BE RESTORED TO PRE-CONSTRUCTION CONDITIONS.



EQUIPMENT LAYOUT PLAN

12" 0 1' 2' 3' 4'

SCALE IN FEET

REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
3	SYSTEM DISCHARGE	DLH	SJR	[illegible]	[illegible]
2	EDITS	RWG	SJR	[illegible]	11/7/95
1	ORIGINAL DRAWINGS	DLH	SJR	[illegible]	10/7/95

EXPIRES 3/29/94

REMEDIATION SYSTEM EQUIPMENT LAYOUT PLAN

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

DATE: MARCH 5, 1996

DRAWING NUMBER: 4 of 10

SAIC
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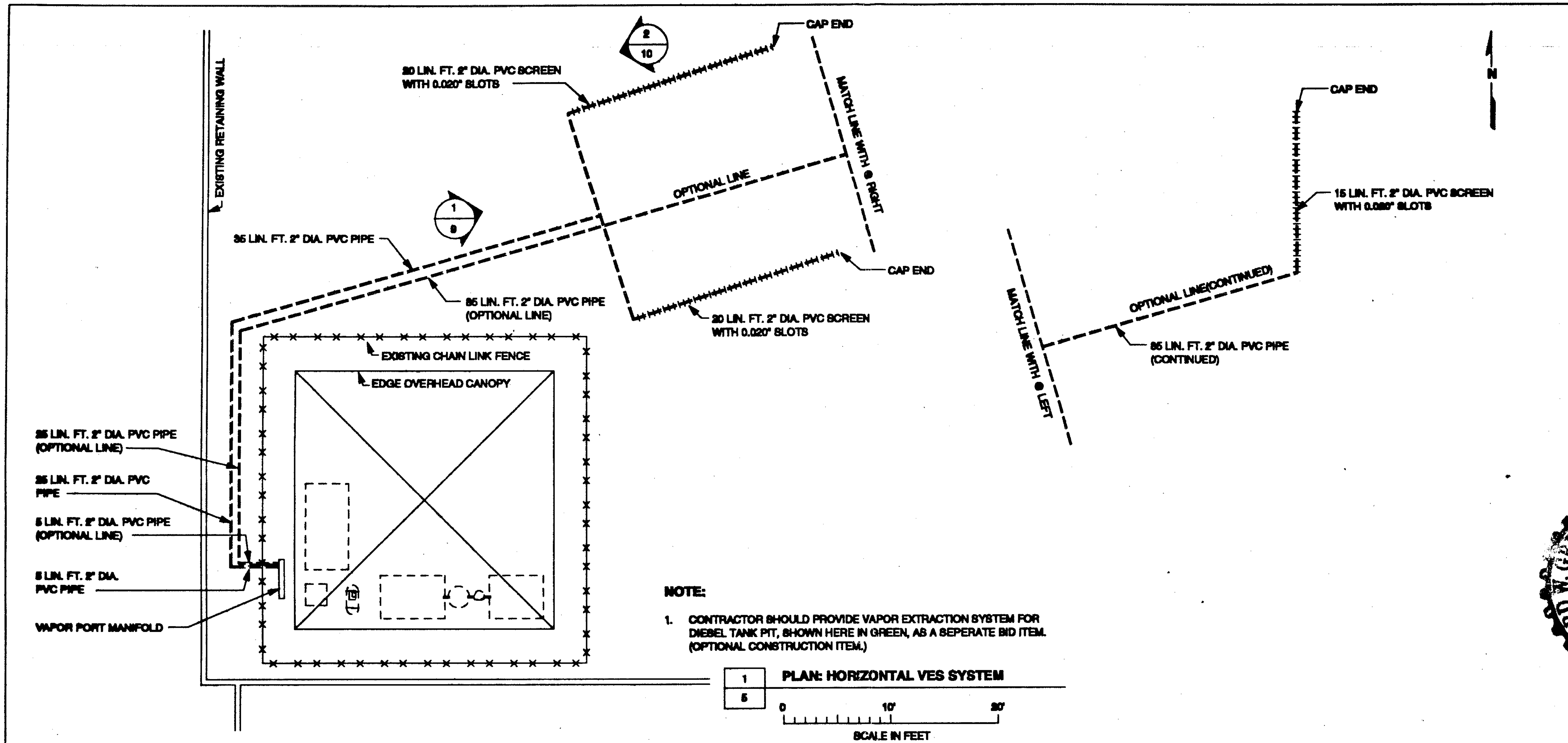
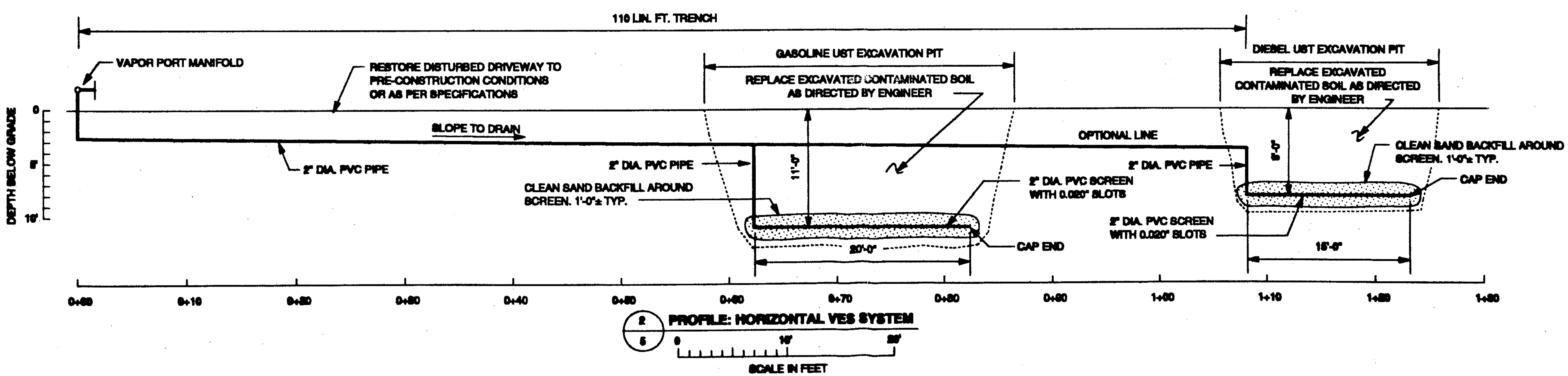
PROJECT NUMBER: 3751.018





REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
2	EDITS	RWG	SJR	MDS	11/10/92
1	ORIGINAL DRAWINGS	DLH	SJR	MDS	10/7/92

HORIZONTAL VES SYSTEM PLAN AND PROFILES

MONTEREY APARTMENTS SEATTLE, WASHINGTON

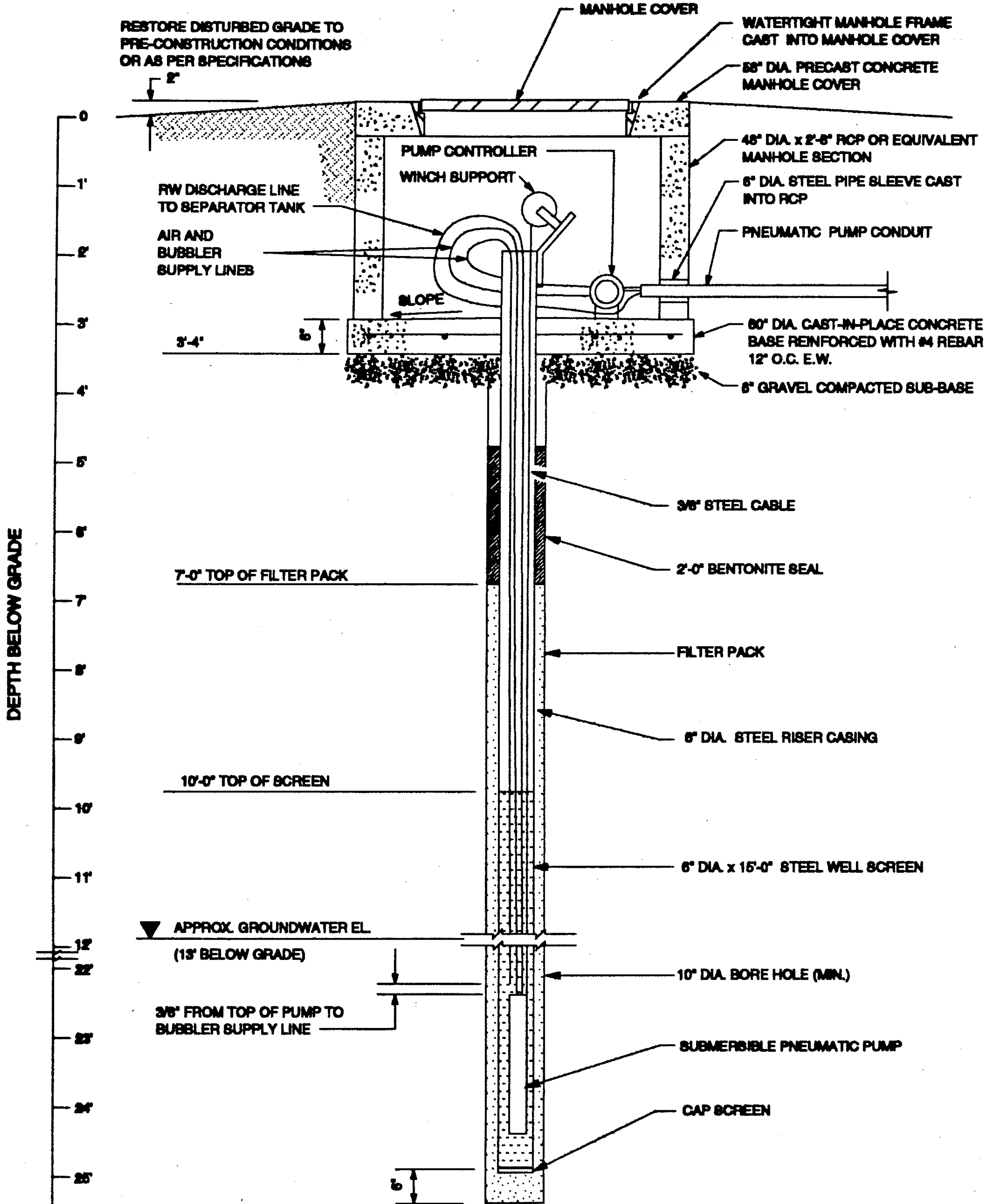
DATE: NOVEMBER 10, 1992

DRAWING NUMBER: 5 of 10

SAIC An Employee-Owned Company

DPRA

PROJECT NUMBER: 2751.013

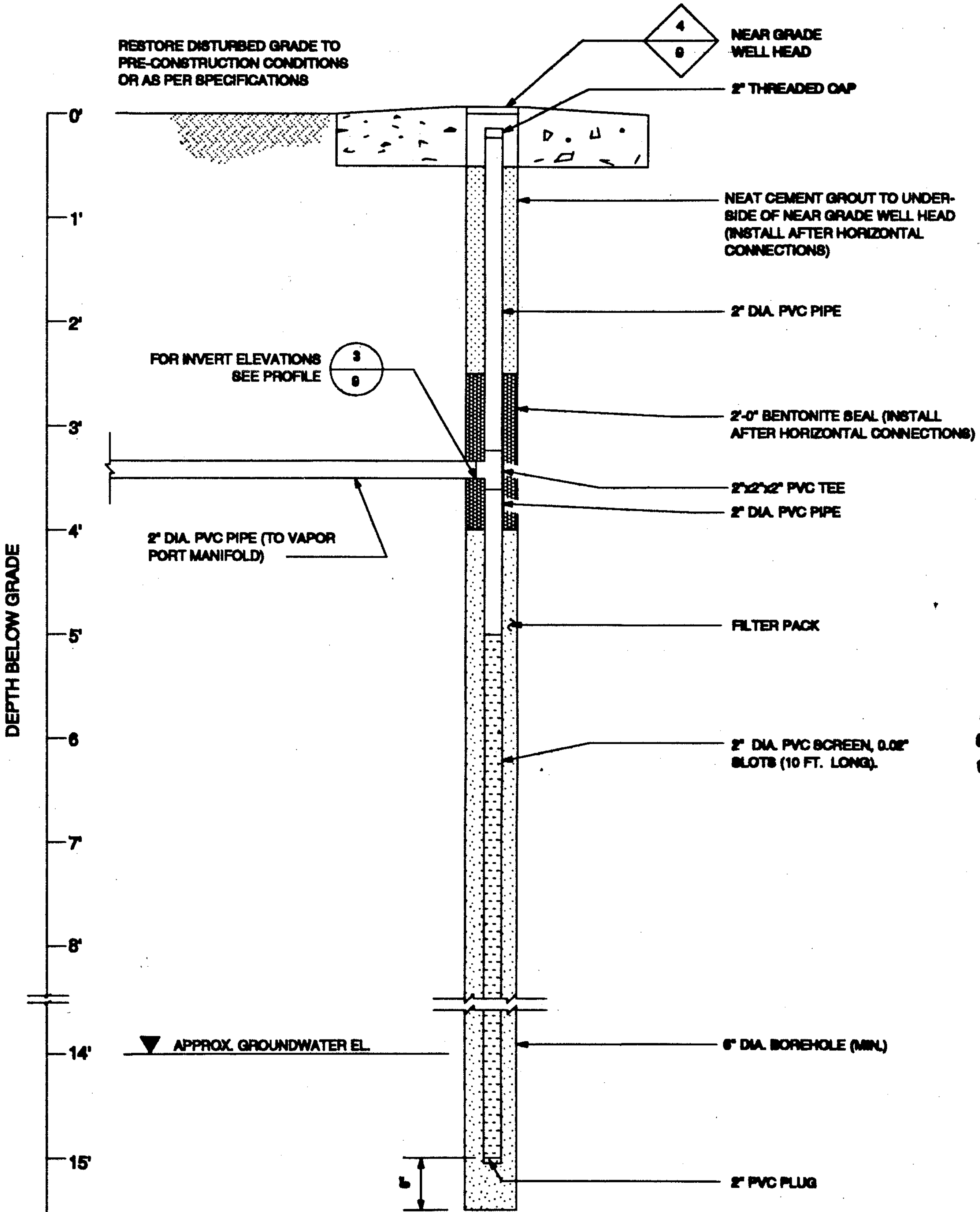


NOTES:

1. ENGINEER WILL VERIFY SCREEN PLACEMENT IN FIELD.
2. RECOVERY WELL RW-5 WILL BE ADVANCED TO 35' INSTEAD OF 25'.

1/6 DETAIL: GROUNDWATER RECOVERY WELL

SCALE: 12" 6" 0 1' 2'



NOTES:

1. ENGINEER WILL VERIFY SCREEN PLACEMENT IN FIELD.

2/6 DETAIL: VAPOR EXTRACTION PORT

SCALE: 12" 6" 0 1'

REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
2	EDITS	RWG	SJR	MDS	11/10/92
1	ORIGINAL DRAWINGS	DLH	SJR	MDS	10/7/92

RICHARD W. GREILING, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER, 17737 — EXPIRES 3/29/94

RECOVERY WELL AND VAPOR PORT DETAILS

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

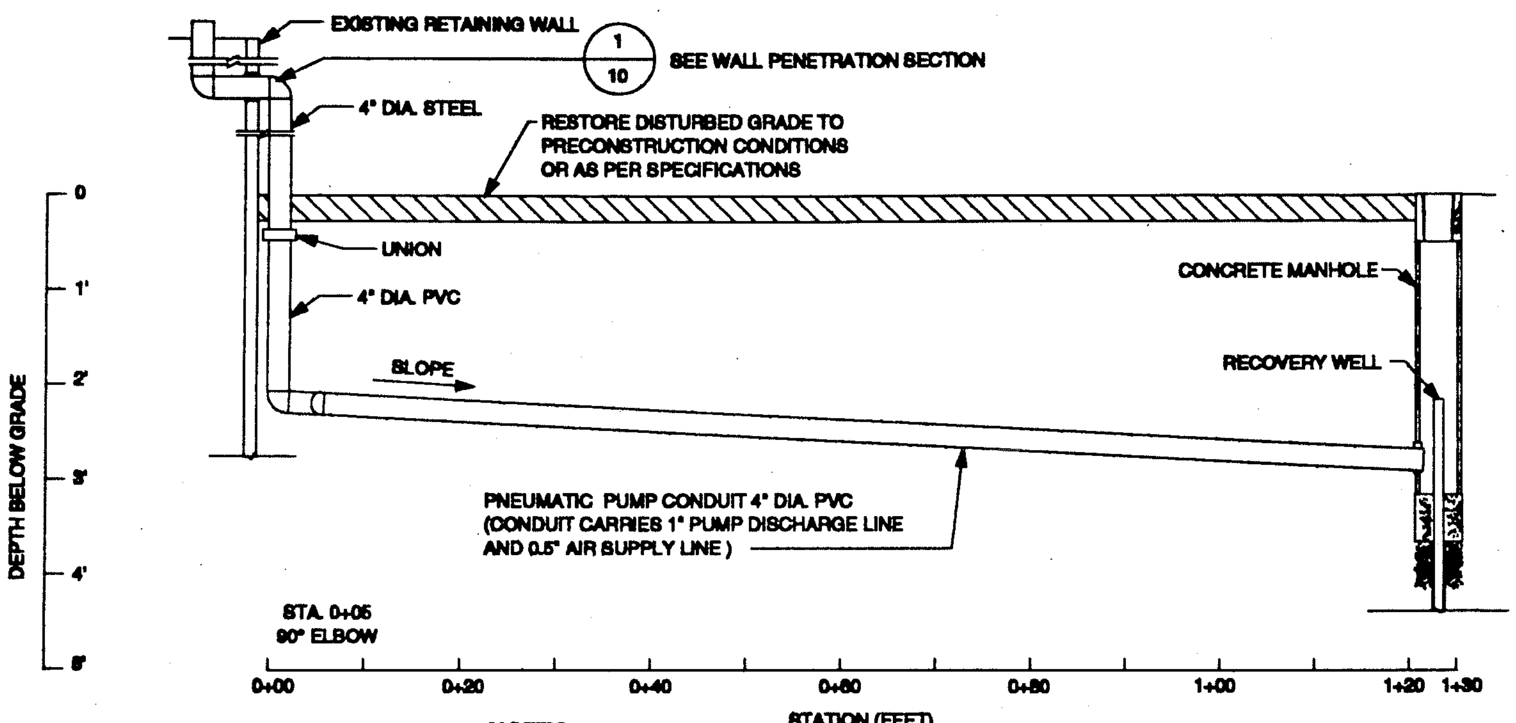
DATE: NOVEMBER 10, 1992

DRAWING NUMBER: 6 of 10

SAIC — An Employee-Owned Company

DPRA

PROJECT NUMBER: 3751.013



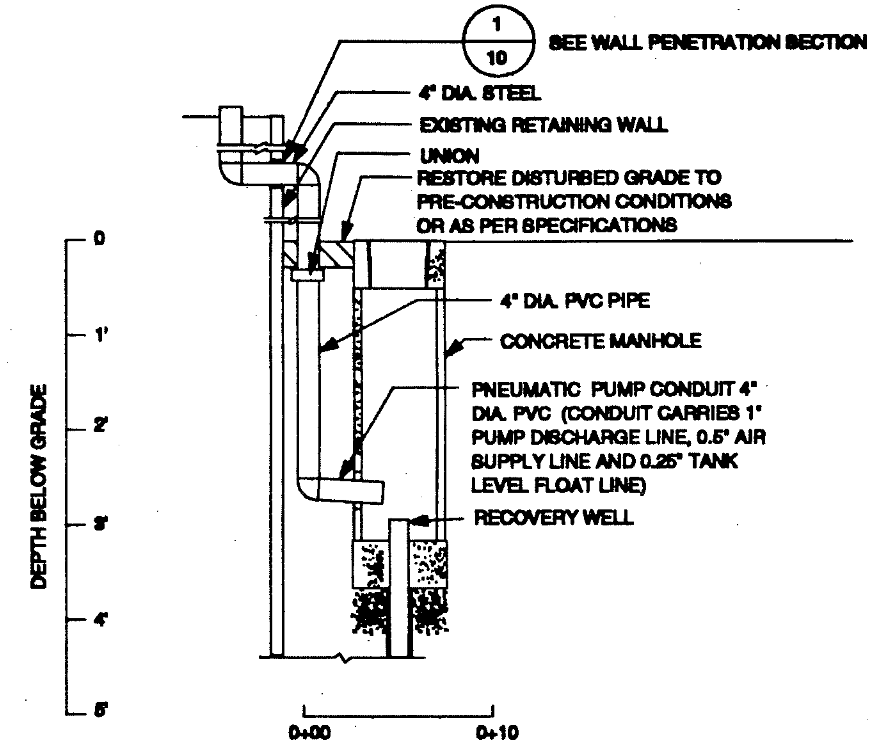
NOTES:

1.) NOTIFY LOCAL UTILITY OPERATORS TO VERIFY UTILITY LOCATIONS BEFORE BEGINNING ANY SUBSURFACE CONSTRUCTION.

2.) CONTRACTOR IS RESPONSIBLE FOR PIPING ROUTE BETWEEN RETAINING WALL AND SYSTEM HOOK-UP.

1/7 **PROFILE: RECOVERY WELL DISCHARGE LINE(RW-3)**

SCALE AS SHOWN



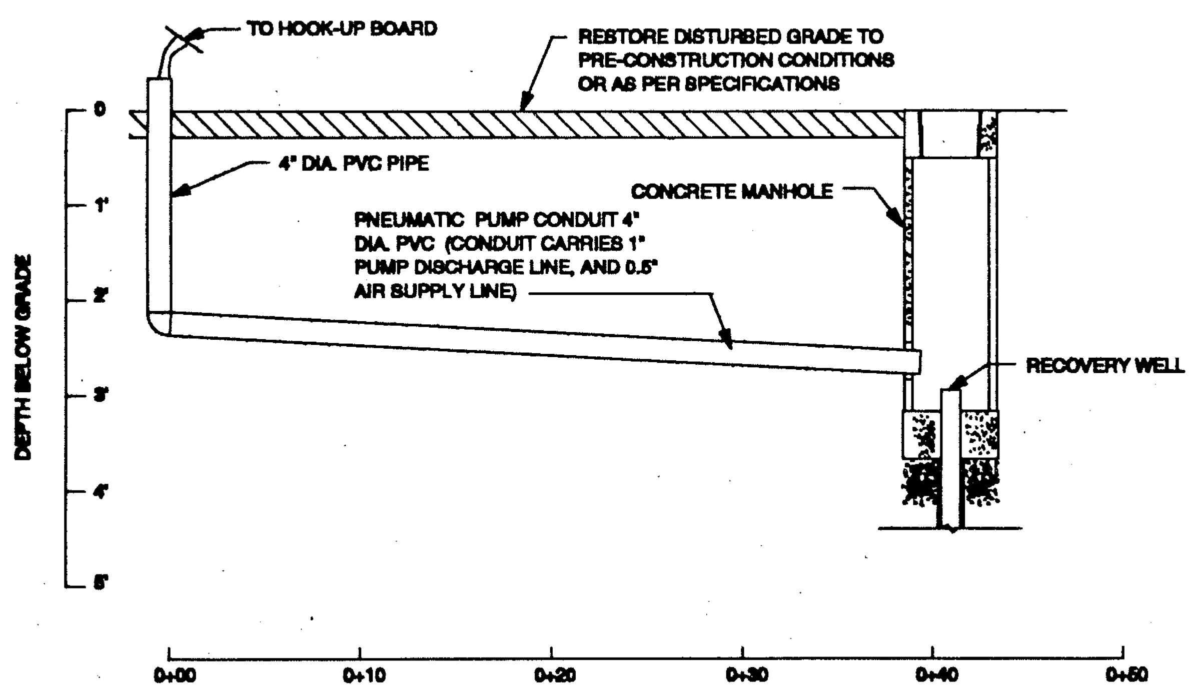
NOTES:

1.) NOTIFY LOCAL UTILITY OPERATORS TO VERIFY UTILITY LOCATIONS BEFORE BEGINNING ANY SUBSURFACE CONSTRUCTION.

2.) CONTRACTOR IS RESPONSIBLE FOR PIPING ROUTE BETWEEN RETAINING WALL AND SYSTEM HOOK-UP.

2/7 **PROFILE: RECOVERY WELL DISCHARGE LINE(RW-5)**

SCALE AS SHOWN

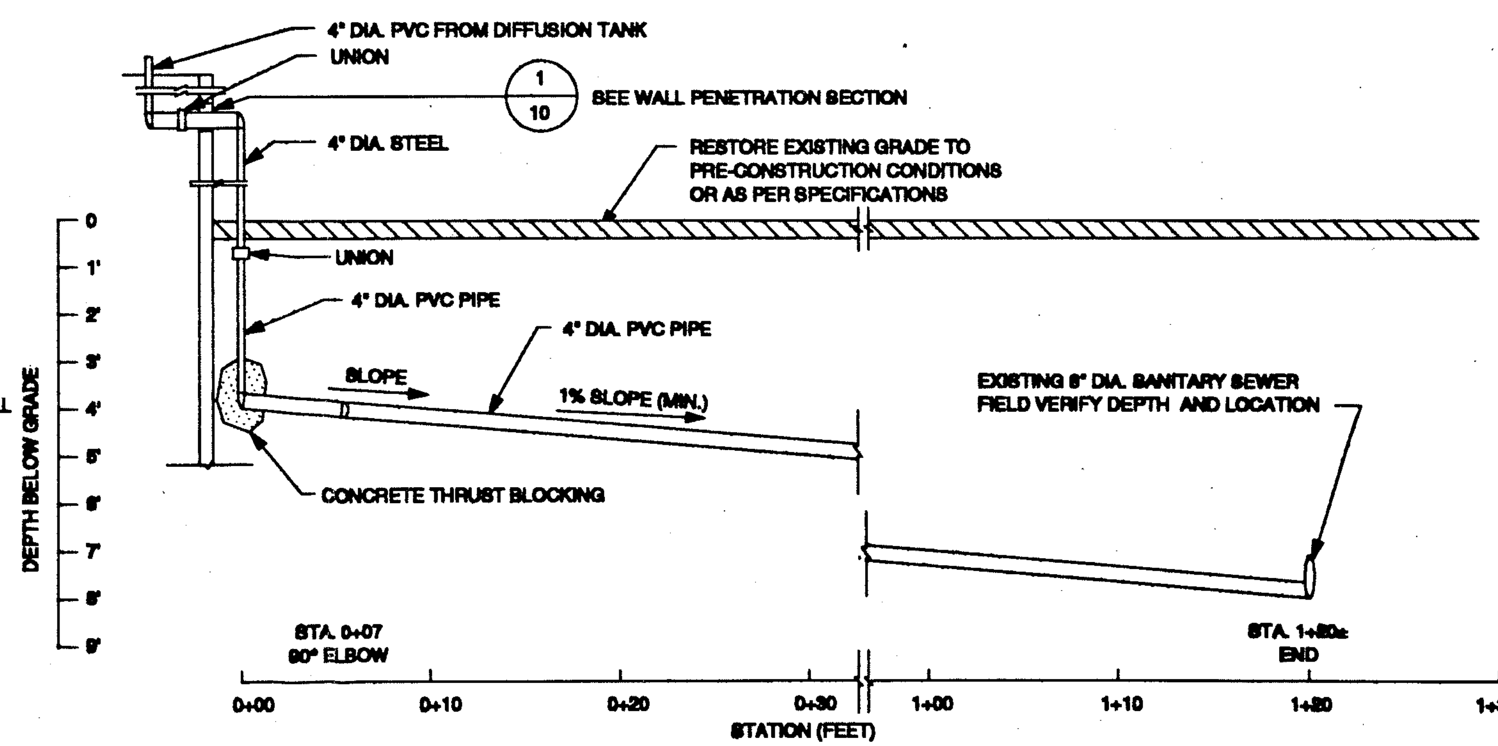


NOTES:

1.) NOTIFY LOCAL UTILITY OPERATORS TO VERIFY UTILITY LOCATIONS BEFORE BEGINNING ANY SUBSURFACE CONSTRUCTION.

3/7 **RECOVERY WELL DISCHARGE LINE(RW-4)**

SCALE AS SHOWN



NOTES:

1) NOTIFY LOCAL UTILITY OPERATORS TO VERIFY UTILITY LOCATIONS BEFORE BEGINNING ANY SUBSURFACE CONSTRUCTION.

2) PROVIDE THRUST BLOCKING AT ALL WYES, BENDS AND TEES.

△ 4/7 **PROFILE: SYSTEM DISCHARGE LINE TO SEWER**

SCALE AS SHOWN

REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
△	SYSTEM DISCHARGE	DLH	SJR	MKS	3/6/98
2	EDITS	RWG	SJR	MKS	11/10/92
1	ORIGINAL DRAWINGS	DLH	SJR	MDS	10/7/92

RICHARD W. GRELLING · STATE OF WASHINGTON · REGISTERED PROFESSIONAL ENGINEER · 17731 · EXPIRES 3/?/9?

DISCHARGE LINE PROFILES

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

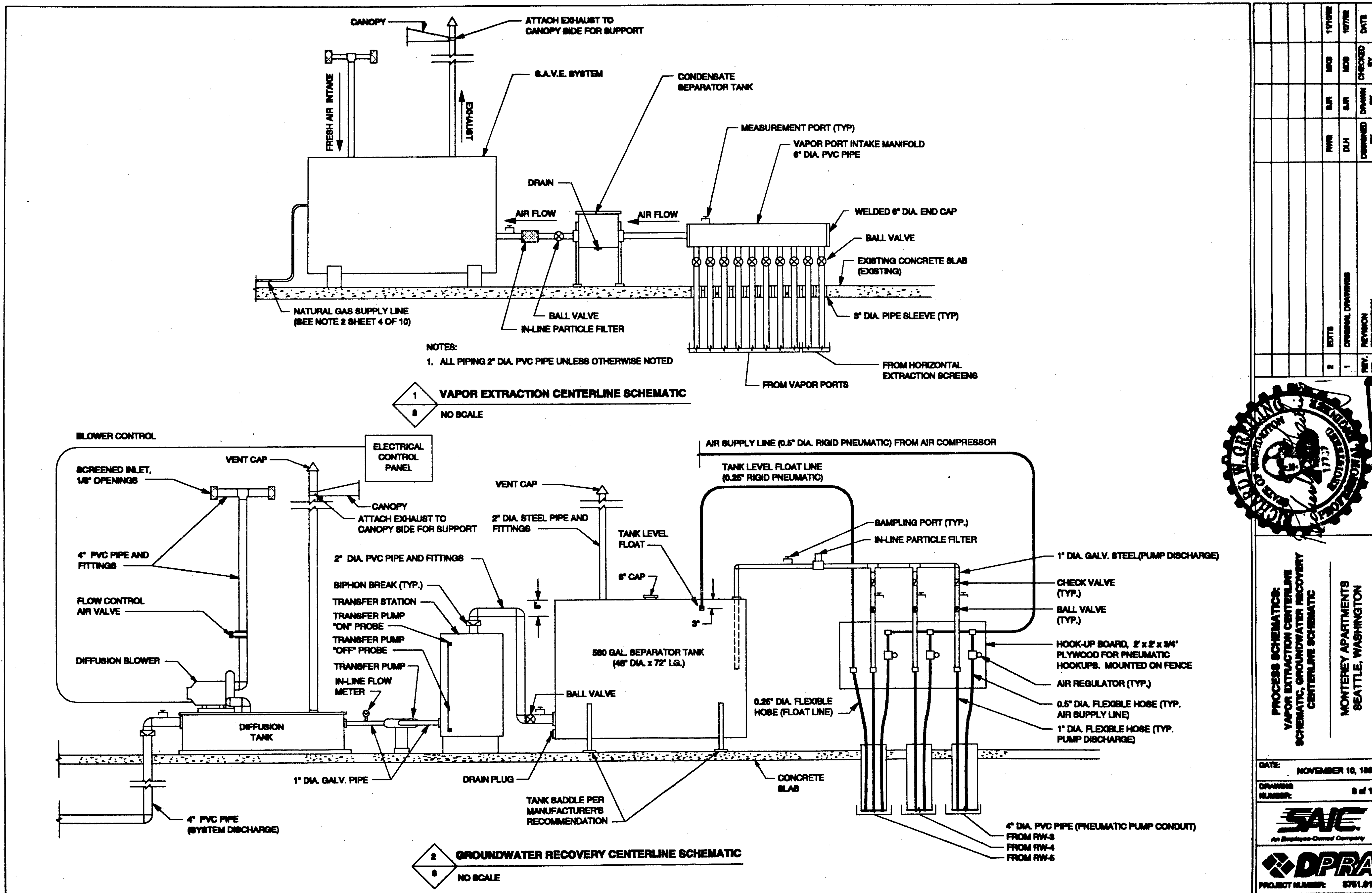
DATE: MARCH 5, 1998

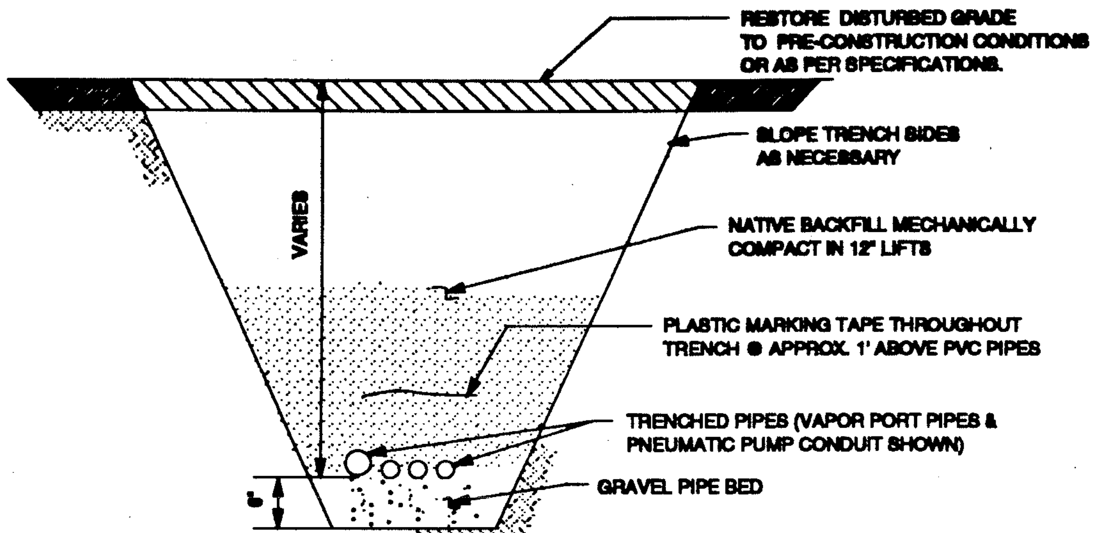
DRAWING NUMBER: 7 of 10

SAIC An Employee-Owned Company

DPRA

PROJECT NUMBER: 3751.013

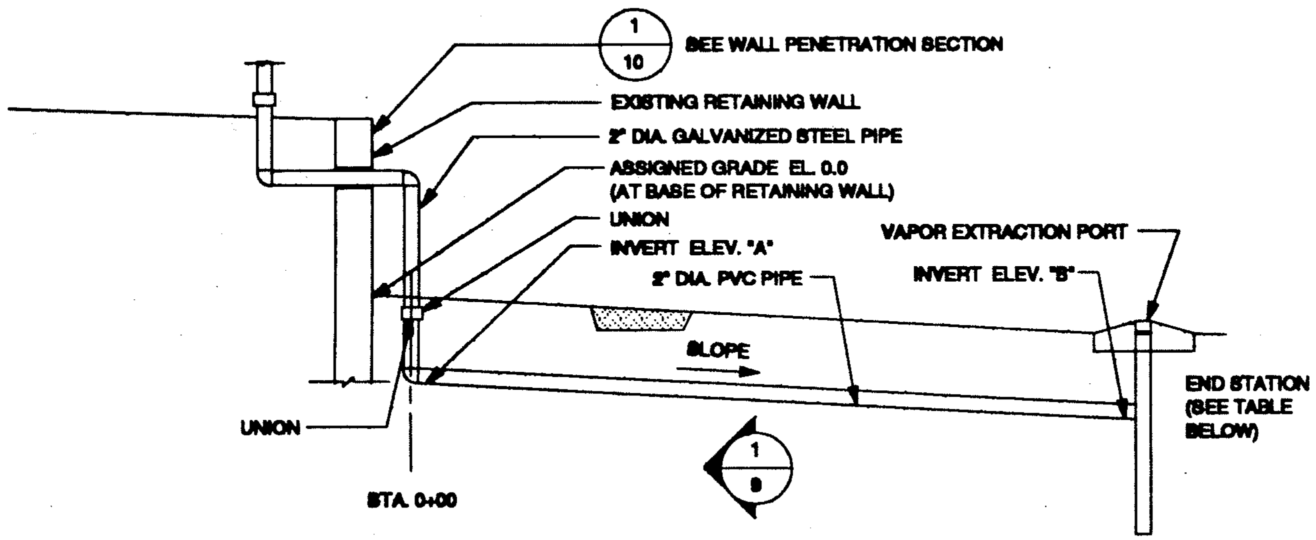

CANOPY
ATTACH EXHAUST TO CANOPY SIDE FOR SUPPORT
FRESH AIR INTAKE
EXHAUST
S.A.V.E. SYSTEM
CONDENSATE SEPARATOR TANK
MEASUREMENT PORT (TYP)
VAPOR PORT INTAKE MANIFOLD 6" DIA. PVC PIPE
DRAIN
AIR FLOW
AIR FLOW
WELDED 6" DIA. END CAP
BALL VALVE
EXISTING CONCRETE SLAB (EXISTING)
NATURAL GAS SUPPLY LINE (SEE NOTE 2 SHEET 4 OF 10)
BALL VALVE
IN-LINE PARTICLE FILTER
3" DIA. PIPE SLEEVE (TYP)
NOTES:
1. ALL PIPING 2" DIA. PVC PIPE UNLESS OTHERWISE NOTED
FROM HORIZONTAL EXTRACTION SCREENS
FROM VAPOR PORTS
1 / 8 VAPOR EXTRACTION CENTERLINE SCHEMATIC
NO SCALE
BLOWER CONTROL
ELECTRICAL CONTROL PANEL
VENT CAP
SCREENED INLET, 1/8" OPENINGS
CANOPY
ATTACH EXHAUST TO CANOPY SIDE FOR SUPPORT
VENT CAP
2" DIA. STEEL PIPE AND FITTINGS
AIR SUPPLY LINE (0.5" DIA. RIGID PNEUMATIC) FROM AIR COMPRESSOR
TANK LEVEL FLOAT LINE (0.25" RIGID PNEUMATIC)
4" PVC PIPE AND FITTINGS
TANK LEVEL FLOAT
SAMPLING PORT (TYP.)
IN-LINE PARTICLE FILTER
2" DIA. PVC PIPE AND FITTINGS
6" CAP
1" DIA. GALV. STEEL(PUMP DISCHARGE)
FLOW CONTROL AIR VALVE
SIPHON BREAK (TYP.)
TRANSFER STATION
CHECK VALVE (TYP.)
TRANSFER PUMP "ON" PROBE
3"
BALL VALVE (TYP.)
TRANSFER PUMP "OFF" PROBE
560 GAL. SEPARATOR TANK (48" DIA. x 72" LG.)
HOOK-UP BOARD, 2' x 2' x 3/4" PLYWOOD FOR PNEUMATIC HOOKUPS. MOUNTED ON FENCE
DIFFUSION BLOWER
TRANSFER PUMP
AIR REGULATOR (TYP.)
IN-LINE FLOW METER
BALL VALVE
0.25" DIA. FLEXIBLE HOSE (FLOAT LINE)
0.5" DIA. FLEXIBLE HOSE (TYP. AIR SUPPLY LINE)
DIFFUSION TANK
1" DIA. FLEXIBLE HOSE (TYP. PUMP DISCHARGE)
1" DIA. GALV. PIPE
DRAIN PLUG
CONCRETE SLAB
TANK SADDLE PER MANUFACTURER'S RECOMMENDATION
4" PVC PIPE (SYSTEM DISCHARGE)
4" DIA. PVC PIPE (PNEUMATIC PUMP CONDUIT)
FROM RW-3
FROM RW-4
FROM RW-5
2 / 8 GROUNDWATER RECOVERY CENTERLINE SCHEMATIC
NO SCALE
PROCESS SCHEMATIC: VAPOR EXTRACTION CENTERLINE SCHEMATIC, GROUNDWATER RECOVERY CENTERLINE SCHEMATIC
MONTEREY APARTMENTS SEATTLE, WASHINGTON
DATE: NOVEMBER 10, 1992
DRAWING NUMBER: 8 of 10
SAIC An Employee-Owned Company
DPRA
PROJECT NUMBER: 3751.013
ORIGINAL DRAWINGS
EDITS
REV. NO.
REVISION DESCRIPTION
DESIGNED BY
DRAWN BY
CHECKED BY
DATE



NOTES:

1. CONTRACTOR MAY CONSOLIDATE VAPOR EXTRACTION & PNEUMATIC PUMP CONDUIT INTO A SINGLE TRENCH WHERE POSSIBLE.
2. CONTRACTOR MAY ALTER TRENCHING ALIGNMENT FROM THAT SHOWN ON PLANS. ALTERATIONS FROM PLANS MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.

1/9 **SECTION: TRENCH (TYPICAL)**
NO SCALE

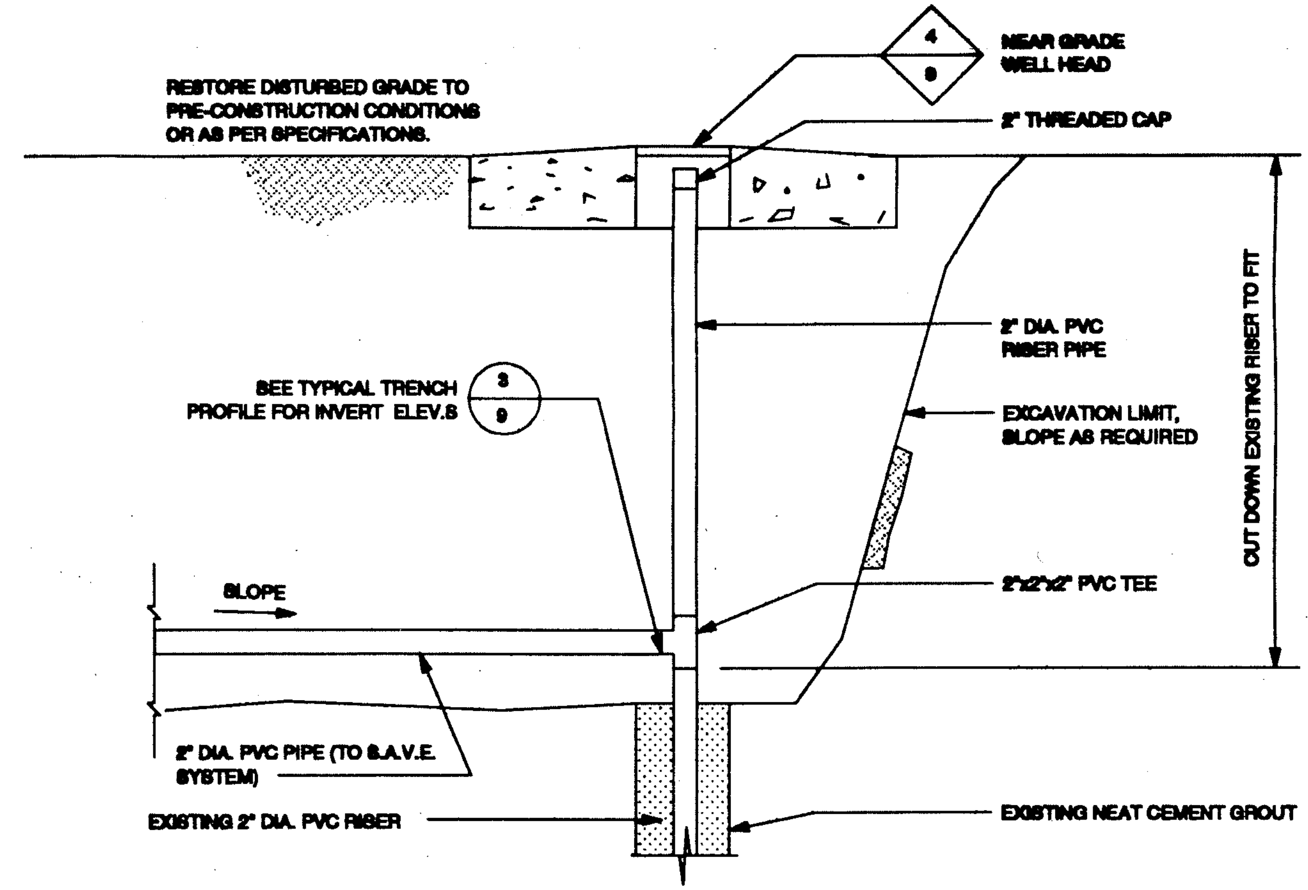


PORT	INVERT ELEV. "A"	INVERT ELEV. "B"	END STATION	APPROX. SLOPE
VP-1	-2.5	-3.5	0+86	1.1%
VP-2	-2.5	-3.5	0+44	2.2%
VP-3	-2.5	-3.5	0+70	1.4%
VP-4	-2.5	-3.5	0+90	1.1%
VP-5	-2.5	-3.5	1+22	0.8%
VP-6	-2.5	-3.5	1+44	0.7%
VP-7	-2.5	-3.5	1+77	0.6%
VP-8	-2.5	-3.5	0+68	1.4%

NOTE:

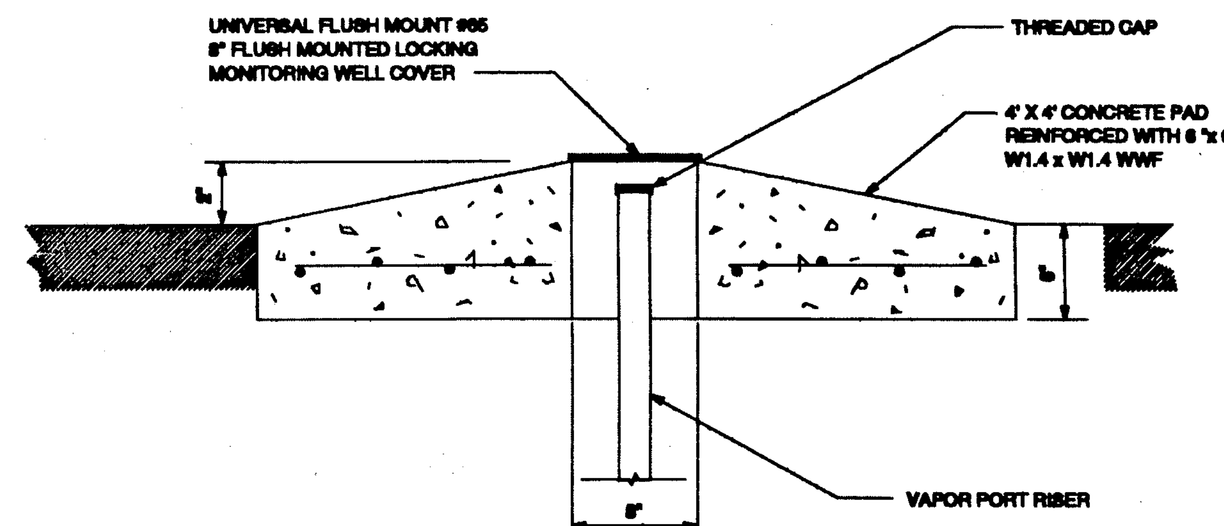
1. INVERT ELEVATIONS RELATIVE TO ASSIGNED GRADE ELEVATION.
2. THE PIPING FOR VAPOR PORT VP-8 DOES NOT EXTEND THROUGH RETAINING WALL.
3. RESTORE DISTURBED GRADE TO PRE-CONSTRUCTION CONDITIONS OR AS PER SPECIFICATIONS.

3/9 **PROFILE: TRENCH (TYPICAL)**
NO SCALE



2/9 **DETAIL: VAPOR PORT CONNECTION**

12" 6" 0 1'
SCALE



4/9 **DETAIL: NEAR GRADE WELL HEAD**

12" 6" 0 1'
SCALE

REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
1	ORIGINAL DRAWINGS	DLH	SJR	MDS	10/7/92
2	EDITS	RWG	SJR	MRG	11/16/92

RICHARD W. GREALING — STATE OF WASHINGTON — 17737 — REGISTERED PROFESSIONAL ENGINEER
EXPIRES 3/29/94

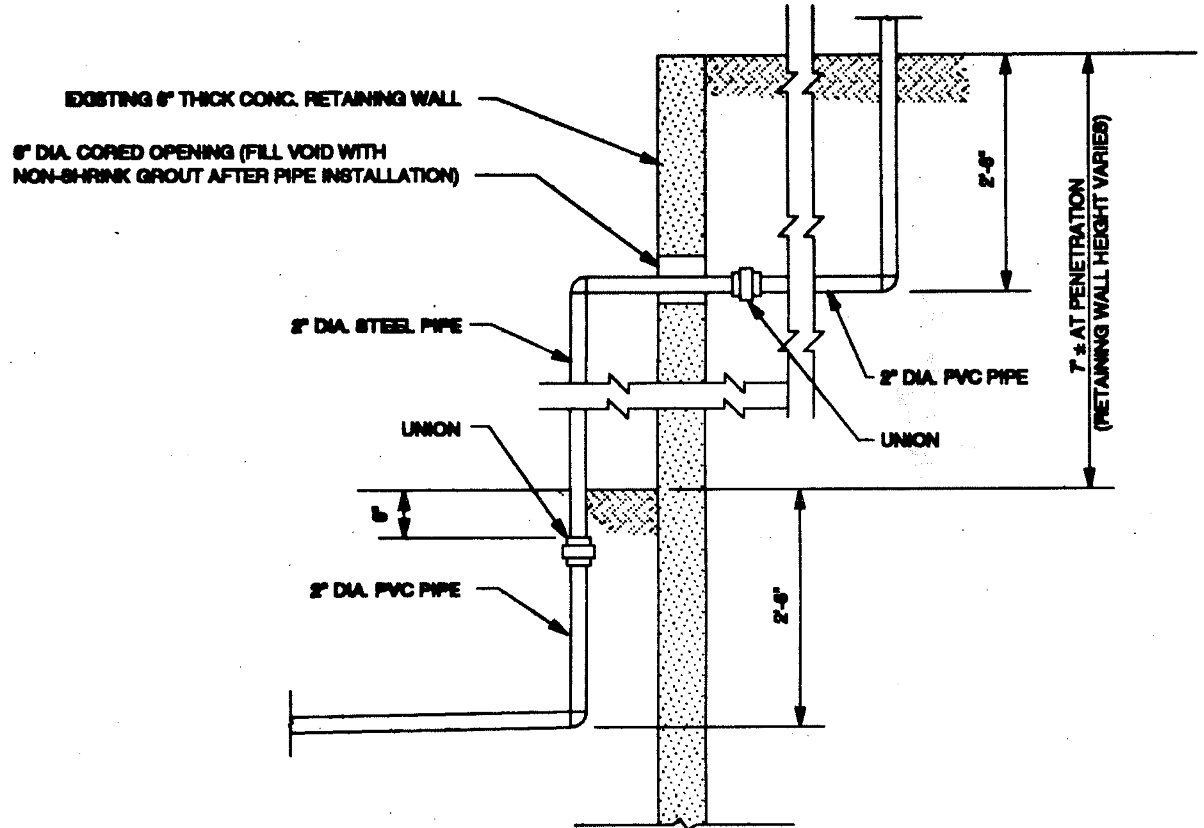
DETAILS
NEAR GRADE WELL HEAD, TYPICAL TRENCH SECTION, TYPICAL TRENCH PROFILE AND VAPOR PORT CONNECTION

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

DATE: NOVEMBER 10, 1992
DRAWING NUMBER: 9 of 10

SAIC
An Employee-Owned Company

DPRA
PROJECT NUMBER: 8761.016

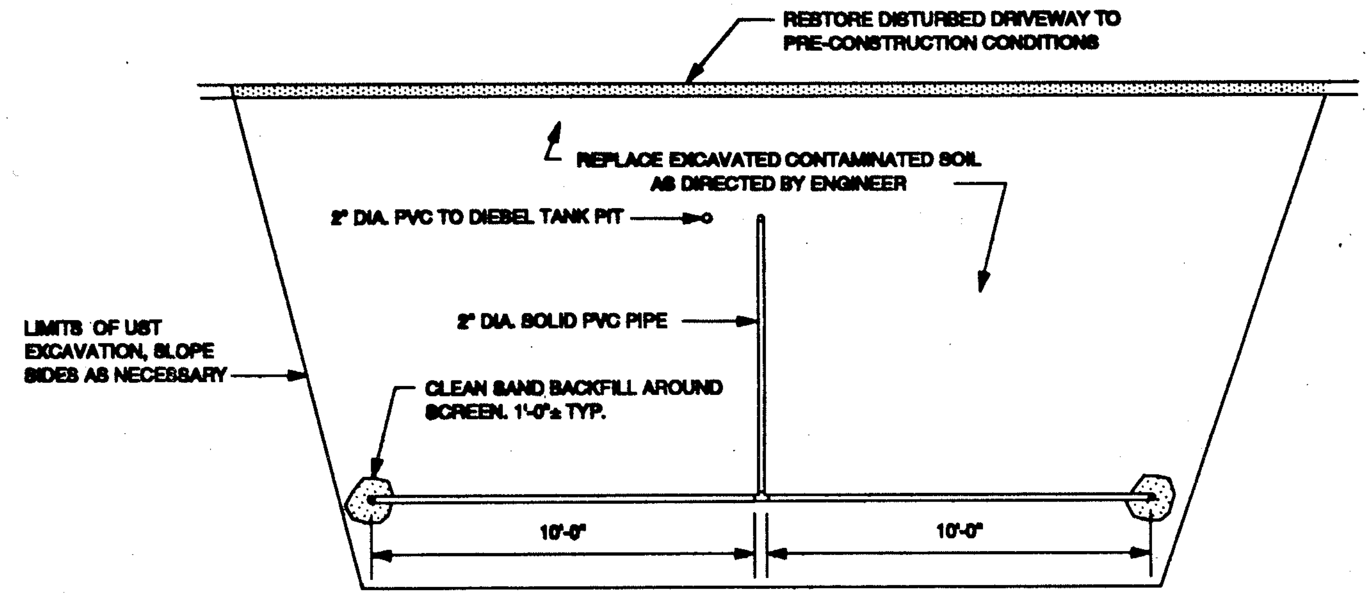


NOTES:

1. NOTIFY LOCAL UTILITY OPERATORS TO VERIFY UTILITY LOCATIONS BEFORE BEGINNING ANY SUBSURFACE CONSTRUCTION.
2. VAPOR EXTRACTION PIPING SHOWN. GROUNDWATER RECOVERY PIPING AND SYSTEM DISCHARGE PIPING WALL PENETRATIONS WILL BE SIMILAR.
3. CONTRACTOR IS RESPONSIBLE FOR PIPING ROUTE BETWEEN RETAINING WALL AND SYSTEM HOOK-UP.

1/10 **SECTION: TYP. RETAINING WALL PENETRATION**

12" 6" 0 1' 2'
SCALE



2/10 **SECTION: HORIZONTAL VES SYSTEM**

0 5' 10'
SCALE IN FEET

REV. NO.	REVISION DESCRIPTION	DESIGNED BY	DRAWN BY	CHECKED BY	DATE
2	EDITS	RWG	SJR	MDB	11/10/92
1	ORIGINAL DRAWINGS	DLH	SJR	MDB	10/7/92

SECTIONS:
TYPICAL WALL PENETRATION &
HORIZONTAL VES SYSTEM

MONTEREY APARTMENTS
SEATTLE, WASHINGTON

DATE: NOVEMBER 10, 1992

DRAWING NUMBER: 10 of 10

SAIC
An Employee-Owned Company

DPRA

PROJECT NUMBER: 3751.013

1 View to the southeast of the Manhattan Express Texaco (Express) Service Station.

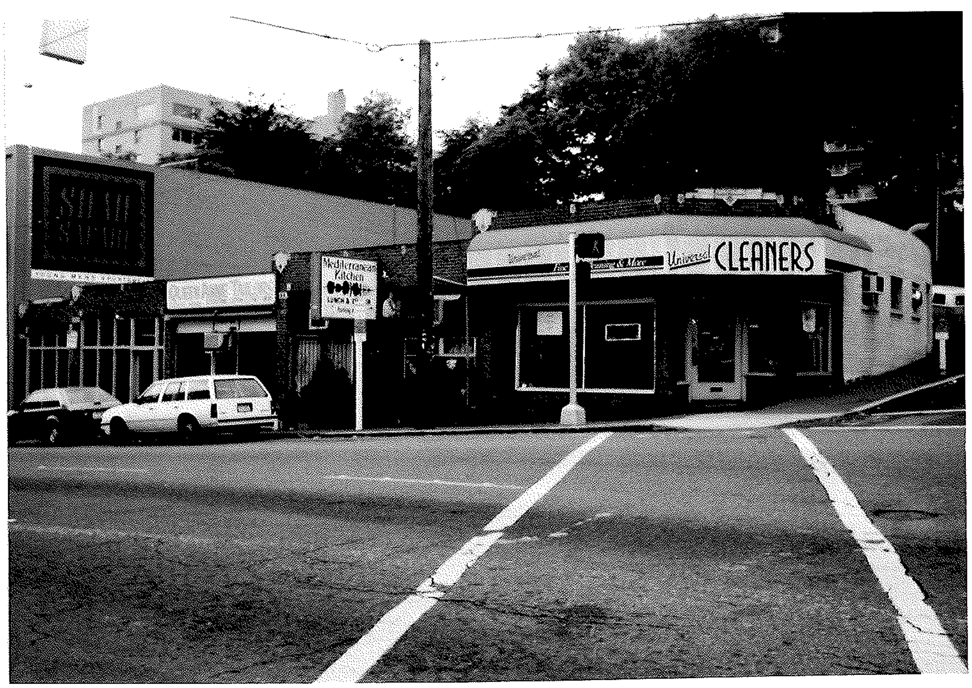
2 View to the west of West Roy Street; the Express station is located in the foreground and the Del Roy apartments in the left background.

3 View to the south of recovery well RW-1 located at the Express station.

4 View to the south of recovery well RW-1 and storage area at the Express station.

5-6 View to the east of the former Unocal Service Station No. 0255.

7 View to the north of Queen Anne Avenue North.



8 View to the north across West Roy Street from the Express station of a dry cleaner, restaurant, and tailor shop.

9 View to the south from the east side of the Express station of Queen Anne Avenue.

10 View to the east of the Monterey Apartment building, located at 622 First Avenue West, Seattle, Washington; the Del Roy Apartments is located to the left.

11 View to the west of the Monterey Apartments parking lot.

12 View to the north of the south side of the Monterey Apartment building.

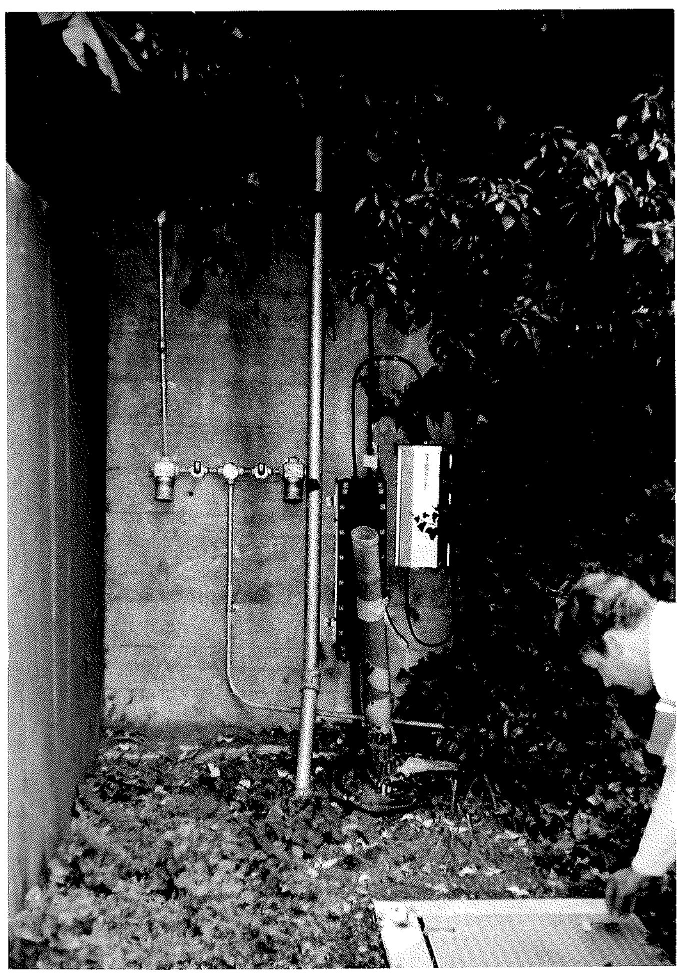
13 View to the north of the east side of the Monterey Apartments property. Monitoring wells MW-7 and MW-2 are located near the corner of the building and recovery well RW-2 is located in the background of the picture, behind the chain link fence.

14 Vent line from former recovery system located on the southeast corner of the Monterey Apartment building.

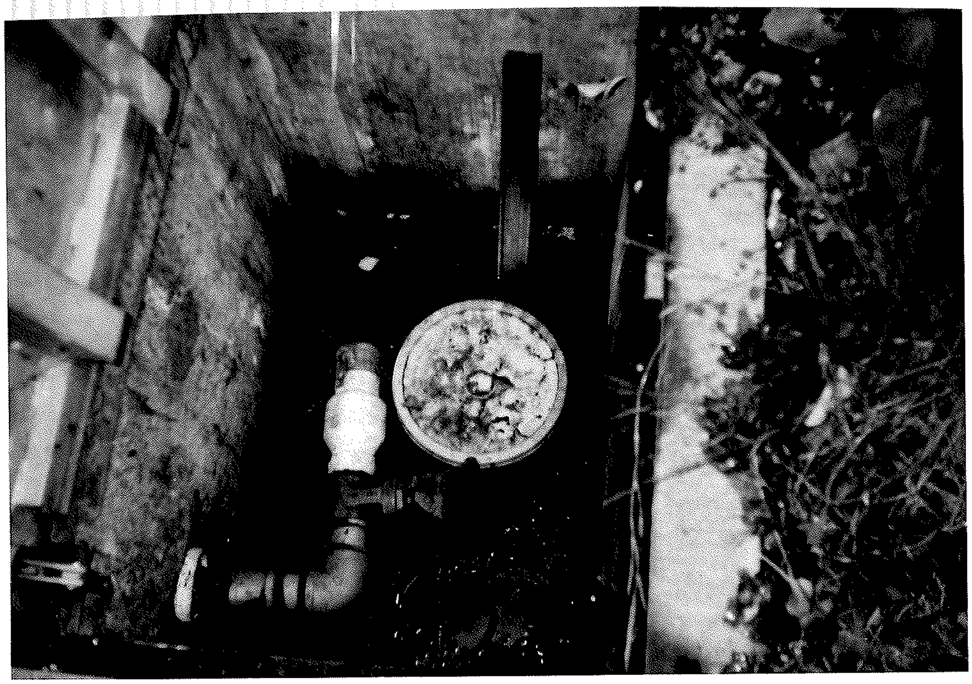
15 The white PVC pipe on the side of the building is the effluent line from the former recovery system. These pipes are located on the east side of the Monterey Apartments property.

16 View to the north of the east side of the Monterey Apartments property.

17 View to the north of recovery well RW-2.



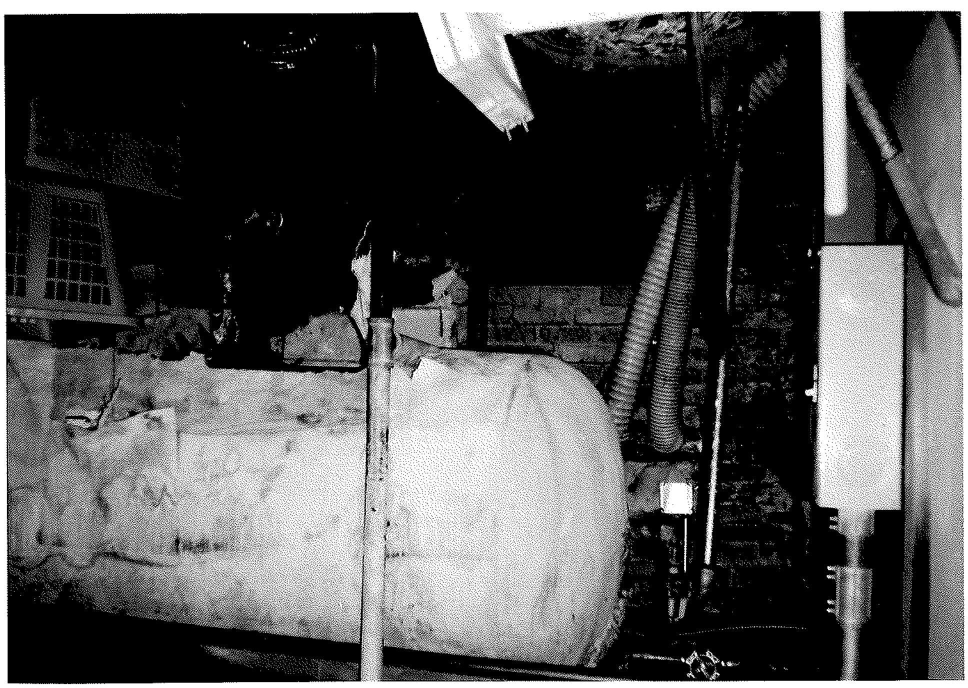
18 View to the east of remnants of the former recovery system near recovery well RW-2.



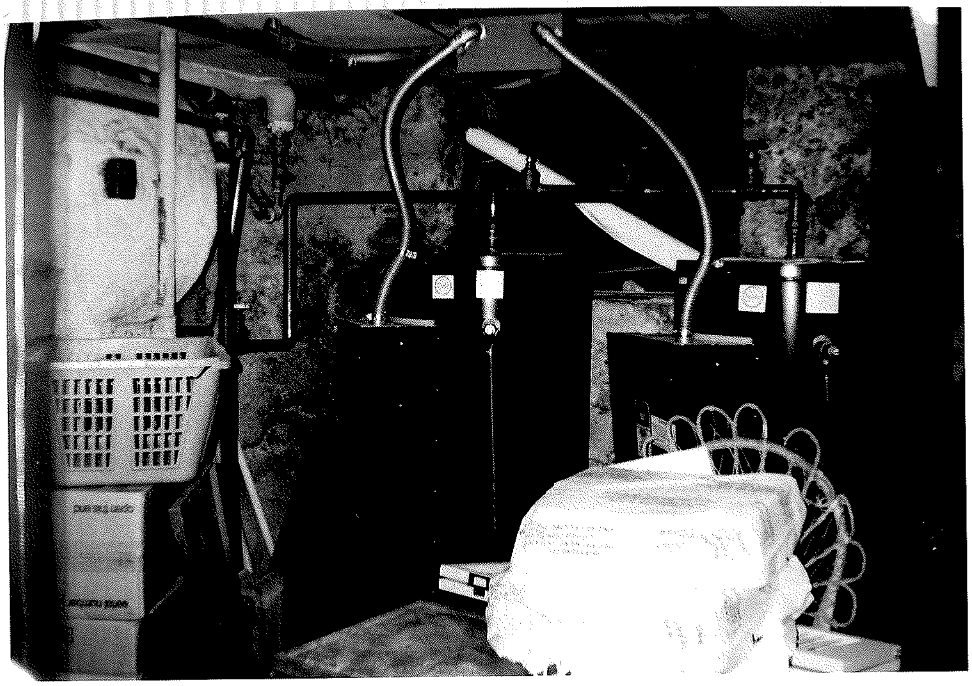
19 Close-up of recovery well RW-2.

20 View to the west of basement hallway of the Monterey Apartments.

21 View to the north of the laundry room located in the east end of the basement of the Monterey Apartments. Note: the sump is located just outside the laundry room door in the background of the photograph.



22 View to the north of the storage room located east of the laundry room in the basement of the Monterey Apartments.

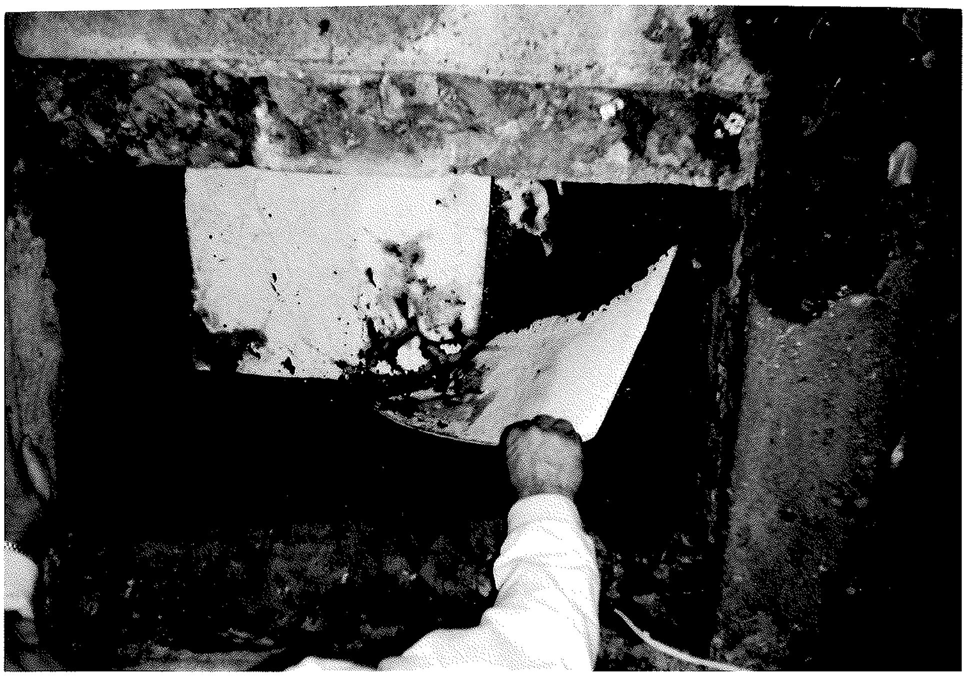


23 View to the east of the storage room located east of the laundry room in the basement of the Monterey Apartments.

24 View to the east of the storage room located east of the laundry room in the basement of the Monterey Apartments.

25 View to the west of a walkway on the east side of the Monterey Apartments. The sump is located beneath the red-colored plywood located at the base of the stairs, just outside the laundry room.

26 Close-up of the sump; note the absorbent pad.



27 Close-up of the sump; note the absorbent pad.

28 View to the east of the Monterey Apartments parking lot located on the south side of the building.

29 View to the north of the Del Roy Apartments on the left of the photograph and the Monterey Apartments on the right.

30 View to the southeast of the Del Roy Apartment building.

31 View to the south down First Avenue West of the Del Roy and Monterey Apartments.

32 View to the northeast of the Del Roy Apartments.

33 View to the east down West Roy Street of the Del Roy Apartments.

34 View to the south of the basement hallway of the Del Roy Apartments.

35 View to the north of the basement hallway of the Del Roy Apartments. Note the door to the crawl space located at the top of the stairs.

36 Close-up of the door to the crawl space.

37 View to the north of the crawl space of the Del Roy Apartments.

38 View to the north of the landing outside of the basement door on the south end of the Del Roy Apartments. Note the Monterey Apartments in the background.

39 View to the north of the landing outside of the basement door on the south end of the Del Roy Apartments. Note the Monterey Apartments in the background.